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# ENCYCLOPÆDIA BRITANNICA

# THE NEW VOLUMES

OF THE

# ENCYCLOPÆDIA BRITANNICA

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# ENCYCLOPÆDIA BRITANNICA.

## VOLUME XXVII (CHICAGO—ELDUAYEN).

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# PREFATORY ESSAY.

## THE INFLUENCE OF MODERN RESEARCH ON THE SCOPE OF WORLD-HISTORY.

**By Henry Smith Williams, M.D., B.Sc.**

WHEN Queen Victoria came to the throne, the year 4004 B.C. was accepted, in all sobriety, as the date of the creation of the world. Perhaps no single statement could more vividly emphasize the change in the point of view from which scholars regard the chronology of ancient history than the citation of this indisputable fact. To-day, though Bibles are still printed with the year 4004 B.C. in the margin of the first chapter of Genesis, no scholar would pretend to regard this reference seriously. On the contrary, the scholarship of to-day regards the fifth millennium B.C. as well within the historical period for such nations as the Egyptians and the Babylonians. It has come to be fully accepted, that when we use such a phrase as "the age of the world" we are dealing with a period that must be measured not in thousands but in millions of years; and that to the age of man must be allotted a period some hundreds of times as great as the five thousand and odd years allowed by the old chronologists. This changed point of view, needless to say, has not been reached without ardent and even bitter controversy. Yet the transformation is unequivocal; and the revised conception no longer seems to connote the theological implications that were at first ascribed to it. It has now become obvious that the data afforded by the Hebrew writings should never have been regarded as sufficiently accurate for the purpose of exact historical computations: that, in short, no historian working along modern scientific lines could well have made the mistake of supposing that the genealogical lists of the Pentateuch afforded an adequate chronology of world-history. But it should not be forgotten that to many generations of close scholarship these genealogical lists seemed to convey such knowledge in the most precise terms, and that at so recent a date as, for example, the year in which Queen Victoria came to the throne, it was nothing less than a rank heresy to question the historical accuracy and finality of chronologies which had no other source or foundation.

This changed point of view regarding the chronology of history may without hesitation be ascribed to the influence of evidence obtained in a single field of inquiry, the field, namely, of Archæology. No doubt the evidence as to the age of the earth and as to the antiquity of man was gathered by a class of workers not formally included in the ranks of the archæologist: workers commonly spoken of as palæontologists, anthropologists, ethnologists, and the like. But the distinction scarcely covers a real difference. The scope of the archæologist's studies must include every department of the ancient history of man as preserved in antiquities of whatever character, be they tumuli along the Baltic, fossil skulls and graven

bones from the caves of France, the flint implements, pottery, and mummies of Egypt, tablets and bas-reliefs from Mesopotamia, coins and sculptures of Greece and Rome, or inscriptions, waxen tablets, parchment rolls, and papyri of a relatively late period of classical antiquity.

If at one time the monuments of Greece and Rome claimed the almost undisputed attention of the archæologist, that time has long since passed. For the most important historical records that have come to us in recent decades we have to thank the Orientalist, though the classical explorer has been by no means idle. It is the purpose of the present essay to point out in general terms the import of the message of archæological discovery in the Victorian Era in its bearings upon the great problems of world-history. Perhaps this purpose may be best attained if we take up these problems one after another, contrasting in each case the old point of view with the new, and briefly outlining the evidence on which the present decision rests. This, of course, is not the place for details as to the archæological discoveries involved. Here we have to do with only such discoveries as have led to broad historical generalizations regarding such subjects as the Antiquity of Man, the Antiquity of Culture, the Chronology of Ancient History, the Status of Bible History, the Credibility of Early Classical History, the Origin and Development of the Art of Writing, and the Evolution of the Fine Arts.

*The Antiquity of Man, the Antiquity of Civilization, and the Chronology of Ancient History.*

With regard to the changed conception as to the age of the earth, it is necessary to recall that this came about through the efforts of the palæontologists and geologists, with only indirect or incidental aid from the archæologists. The reform movement began actively with James Hutton in the later years of the 18th century, and was forwarded by the studies of William Smith in England and of Cuvier in France; but the really efficient champion of the conception that the earth is very old was Sir Charles Lyell, who published the first edition of his epoch-making *Principles of Geology* only a few years before Queen Victoria came to the throne. Lyell demonstrated to the satisfaction, or—perhaps it should rather be said—to the dissatisfaction, of his contemporaries that the story of the geological ages as recorded in the strata of the earth becomes intelligible only when vast stretches of time are presupposed. Of course the demonstration was not accepted at once. On the contrary, the champions of the tradition that the earth was less than six thousand years old held their ground most tenaciously, and the earlier years of the Victorian Era were years of bitter controversy. The result of the contest was never in doubt, however, for the geological evidence, once it had been gathered, was unequivocal; and by about the middle of the century it was pretty generally admitted that the age of the earth must be measured by an utterly different standard from that hitherto in vogue. This concession, however, by no means implied a like change of view regarding the age of man. A fresh volume of evidence required to be gathered, and a new controversy to be waged, before the old data for the creation of man could be abandoned. Lyell again was in the forefront of the progressive movement, and his work on *The Antiquity of Man*, published in 1863, gave currency for the first time to the new opinions. The evidence upon which these opinions were based had been gathered by such anthropologists as Schmerling, Boucher de Perthes, and others, and it had to do chiefly with the finding of implements of human construction associated with the remains of extinct animals in the beds of caves, and with the recovery of similar antiquities from alluvial deposits the great age of which was demonstrated by their depth. Every item of the evidence was naturally subjected to the closest scrutiny, but at last the conservatives were forced reluctantly to confess themselves beaten. Their traditional arguments were powerless before the array of data marshalled by the new science of prehistoric archæology. Looking back even at the short remove of a single generation, it is difficult to appreciate how revolutionary was the conception of the antiquity of man thus inculcated. It rudely shocked the traditional attitude of scholarship towards the history of our race. It disturbed the most cherished traditions and the most sacred themes. It seemed to threaten the very foundations of religion itself. Yet the present generation accepts the antiquity of man as a mere matter of fact. Here, as so often elsewhere, the heresy of an elder day has come to seem almost an axiomatic truth.

This is not the place to suggest, even in the roughest outline, the social, ethical, and religious implications that were bound inseparably with the revolutionary conception as to man's creation. It may not be amiss to add, however, that in establishing the broad fact of man's antiquity, prehistoric archæology as yet falls short of the power to estimate, even roughly, in terms of years the periods with which it deals; and history, in the narrower sense, can hardly be said to exist without chronology. On the other hand, some of the most remarkable advances for which the historian must thank the archæologist have to do with the chronology of the early periods of Oriental history. Indeed, the greatest feat of the archæologist has been the opening up to our observation, and the bringing within the scope of the historian, of long periods which, without his aid, must still have belonged to the vague realms of the prehistoric.

If we go back in imagination to the beginning of the Victorian Era and ask what was then known of the history of Ancient Egypt, Mesopotamia, and Asia Minor, we find ourselves confronted with a startling paucity of knowledge. The key to the mysteries of Egyptian history had indeed been found, thanks to the recent efforts of Thomas Young and Champollion, but the deciphering of inscriptions had not yet progressed far enough to give more than a vague inkling of what was to follow. It remained, then, virtually true, as it had been for two thousand years, that for all that we could learn of the history of the Old Orient in pre-classical days, we must go solely to the pages of the Bible and to a few classical authors, notably Herodotus and Diodorus. A comparatively few pages summed up, in language often vague and mystical, all that the modern world had been permitted to remember of the history of the greatest nations of antiquity. To these nations the classical writers had ascribed a traditional importance, the glamour of which still lighted their names, albeit revealing them in the vague twilight of tradition rather than in the clear light of history. It would have been a bold, not to say a reckless, dreamer who dared predict that any future researches could restore to us the lost knowledge that had been forgotten for more than two millenniums. Yet the Victorian Era was scarcely ushered in before the work of rehabilitation began, which was to lead to the most astounding discoveries and to an altogether unprecedented extension of historical knowledge. Early in the 'forties the Frenchman Botta, quickly followed by Sir Henry Layard, began making excavations on the site of ancient Nineveh, the name and fame of which were a tradition having scarcely more than mythical status. The spade of the discoverer soon showed that all the fabled glories of the ancient Assyrian capital were founded on realities, and evidence was afforded of a state of civilization and culture such as few men supposed to have existed on the earth before the Golden Age of Greece. Not merely were artistic sculptures and bas-reliefs found that demonstrated a high development of artistic genius, but great libraries were soon revealed,—books consisting of bricks of various sizes, or of cylinders of the same material, inscribed while in the state of clay with curious characters, which became indelible when baking transformed the clay into brick. No one was able to guess, even in the vaguest way, the exact interpretation of these odd characters; but, on the other hand, no one could doubt that they constituted a system of writing, and that the piles of inscribed tablets were veritable books. There were numerous sceptics, however, who did not hesitate to assert that the import of the message so obviously locked in these curious inscriptions must for ever remain an absolute mystery. Here, it was said, were inscriptions written in an unknown character and in a language that for at least two thousand years had been absolutely forgotten. In such circumstances nothing less than a miracle could enable human ingenuity to fathom the secret. Yet the feat pronounced impossible by mid-century scepticism was accomplished by contemporary scholarship, amidst the clamour of opposition and incredulity. Its success contains at once a warning to those doubters who are always crying out that we have reached the limitations of knowledge, and an encouragement and stimulus to would-be explorers of new intellectual realms.

In a few words the manner of the discovery was this. It appears at a glance that the Assyrian written character consists of groups of horizontal, vertical, or oblique strokes. The characters thus composed, though so simple as to their basal unit, are appallingly complex in their elaboration. The Assyrians, with all their culture, never attained the stage of analysis which demonstrates that only a few fundamental

sounds are involved in human speech, and hence that it is possible to express all the niceties of utterance with an alphabet of little more than a score of letters. Halting just short of this analysis, the Assyrian ascribed syllabic values to the characters of his script, and hence, instead of finding twenty odd characters sufficient, he required about five hundred. There was a further complication in that each one of these characters had at least two different phonetic values; and there were other intricacies of usage which, had they been foreknown by inquirers in the middle of the 19th century, might well have made the problem of decipherment seem an utterly hopeless one.

Fortunately it chanced that another people, the Persians, had adopted the Assyrian wedge-shaped stroke as the foundation of a written character, but, making that analysis of which the Assyrians had fallen short, had borrowed only so many characters as were necessary to represent the alphabetical sounds. This made the problem of deciphering Persian inscriptions a relatively easy one. In point of fact this problem had been partially solved in the early days of the 19th century, thanks to the sagacious guesses of the German philologist Grotefend. Working with some inscriptions from Persepolis which were found to contain references to Darius and Xerxes, Grotefend had established the phonetic values of certain of the Persian characters, and his successors were perfecting the discovery just about the time when the new Assyrian finds were made. It chanced that there existed on the polished surface of a cliff at Behistun in Western Persia a tri-lingual inscription which, according to Diodorus, had been made by Queen Semiramis of Nineveh, but which, as is now known, was really the work of King Darius. One of the languages of this inscription was Persian; another, as it now appeared, was Assyrian, the language of the newly discovered books from the libraries of Nineveh. There was reason to suppose that the inscriptions were identical in meaning; and fortunately it proved, when the inscriptions were made accessible to investigation through the efforts of Sir Henry Rawlinson, that the Persian inscription contained a large number of proper names. It was well known that proper names are usually transcribed from one language into another with a tolerably close retention of their original sounds. For example, the Greek names *Ptolemaios* and *Kleopatra* became a part of the Egyptian language and appeared regularly in Egyptian inscriptions after Alexander's general became King of Egypt. Similarly, the Greek names *Kyros*, *Darios*, and *Xerxes* were as close an imitation as practicable of the native names of these Persian monarchs. Assuming, then, that the proper names found in the Persian portion of the Behistun inscription occurred also in the Assyrian portion, retaining virtually the same sound in each, a clue to the phonetic values of a large number of the Assyrian characters was obviously at hand. Phonetic values known, Assyrian was found to be a Semitic language cognate to Hebrew.

These clues were followed up by a considerable number of investigators, with Sir Henry Rawlinson in the van. Thanks to their efforts, the new science of Assyriology came into being, and before long the message of the Assyrian books had ceased to be an enigma. Of course this work was not accomplished in a day or in a year, but, considering the difficulties to be overcome, it was carried forward with marvellous expedition. In 1857 the new scholarship was put to a famous test, in which the challenge thrown down by Sir George Cornewall Lewis and Ernest Renan was met by Rawlinson, Hincks, Oppert, and Fox Talbot in a conclusive manner. The sceptics had declared that the new science of Assyriology was itself a myth: that the investigators, self-deceived, had in reality only invented a language, and read into the Assyrian inscriptions something utterly alien to the minds of the Assyrians themselves. But when a committee of the Royal Asiatic Society, with George Grote at its head, decided that the translations of an Assyrian text made independently by the scholars just named were at once perfectly intelligible and closely in accord with one another, scepticism was silenced, and the new science was admitted to have made good its claims.

Naturally the early investigators did not fathom all the niceties of the language, and the work of grammatical investigation has gone on continuously under the auspices of a constantly growing band of workers. Doubtless much still remains to be done; but the essential thing, from the present standpoint, is that a sufficient knowledge of the Assyrian language has been acquired to ensure trustworthy translations of

the cuneiform texts. Meanwhile, the material found by Botta and Layard, and other successors, in the ruins of Nineveh has been constantly augmented through the efforts of companies of other investigators, and not merely Assyrian, but much earlier Babylonian and Chaldæan texts in the greatest profusion have been brought to the various museums of Europe and America. The study of these different inscriptions has utterly revolutionized our knowledge of Oriental history. Many of the documents are strictly historical in their character, giving full and accurate contemporary accounts of events that occurred some thousands of years ago. Exact dates are fixed for long series of events that previously were quite unknown. Monarchs whose very names had been forgotten are restored to history, and the records of their deeds inscribed under their very eyes are before us,—contemporary documents such as neither Greece nor Rome could boast, nor any other nation, with the single exception of Egypt, until strictly modern times.

There are, no doubt, gaps in the record; there are long periods for which the chronology is still uncertain. Naturally there is an increasing vagueness as one recedes further into the past, and for the earlier history of Chaldæa there is great uncertainty. Nevertheless, the Assyriologist speaks with a good deal of confidence of dates as remote as 3800 B.C., the time ascribed to King Sargon, who was once regarded as a mythical person, but is now known to have been an actual monarch. Indeed, there are tablets in the British Museum labelled 4500 B.C.; and later researches, particularly those of the expedition of the University of Pennsylvania at Nippur, have brought us evidence which, interpreted with the aid of estimates as to the average rate of accumulation of dust deposits, leads to the inference that a high state of civilization had been attained in Mesopotamia at least 9000 years ago.

While the Assyriologists have been making these astonishing revelations, the Egyptologists have not been behindhand. Such scholars as Lepsius, Brugsch, de Rougé, Lenormant, Birch, Mariette, Maspero, and Erman have perfected the studies of Young and Champollion; while at the same time these and a considerable company of other explorers, most notable of whom are Gardner Wilkinson and Professor Flinders Petrie, have brought to light a vast accumulation of new material, much of which has the highest importance from the standpoint of the historian. Lists of kings found on the temple wall at Abydos, in the fragments of the Turin papyrus and elsewhere, have cleared up many doubtful points in the lists of Manetho, and at the same time, as Professor Petrie has pointed out, have proved to us how true a historian that much-discussed writer was. Manetho, it will be recalled, was the Egyptian who wrote the history of Egypt in Greek in the time of the Ptolemies. His work in the original unfortunately perished, and all that we know of it we learn through excerpts made by a few later classical writers. These fragments have until recently, however, given us our only clue to the earlier periods of Egyptian history. Until corroboration was found in the Egyptian inscriptions themselves, not only were Manetho's lists in doubt, but scepticism had been carried to the point of denying that Manetho himself had ever existed. This is only one of many cases where the investigations of the archæologist have proved not iconoclastic but reconstructive, tending to restore confidence in classical traditions which the scientific historians of the age of Niebuhr and George Cornewall Lewis regarded with scepticism.

As to the exact dates of early Egyptian history there is rather more of vagueness than for the corresponding periods of Mesopotamia. Indeed, approximate accuracy is not attained until we are within sixteen hundred years of our own era; but the sequence of events of a period preceding this by two thousand years is well established, and the recent discoveries of Professor Petrie carry back the record to a period which cannot well be less than five thousand, perhaps not less than six thousand years B.C. Both from Egypt and Mesopotamia, then, the records of the archæologist have brought us evidence of the existence of a highly developed civilization for a period exceeding by hundreds, perhaps by thousands, of years the term which had hitherto been considered the full period of man's existence.

We may note at once how these new figures disturb the historical balance. If our forerunners of eight or nine thousand years ago were in a noonday glare of civilization, where shall we look for the

much-talked-of "dawnings of history"? By this new standard the Romans seem our contemporaries in latter-day civilization; the "Golden Age" of Greece is but of yesterday; the pyramid-builders are only relatively remote. The men who built the temple of Bel at Nippur, in the year (say) 5000 B.C., must have felt themselves at a pinnacle of civilization and culture. As Professor Mahaffy has suggested, the era of the Pyramids may have been the veritable autumn of civilization. Where, then, must we look for its springtime? The answer to that question must come, if it come at all, from what we now speak of as prehistoric archæology; the monuments from Memphis and Nippur and Nineveh, covering a mere ten thousand years or so, are records of recent history.

*Archæology and Bible History.*

The efforts of the students of Oriental archæology have been constantly stimulated by the fact that their studies brought them more or less within the field of Bible history. A fair proportion of the workers who have delved so enthusiastically in the fields of Egyptian and Assyrian exploration would never have taken up the work at all but for the hope that their investigations might substantiate the Hebrew records. For a long time this hope proved illusory, and in the case of Egyptian archæology the results have proved disappointing even up to the very present. Considering the important part played by the Egyptian sojourn of the Hebrews, as narrated in the Scriptures, it was certainly not an over-enthusiastic prediction that the Egyptian monuments when fully investigated would divulge important references to Joseph, to Moses, and to the all-important incidents of the Exodus; but half a century of expectant attention in this direction has led only to disappointment. It would be rash, considering the buried treasures that may yet await the future explorer, to assert that such records as those in question can never come to light. But, considering the fulness of the contemporary Egyptian records of the XIXth dynasty that are already known, it becomes increasingly doubtful whether the Hebrews in Egypt played so important a part in history, when viewed from the Egyptian standpoint, as their own records had seemed to imply. As the forgotten history of Oriental antiquity has been restored to us, it has come to be understood that, politically speaking, the Hebrews were a relatively insignificant people, whose chief importance from the standpoint of material history was derived from the geographical accident that made them a sort of buffer between the greater nations about them. Only once, and for a brief period, in the reigns of David and Solomon did the Hebrews rise to anything like an equal plane of political importance with their immediate neighbours. What gave them a seeming importance in the eyes of posterity was the fact that the true history of the Egyptians, Mesopotamians, Arabians, and Hittites had been well-nigh forgotten. The various literatures of these nations were locked from view for more than two thousand years, while the literature of Israel had not merely been preserved, but had come to be regarded as inspired and sacred among all the cultured nations of the Western world. Now that the lost literatures have been restored to us, the status of the Hebrew writings could not fail to be disturbed. Their very isolation had in some measure accounted for their seeming importance.

All true historical perspective is based upon comparison, and where only a single account has been preserved of any event or of any period of history, it is extremely difficult to judge that account with historical accuracy. An illustration of this truth is furnished in profane history by the account which Thucydides has given us of the Peloponnesian War. For most of the period in question Thucydides is the only source; and despite the inherent merits of a great writer, it can hardly be doubted that the tribute of almost unqualified praise that successive generations of scholars have paid to Thucydides must have been in some measure qualified if, for example, a Spartan account of the Peloponnesian War had been preserved to us. Professor Mahaffy has pointed out that many other events in Greek history are viewed by us in somewhat perverted perspective because the great writers of Greece were Athenians rather than Spartans or Thebans. Even in so important a matter as the great conflict between Persia and Greece it has been suggested more than once that we should be able to gain a much truer view were Persian as well as Greek accounts accessible.

Not many years ago it would have been accounted a heresy to suggest that the historical books of the Old Testament had conveyed to our minds estimates of Oriental history that suffered from this same defect; but to-day no one who is competent to speak with authority pretends to doubt that such is really the fact. Even conservative students of the Bible urge that its historical passages must be viewed precisely in the light of any other historical writings of antiquity; and the fact that the oldest Hebrew manuscript dates only from the 8th century A.D., and therefore of necessity brings to us the message of antiquity through the fallible medium of many generations of copyists, is far more clearly kept in mind than it formerly was. Every belief of mankind is in the last analysis amenable to reason, and finds its origin in evidence that can appeal to the arbitrament of common sense. This evidence may in certain cases consist chiefly of the fact that generations of our predecessors have taken a certain view regarding a certain question; indeed most of our cherished beliefs have this foundation. But when such is the case, mankind has never failed in the long-run to vindicate its claim to rationality by showing a readiness to give up the old belief whenever tangible evidence of its fallaciousness was forthcoming. The case of the historical books of the Old Testament furnishes no exception. These had been sacred to almost a hundred generations of men, and it was difficult for the eye of faith to see them as other than absolutely infallible documents. Yet the very eagerness with which the champions of the Hebrew records searched for archæological proofs of their validity, was a tacit confession that even the most unwavering faith was not beyond the reach of external evidence. True, the believer sought corroboration with full faith that he would find it; but the very fact that he could think such external corroboration valuable implied, however little he may have realized it, the subconscious concession that he must accept external evidence at its full value, even should it prove contradictory. If, then, an Egyptian inscription of the XIXth dynasty had come to hand in which the names of Joseph and Moses, and the deeds of the Israelites as a subject people who finally escaped from bondage by crossing the Red Sea, were recorded in hieroglyphic characters, such a monument would have been hailed with enthusiastic delight by every champion of the Pentateuch, and a wave of supreme satisfaction would have passed over all Christendom.

It is not too much, then, to say that failure to find such a monument has caused deep disappointment to Bible scholars everywhere. It does not follow that faith in the Bible record is shaken, although in some quarters there has been a pronounced tendency to regard the history of the Egyptian sojourn as mythical; yet it cannot be denied that Egyptian records, corroborating at least some phases of the Bible story, would have been a most welcome addition to our knowledge. Some recent finds have, indeed, seemed to make inferential reference to the Hebrews, and the marvellous collection of letters of the XVIIIth dynasty found at Tel el-Amarna—letters to which we shall refer later—have the utmost importance as proving a possible early date for the Mosaic accounts. But such inferences as these are but a vague return for the labour expended, and an almost cruelly inadequate response to seemingly well-founded expectations.

When we turn to the field of Babylonian and Assyrian archæology, however, the case is very different. Here we have documents in abundance that deal specifically with events more or less referred to in the Bible. The records of kings whose names hitherto were known to us only through Bible references have been found in the ruins of Nineveh and Babylon, and personages hitherto but shadowy now step forth as clearly into the light of history as an Alexander or a Cæsar. Moreover, the newly discovered treasures deal with the beliefs of the people as well as with their history proper. The story of the books now spoken of as the "Creation" and "Deluge" tablets of the Assyrians, in the British Museum, which were discovered in the ruins of Nineveh by Layard and by George Smith, has been familiar to everyone for a good many years. The acute interest which they excited when George Smith deciphered their contents in 1872 has to some extent abated, but this is only because scholars are now pretty generally agreed as to their bearing on the corresponding parts of Genesis. The particular tablets in question date only from about the 7th century B.C., but it is agreed among Assyriologists that they are copies of older texts current in Babylonia for many centuries before, and it is obvious

that the compilers of Genesis had access to the Babylonian stories. In a word, the Hebrew Genesis shows unequivocal evidence of Babylonian origin, but, in the words of Professor Sayce, it is but "a paraphrase and not a translation." However disconcerting such a revelation as this would have been to the theologians of an elder day, the Bible scholars of our own generation are able to regard it with entire composure.

From the standpoint of the historian even greater interest attaches to the records of the Assyrian and Babylonian kings when compared with the historical books of the Old Testament. For some centuries the inhabitants of Palestine were subject to periodical attacks from the warlike inhabitants of Mesopotamia, as even the most casual reader of the Bible is aware. When it became known that the accounts of these invasions formed a part of the records preserved in the Assyrian libraries, historian and theologian alike waited with breathless interest for the exact revelations in store; and this time expectation was not disappointed. As, one after another, the various tablets and cylinders and annalistic tablets have been translated, it has become increasingly clear that here are almost inexhaustible fountains of knowledge, and that sooner or later it may be possible to check the Hebrew accounts of the most important periods of their history with contemporaneous accounts written from another point of view. It is true that the cases are not very numerous where precisely the same event is described from opposite points of view, but, speaking in general terms rather than of specific incidents, we are already able to subject considerable portions of history to this test.

The records of Shalmaneser II., Tiglath-Pileser III., and Sennacherib, kings of Assyria, of Nebuchadrezzar, king of Babylon, and of Cyrus, king of Persia, all contain direct references to Hebrew history. An obelisk of Shalmaneser II. contains explicit reference to the tribute of Jehu of Samaria, and graphically depicts the Hebrew captives. Tiglath-Pileser III., a usurper who came to the throne of Assyria in 745 B.C., and whose earlier name of Pul proved a source of confusion to the later Hebrew writers, left records that have served to clear up the puzzling chronology of a considerable period of the history of Samaria. Most interesting of all, perhaps, are the annals of Sennacherib, the destruction of whose hosts by the angel of God is so strikingly depicted in the Book of Kings. The court historian of Sennacherib naturally does not dwell upon this event, but he does tell of an invasion and conquest of Palestine. The Hebrew account of the death of Sennacherib is corroborated by a Babylonian inscription. Here, however, there is an interesting qualification. The account in the Book of Kings is so phrased that one might naturally infer from it that Sennacherib was assassinated by his sons immediately after his return from the disastrous campaign in Palestine; but in point of fact, as it now appears, the Assyrian king survived that campaign by twenty years. One cannot avoid the suspicion that in this instance the Hebrew chronicler purposely phrased his account to convey the impression that Sennacherib's tragic end was but the slightly delayed culmination of the punishment inflicted for his attack upon the "chosen people." On the other hand, the ambiguity may be quite unintentional, for the Hebrew writers were notoriously lacking in the true historical sense, which shows itself in a full appreciation of the value of chronology.

One of the most striking instances of the way in which mistakes of chronology may lead to the perversion of historical records is shown in the Book of Daniel in connexion with the familiar account of the capture of Babylon by Cyrus. Within the past generation records of Cyrus have been brought to light, as well as records of the conquered Babylonian king himself, which show that the Hebrew writers of the later day had a peculiarly befogged impression of a great historical event—their misconception being shared, it may be added, by the Greek historian Herodotus. When the annalistic tablet of Cyrus was translated, it was made to appear, to the consternation of Bible scholars, that the city of Babylon had capitulated to the Persian—or more properly to the Elamite—conqueror without a struggle. It appeared, further, that the king ruling in Babylon at the time of the capitulation was named not Belshazzar, but Nabonidos. This king, as appears from his own records, had a son named Belshazzar, who commanded Babylonian armies in outlying provinces, but who never came to the throne. Nothing

could well be more disconcerting than such a revelation as this. It is held, however, that the startling discrepancies are not so difficult to explain as may appear at first sight. The explanation is found, so the Assyriologist assures us, in the fact that both Hebrew and Greek historians, writing at a considerable interval after the events, and apparently lacking authentic sources, confused the peaceful occupation of Babylon by Cyrus with its siege and capture by a successor to that monarch, Darius Hystaspes. As to the confusion of Babylonian names,—in which, by the way, the Hebrew and Greek authors do not agree,—it is explained that the general, Belshazzar, was perhaps more directly known in Palestine than his father the king. But the vagueness of the Hebrew knowledge is further shown by the fact that Belshazzar, alleged king, is announced as the son of Nebuchadrezzar (misspelled Nebuchadnezzar in the Hebrew writings), while the three kings that reigned after Nebuchadrezzar, and before Nabonidos usurped the throne, are quite overlooked.

Our present concern with the archæological evidence thus briefly outlined, and with much more of the kind, may be summed up in the question: What in general terms is the inference to be drawn by the world-historian from the Assyrian records in their bearings upon the Hebrew writings? At first sight this might seem an extremely difficult question to answer. Indeed, to answer it to the satisfaction of all concerned might well be pronounced impossible. Yet it would seem as if a candid and impartial historian could not well be greatly in doubt in the matter. On the one hand, the general agreement everywhere between the Hebrew accounts and contemporaneous records from Mesopotamia proves beyond cavil that, broadly speaking, the Bible accounts are historically true, and were written by persons who in the main had access to contemporaneous documents. On the other hand, the discrepancies as to details, the confusion as to exact chronology, the manifest prejudice and partizanship, and the obvious limitations of knowledge make it clear that the writers partook in full measure of the shortcomings of other historians, and that their work must be adjudged by ordinary historical standards.

As much as this is perhaps conceded by most, if not all, schools of Bible criticism of to-day. Professor Sayce, one of the most distinguished of Oriental Assyriologists, writing as an opponent of the purely destructive "Higher Criticism," demands no more than that the Book of Genesis "shall take rank by the side of the other monuments of the past as the record of events which have actually happened and been handed on by credible men"; that it shall, in short, be admitted to be "a collection of ancient documents which have all the value of contemporaneous testimony," but which being in themselves "wrecks of vast literatures which extended over the Oriental world from a remote epoch," cannot be understood aright "except in the light of the contemporaneous literature of which they form a portion." From the point of view implied by such words as these, it is only necessary to recall the mental attitude of our grandfathers to appreciate in some measure the revolution in thought that has been wrought in this field within the last half-century, largely through the instrumentality of Oriental archæology.

### *Archæology and Classical History.*

We have just seen that the general trend of Oriental Archæology has been reconstructive rather than iconoclastic. Equally true is this of recent Classical Archæology. Here no such revolution has been effected as that which virtually created anew the history of Oriental Antiquity; yet the bearings of the new knowledge are similar in kind if different in degree. The world had never quite forgotten the history of the primitive Greeks as it had forgotten the Mesopotamians, the Himyaritic nations, and the Hittites; but it remembered their deeds only in the form of poetical myths and traditions. These traditions, finding their clearest delineation in the lines of Homer, had been subjected to the analysis of the critical historians of the early decades of the 19th century, and their authenticity had come to be more than doubted. The philological analysis of Wolf and his successors had raised doubts as to the very existence of Homer, and at one time the main current of scholarly opinion had set strongly in the direction of the belief that the *Iliad* and the *Odyssey* were in reality but latter-day collections of divers

recitals that had been handed down by word of mouth from one generation to another of bards through ages of illiteracy. It was strenuously contended that the case could not well be otherwise, inasmuch as the art of writing must have been quite unknown in Greece until after the alleged age of the traditional Homer, whose date had been variously estimated at from 1000 to 800 B.C. by less sceptical generations. It had come to be a current belief that the *Iliad* was first committed to writing in the age of Pisistratus. A prominent controversialist, Mr Paley, even went so far as to doubt whether a single written copy of the *Iliad* existed in Greece at the time of the Peloponnesian War. The doubts thus cast upon the age when the Homeric poems first assumed the fixed form of writing were closely associated with the universal scepticism as to the historical accuracy of any traditions whatever regarding the early history of Greece. Cautious historians had come to regard the so-called "Heroic Age" as a prehistoric period regarding which nothing definite was known, or in all probability could be known. It was ably argued by Sir George Cornewall Lewis, in connexion with his inquiries into early Roman history, that a verbal tradition is not transmitted from one generation to another in anything like an authentic form for a longer period than about a century. If, then, the art of writing was unknown in Greece before, let us say, the 6th century B.C., it would be useless to expect that any events of Grecian history prior to about the 7th century B.C. could have been transmitted to posterity with any degree of historical accuracy.

Notwithstanding the allurements of the subject, such conservative historians as Grote were disposed to regard the problems of early Grecian history as inscrutable, and to content themselves with the recital of traditions without attempting to establish their relationship with actual facts. It remained for the more robust faith of a Schliemann to show that such scepticism was all too faint-hearted, by proving that at such sites as Tiryns, Mycenæ, and Hissarlik evidences of a very early period of Greek civilization awaited the spade of the excavator. Thanks to the enthusiasm of Schliemann and his successors, we can now substitute for the mythical "Age of Heroes" a historical "Mycenæan Age" of Greece, and give tangible proof of its relatively high stage of civilization. Schliemann may or may not have been correct in identifying one of the seven cities that he unearthed at Hissarlik as the fabled Troy itself, but at least his efforts sufficed to give verisimilitude to the Homeric story. With the lessons of recent Oriental archæology in mind, few will be sceptical enough to doubt that some such contest as that described in the *Iliad* actually occurred. And now, thanks to the efforts of a large company of workers, notably Dr Arthur Evans and his associates in Cretan exploration, we are coming to speak with some confidence not merely of a Mycenæan but of a pre-Mycenæan Age.

As yet we see these periods somewhat darkly. The illuminative witness of written records is in the main denied us here. Some most archaic inscriptions have indeed been found by the explorers in Crete, but these for the present serve scarcely any other purpose than to prove the antiquity of the art of writing among a people who were closely in touch with the inhabitants of Hellas proper. Most unfortunately for posterity, the Greeks wrote mainly on perishable materials, and hence the chief records even of their later civilization have vanished. The only fragments of Greek manuscripts antedating the Christian era that have been preserved to us have been found in Egypt, where a hospitable climate granted them a term of existence not to be hoped for elsewhere. No fragment of these papyri, indeed, carries us further back than the age of the Ptolemies; but the Greek inscriptions on the statues of Rameses II. at Abu-Simbel, in Nubia, give conclusive proof that the art of writing was widely disseminated among the Greeks at least three centuries before the age of Alexander. This carries us back towards the traditional age of Homer.

The Cretan inscriptions belong to a far older epoch, and are written in two non-Grecian scripts of undetermined affinities. Here, then, is direct evidence that the Aegean peoples of the Mycenæan Age knew how to write, and it is no longer necessary to assume that the verses of the *Iliad* were dependent on mere verbal transmission for any such period as has been supposed.

But even were direct evidence of the knowledge of the art of writing in Greece of the early day

altogether lacking, none but the hardiest sceptic could doubt, in the light of recent archæological discoveries elsewhere, that the inhabitants of ancient Hellas of the "Homeric Age" must have shared with their contemporaries the capacity to record their thoughts in written words. We have seen that Oriental archæology has in recent generations revolutionized our conceptions of the antiquity of civilization. We have seen that written documents have been preserved in Mesopotamia to which such a date as 4500 B.C. may be ascribed with a good deal of confidence; and that from the third millennium B.C. a flood of contemporary literary records comes to us both from Egypt and Mesopotamia. But until recently it had been supposed that Hellas was shut out entirely from this Oriental culture. Historians have found it hard to dispel the idea that civilization in Greece was a very late development, and that the culture of the age of Solon sprang, in fact, suddenly into existence, as it seems to do in the records of the historian. But the excavations that have given us a knowledge of the Mycenæan Age have proved conclusively, not alone that civilization existed in Greece in an early day, but that this civilization was closely linked with the civilization of Egypt. Not only have antiquities been found in Crete that point to Egyptian inspiration, but quite recently Professor Petrie has found at Tel el-Amarna Mycenæan pottery. The latter find has a peculiar significance, since the date of the Tel el-Amarna collection is definitely fixed between the years 1400 and 1370 B.C.

It is demonstrated, then, that as early as the beginning of the 14th century B.C. the Mycenæan civilization was in touch with the ancient civilization of Egypt. One must not infer from this, however, that the two civilizations met on anything like an equality. Indeed, in the wonderful Tel el-Amarna collection there is a suggestive absence of literary documents from the Aegean that demands a word of notice. The Tel el-Amarna collection, it will be recalled, consists of the royal archives of King Amenophis IV. of the XVIIIth Egyptian dynasty, who in the latter years of his reign chose to be known as Khu-n-Aten, "the glory of the solar disc." This monarch had retired from Thebes and established his court on the site now known as Tel el-Amarna, where he founded the city which existed only during the brief period of thirty years ending with the death of the monarch about 1370 B.C. The date of the documents found in the royal library is, therefore, fixed within very narrow limits. The documents in question consist chiefly of letters, and constitute one of the most important of archæological finds. These letters came to the king from almost every part of Western Asia, including Palestine and Phœnicia, Babylonia, and Asia Minor. Strangely enough, all the letters are written in the Babylonian character, and most of them are in the Babylonian language. They afford, therefore, most striking evidence of a widespread diffusion of Babylonian culture. Incidentally they prove, to the utter confusion of a certain school of Bible critics, that the art of writing was familiarly known in Canaan, and that Egypt and Western Asia were in full literary connexion with one another, long before the time of the Exodus. Hence all the elaborate arguments based on the supposition that Moses probably could not write fall to the ground. On the other hand, the absence of letters from Mycenæ among the tablets of Tel el-Amarna must be regarded as at least suggestive. Seemingly the widespread Babylonian culture had not reached the Aegean peoples; yet these peoples cannot have been wholly ignorant of things with which commercial intercourse brought them in contact. The point is of no very great significance, however, since no one has pretended that the Western civilization compared with the Eastern in point of antiquity; and in any event, no amount of negative evidence weighs a grain in the balance against the positive evidence of the Cretan inscriptions.

In short, then, the researches of the archæologist are tending to reconstruct the primitive classical history; and here, as in the Orient, it is evident that historians of the earlier day were constantly blinded by a misconception as to the antiquity of civilization. Such a fruitage as that of Greek culture of the age of Pericles does not come to maturity without a long period of preparation. Here, as elsewhere, the laws of evolution hold, permitting no sudden stupendous leaps. But it required the arduous labours of the archæologist to prove a proposition that, once proven, seems self-evident.

*Archæology and the Evolution of Art.*

What is true of Greek civilization in general is specifically true of the flower of that civilization, Greek art. Whoever would see the story of the evolution of Greek art illustrated, should go to the British Museum and pass from the Egyptian Hall, with its grotesque colossi, to the Assyrian rooms, with their marvellous bas-reliefs, and then on to the Elgin Marbles from the Parthenon. In particular, the art treasures of the Assyrian collection should demand the closest scrutiny. In the Nineveh gallery, for example, where one finds collections of strange Assyrian books, the walls are flanked everywhere with bas-reliefs that come from some buried palace that once stored the literary treasures.

It appears that the kings of that far-off time and land were connoisseurs of art as well as patrons of literature; and the art treasures of their palaces certainly form the most striking, if not the most important, part of the mementoes they have left to us. The more closely these figures in low relief are examined, the more wonderful they will seem. They take the place of the Egyptian carvings in the round; and if they are less striking to first view than the great sarcophagi, the grotesque gods, and colossal animal forms of that people, they will prove infinitely more expressive and incomparably more artistic on closer inspection. For these flat sculptures depict, not alone gods and sacerdotal scenes, but everyday affairs and the events of Assyrian history. The bas-relief was clearly the focal point of Assyrian art. Even the great bulls and lions that guarded the palace entrances were only partially detached from their background, and a frescoed statue of King Assur-nazir-pal shows the same tendency. The full rounded statue was not indeed unknown to them, as several examples testify; but their real *forte* lay in mural decoration in low relief. And the particular walls on which the artists mainly expended their skill, if we may judge from what the ruins have revealed to us, were not the walls of temples but the palaces of kings. It is quite clear that these great conquerors of antiquity were very human, very like their successors of after times. They loved to have their heroic deeds, real or alleged, heralded to the world, and recalled incessantly to their own memories. So one finds whole histories epitomized on these walls,—wars, conquests, victories; the storming of cities, the slaughter of the enemy, the leading of captives, and bringing of tribute by subject people,—everything, in short, but Assyrian reverses; the court artist, true to his colours then as now, never made the mistake of depicting those.

As historical records these sculptures are of priceless value, both for what they tell of political history and for the light they throw on the powers and limitations of antique art. But before you venture to judge the Assyrian artist in the latter regard, you must pass on to the room of Assur-nazir-pal, and from that to the adjacent room, where the mural decorations of the dining-hall of the last of the great Assyrian kings, Assur-bani-pal, have been placed *in situ*, reproducing an effect which they first made in the palace at Nineveh in the 7th century B.C. Here you may see at once both another phase of royal life in Assyria and another stage of Assyrian art. Not war, but the chase is now the theme. King Assur-bani-pal is seen in pursuit of the goat, the wild ass, the lion. The king, of course, towers above his attendants, though not in the grotesque disproportion of the Egyptian paintings. To the Oriental mind such excessive stature seemed indissoluble from royal station. One recalls how the mother of Darius, made captive at Issus, mistook Hephæstion for the king, because he was taller than Alexander; and how Agesilaus, when he went to Egypt as an ally of the Egyptians, was held in contempt, despite his renown, because of his diminutive stature; and one cannot help wondering what would have been the real aspect of the Assyrian and Egyptian monarch could they have been subjected to the camera. Be that as it may, there was apparently no doubt in the mind of the court artist as to what his chisel should reveal in this respect, and the king may always be distinguished by his stature, without regard to his royal robes. Still, it is notable, as a distinction between Egyptian and Assyrian art, that the realistic eye of the Assyrian sculptor never let him depict the king as a Brobdingnag among the pigmies, after the Egyptian fashion. At the most he is a head taller than those about him.

The royal hunter pursues his quarry sometimes on foot, more usually standing in his chariot. His

weapon is usually the bow, sometimes the spear; on one occasion he grapples with the lion, hand to jowl, and stabs the quarry to the heart with a short sword. The quiet dignity and royal calm with which the feat is achieved must have ensured the artist a high and enduring place in the royal favour. The action, however, of the human figures in these sculptures is always sedate and reposeful, suggestive of reserved strength perhaps, or possibly of the artist's limitations. Whichever it is, the real power of the artist is not shown in the human figures. These, to be sure, are in part strongly anatomized; in the main, they are fairly proportioned, and, unlike the Egyptian figures, they have the shoulders drawn in proper perspective. But the faces are fixed, impassive; the eyes are not in perspective, and, as a whole, they cannot claim high merit as works of art, viewed from an abstract modern standpoint. Considered in relation to their time, they are wonderful enough, so far ahead are they of anything that we could suppose to have been accomplished in the world of that day. But they fall far short of the standard which the same artist has himself given us in animal figures of his composition. It seems as if the human figures might have been done from memory, whereas the animal forms are clearly enough from the natural model. Indeed, when we turn to these animal figures we may criticize them, not with reservation as to their age, but from the standpoint of modern art, and as individual figures they will not be found wanting. The three fundamental canons—"proportion, action, aspect"—have been successfully met. The lions skulk sullenly from their cages, spring furiously into action, or roll in death-agony at the will of the depicter. The lioness, with spine broken by an arrow, dragging her palsied hind-quarters, is a veritable masterpiece. The same is true of many of the figures of goats, of running and pacing wild asses, and of dogs. As a whole, these animal frescoes are nothing less than wonderful. It is worth a visit to London from the remotest land to see these sculptures from the palace of the old Assyrian king.

Still, though these bas-reliefs have intrinsic merits as works of art, their chief value is for what they teach regarding the evolution of art in the world. Previously to their discovery it had been supposed that the stiff formalism of Egyptian sculpture represented the fullest flight of pre-Grecian art; and that Greek art itself had stepped suddenly forth, rather a new creation than an evolution. But the pick and shovel of Layard at Nineveh dispelled that illusion. For these art treasures, that had lain there under the deposits of centuries, were found to represent an enormous advance upon Egyptian models, precisely in the direction of that realism for which Greek art is distinguished.

If we would judge how direct and unequivocal was the impulse which the dying nation transferred to the adolescent one in point of art, we have but to take a few steps in the British Museum, from the Assyrian rooms to the wonderful hall that holds Lord Elgin's trophies from the desecrated Parthenon. Look then upon the frieze of bas-relief that bears the magic name of Phidias. If anything can reconcile us to the act that deprived Greece of her priceless heirlooms, it is the fact that they have found lodgment here close beside their Oriental prototypes, where half a million visitors each year may at least have an opportunity to learn the lesson that human progress is an accretion, a growth, a building upon foundations; and, specifically, that Greek art, no less than other forms of human culture, was an evolution, and not an isolated miracle. For what is the Parthenon frieze, as we now come to it fresh from the palaces of Nineveh, but an Assyrian fresco adapted to the needs and ideals of another race and developed by the genius of a newer civilization? The profiled figures in low relief coursing together, are they different in conception from the profiled figures of the palaces we have just left? The horses of the Parthenon frieze might almost seem to have stepped bodily from the palaces of Assur-bani-pal. They have gained something in suppleness of limb, have altered their attitude in a measure, to be sure, thanks to their new environment. But their type has not changed by so much as an actual breed of horses might be changed in as many generations. Note the head, the most typical and characteristic feature of this Grecian steed. Line for line it is the same head, trappings aside, that we have just seen at Nineveh. Even the defects of the Assyrian drawing are there—the too small and slender face, and receding lower jaw, the tiny ear, the far too full and "chuffy" neck. Possibly no horse in nature was ever like this, but the Assyrian artist so conceives it; the Greek copies that conception; and the distorted type will be transmitted down

the generations to the Italian of the Renaissance, to the classical painters of Spain, the Netherlands, and Germany, and France; nay, even to the artist of the 19th century. The court artist of an Oriental prince of the 9th or 10th century B.C. conceives a certain ideal; and, following him, a certain type of sculptured horse, such as the artist who carved it has never seen, steps before the chariots on Napoleon's Arc de Triomphe, in 19th-century Paris.

We have only been able to indicate some of the most important of the issues raised by modern research. Enlightening as the results have been, they are even more striking as the promise of further investigation. At the opening of the Twentieth Century the field of inquiry stretched out on all sides, and the method of cultivating it for the profit of all mankind—since the true history of man on the earth must always be of the supremest interest to intelligent people—had been brought home to us by the new treasures already at our disposal. Strangely enough, there were still obstacles—pecuniary or political—to be faced by those expert archæologists who had best proved their title to support. But in the light of accomplished facts, it is not reasonable to suppose that a work so successfully begun will not be pushed forward further and further, till every available source of knowledge has been tapped.

# ENCYCLOPÆDIA BRITANNICA.

## NEW VOLUMES.

## CHICAGO.

**Chicago,** the second city in size in the United States, situated in Cook county, state of Illinois, in 41° 50′ N. lat. and 87° 34′ W. long. It stretches along the west shore of Lake Michigan for nearly 30 miles. The Chicago river, which empties into the lake, is about a mile long, being formed by the junction of branches from the north-west and south-west. The main river and the branches are an important part of the harbour, vessels being docked all along the banks. A series of breakwaters protect the mouth of the river from the lake storms and make a secure basin. The rivers divide the city into three divisions, the north, south, and west sides. The streets generally intersect at right angles. The total area of the city is 190½ square miles. There are 4074 miles of streets and alleys—1269·4 improved and 2804·6 unimproved. The extreme length of the city is 26½ miles and the extreme breadth 14½ miles. In 1880 the population numbered 503,185; in 1890, 1,099,850; and in 1900, 1,698,575. The native-born population (1900) was 1,111,463, and the foreign-born 587,112; the total coloured population was 31,435, of whom 30,150 were negroes, and the balance Chinese, Japanese, and Indians. Out of 511,048 males of voting age (21 years and over), 20,572 were illiterate (unable to write), of whom 19,336 were foreign-born. Of the total number of males of voting age, as given above, 237,688 were native-born and 273,360 were foreign-born. Of the latter number, 186,660 were naturalized, 10,398 had filed their first naturalization papers, 35,897 were aliens, and the citizenship of 40,405 was returned by the U.S. census enumerators as unknown. The number of births registered in 1900 was 29,568. The number registered is thought to be perhaps 80 per cent. of the total. The number of deaths in the census year ending 31st May 1900 was 27,533, showing a death-rate of 16·2 per thousand. In 1890 the death-rate was 19·1. As the number of births is only slightly in excess of the number of deaths, it is obvious that the growth of the city in population comes mainly from immigration.

*Railways.*—Chicago is one of the great railway centres in the United States. Trunk lines reach east to Montreal, Boston, New York, Philadelphia, Baltimore; south to Charleston, Savannah, Florida, Mobile, New Orleans, Texas; west to the Pacific by all the overland routes. Nearly all the traffic between the northern Atlantic seaboard and the Far West passes through Chicago, and the trade of the city extends in every direction. The Illinois and Michigan canal connects the Chicago river with the waters of the Mississippi for small craft, and it seems not unlikely that some day the new drainage canal will become a ship canal, thus making it possible for large vessels to ply between New Orleans and Chicago. Local transit is provided partly by the trunk railways, partly by four elevated railways, one on the south side, two on the west side, and one on the north side, all worked by electricity. The trams are operated by cables or electricity. The local lines, both elevated and tram, belong to private corporations which hold charters for a term of years from the city. One important effect of the abundant provision for local travel is seen in the concentration of business in the comparatively small area south of the main river and between the south branch and the lake. Another effect is the wide diffusion of the residential quarter, there being many areas within the city limits very sparsely built up. In consequence of the enormous value of land in the down-town district, the erection of very high buildings for business purposes has become imperative. The highest is the Masonic temple, which has 22 storeys, with a total height of 302 feet. The Monadnock, an office building, has no less than 6000 occupants, and constitutes a postal district by itself—as is the case, indeed, with other such buildings.

*Education.*—Education, as generally in the United States, is largely in the hands of the state, but is liberally supplemented by private effort, by corporations endowed from private munificence, and by church schools. Besides the usual primary, secondary, and higher institutions, there are technical and professional schools and a variety of

special bodies. In addition to institutions with a distinctly scholastic aim, there are libraries, museums, art galleries, and semi-public musical organizations. The free public-school system includes elementary schools, high schools, and a normal school. The following statistics are for the school year ending 30th June 1900:—

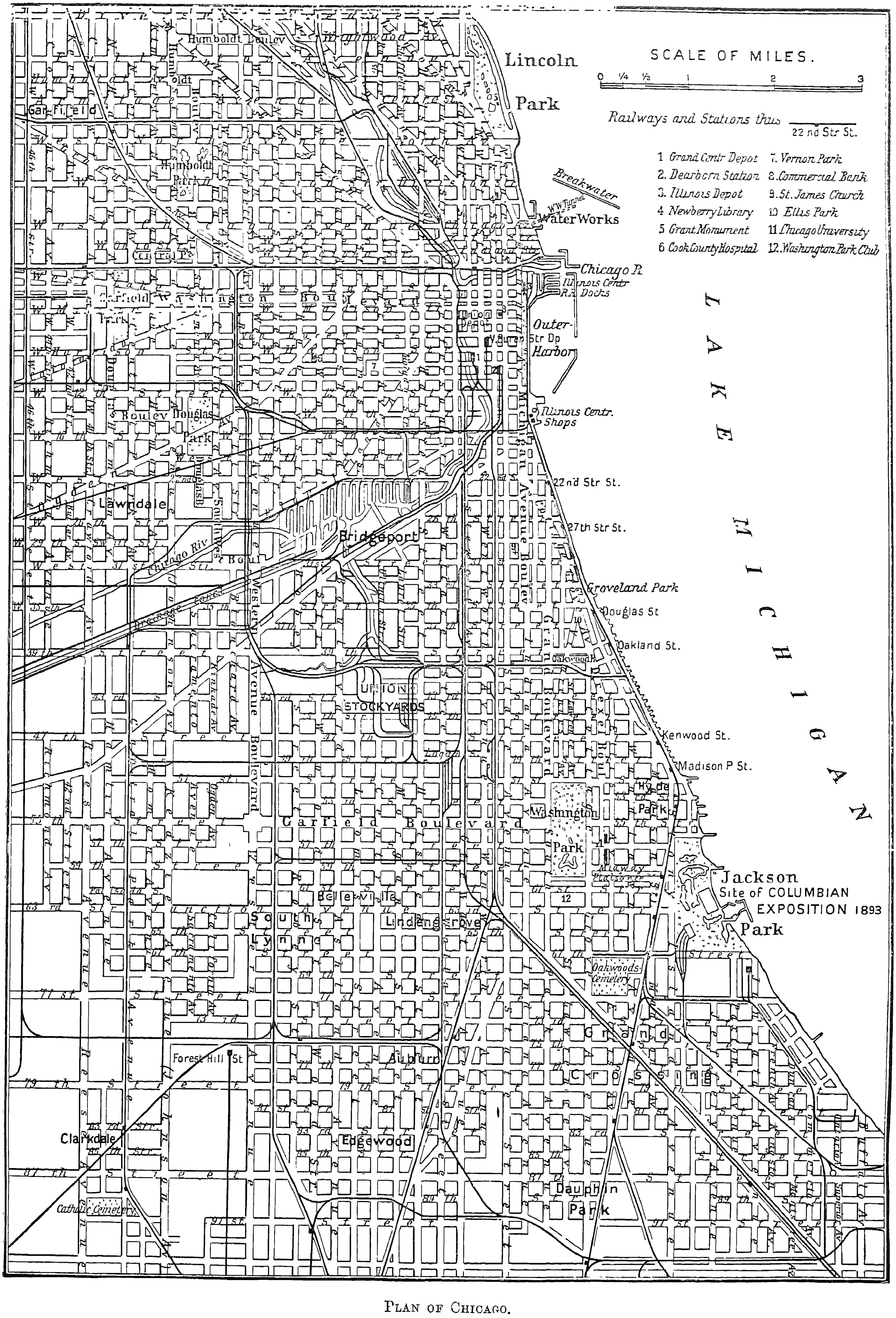
| | Number of Schools. | Number of Teachers. | Number of Pupils. |
|---|---|---|---|
| Elementary schools . | 130 | 5420 | 203,880 |
| High schools . . | 15 | 349 | 8,902 |
| Normal schools . . | 1 | 31 | 352 |
| Totals . . . | 146 | 5800 | 213,134 |

In 1900 there were 526,013 persons of school age (5 to 20 years).

The cost of the public schools for the year ending 30th June 1900 was $7,096,674. Of this sum $6,295,133 came from taxation and $801,541 from the income on invested funds. In 1898 the private schools had 323 teachers and 7625 pupils, and the parochial and church schools 1301 teachers and 78,989 pupils, exclusive of numerous kindergarten and business schools. There are three universities, situated wholly or in part in Chicago—Lake Forest University, North-Western University, and the University of Chicago. They were founded under Presbyterian, Methodist, and Baptist auspices respectively. The academic departments of the two former are in the suburbs of Lake Forest and Evanston, the professional departments being in Chicago. Lake Forest, for the year ending June 1900, had 126 students in the college at Lake Forest, 561 in the college of dental surgery, and 364 in the college of law—a total of 1051. North-Western University had an attendance, for the year ending June 1900, of 572 students in the college of liberal arts, 42 in the graduate school, 182 in theology, 211 in law, 413 in medicine, 235 in pharmacy, 566 in dentistry, and 292 in music, there being a total of 2358 (excluding repetitions). There were in the same departments 277 professors and instructors. The University of Chicago alluded to in the ninth edition of this work went out of existence in 1886. In 1890 a new institution of the same name (see separate heading below) was incorporated under the laws of Illinois, and was opened on 1st October 1892. Schools of law and medicine include those connected with the North-Western and Lake Forest Universities, the Rush Medical College (affiliated with the University of Chicago), the College of Physicians and Surgeons (the medical department of the University of Illinois), and several which are independent. Theological schools, besides those of the universities, are the M'Cormick Theological Seminary (Presbyterian), the Chicago Theological Seminary (Congregational), the Western Episcopal Theological Seminary, the German Lutheran Theological Seminary, and some others. The Lewis Institute, on the west side, and the Armour Institute of Technology, on the south side, both largely endowed, provide education in which technical instruction is prominent. The Chicago Institute, founded and endowed by Mrs Anita M'Cormick Blaine as an independent school for the training of teachers, is now a part of the University of Chicago. The Chicago Art Institute conducts an art school and maintains a collection of pictures, reproductions of sculpture and bronzes, and original Egyptian antiquities. The library, consisting of over 2000 volumes and 16,000 photographs, is used in connexion both with the school and with the museum. The building, which stands on the Lake Front Park and is the property of the city, cost a little over $700,000. Of this sum $200,000 was paid by the World's Columbian Exposition, and the rest by the institute and by gifts from its friends. The art school had 1904 students in 1899-1900. The collection of pictures contains excellent examples of the works of old and modern masters. The Field Columbian Museum occupies the building in Jackson Park which was the art gallery of the Columbian Exposition of 1893. The nucleus of the collection was in large gifts from exposition exhibitors, and many additions have been made since. Besides the libraries of the various institutions of learning, there are a public library and two endowed libraries, the Newberry and the Crerar. The public library has an annual appropriation of about $276,000 from the Common Council, and has 272,000 volumes on its shelves. The Newberry Library, on the north side, possesses an endowment fund of about $2,500,000, and has 230,000 volumes. It is especially rich in Americana. The John Crerar Library has an endowment fund of $3,500,000, an income (for 1900) of $157,285, and 70,406 books. This library is limited to books on science (including the social sciences). The library of the University of Chicago has 337,915 volumes, and that of the Chicago Law Institute (which is accommodated in the Court House) has upwards of 37,000 titles. The Chicago orchestra, mainly supported by voluntary contributions, is devoted to rendering classical music.

*Religion and Charity.*—There are in Chicago 775 churches, or parishes, representing 36 distinct ecclesiastical organizations. The Baptists have 60 parishes, the Congregationalists 83, the Episcopalians 42, the Lutherans 87, the Methodist Episcopalians 145, the Presbyterians 48, and the Roman Catholics 118. There are also upwards of a hundred missions maintained by the various churches. There are 45 hospitals and several infirmaries and dispensaries in the city. The Cook County Hospital belongs to the county. The others are in the main supported by churches or by private benevolence. Provision is made for indigent patients as well as for those who are able to pay for treatment. There are 55 asylums and homes for the destitute, for orphans, for the aged, the erring, for those afflicted with incurable disease, for the friendless, and the like. Of these the Cook County Insane Asylum and the Cook County Poor House belong to the public. The rest, like the hospitals, are supported by churches or by private benevolence. Chicago has its full share of temporary distress, of habitual mendicancy, of economic inefficiency, of vicious poverty. The city is, however, well equipped with the customary institutions for dealing with such cases. Moreover, to prevent the overlapping of charitable work, and also as a precaution against fraud, there has been organized since the World's Fair the bureau of charities. For this purpose the city is divided into districts, in each of which there is a local organization, under the general direction of a central committee. All cases are registered, new cases being examined in detail. Nearly 50,000 family records are on file in the bureau registration. During 1899, 11,274 applications were made for the services of the bureau. About 25 per cent. of these were sent to the bureau for investigation by co-operating agencies.

*Commerce and Industry.*—Chicago is a centre of manufacturing and commerce on the largest scale. Among the leading industries may be enumerated meat-packing, agricultural implements, railroad cars, printing, electrical apparatus, brewing, bicycles, pianos, mill machinery, and shipbuilding. Chicago is the greatest grain market in the world. Some idea of the extent of the industries of the city may be obtained from the following statistics for 1899. The receipts of live stock amounted to 14,623,435 head, valued at $233,711,180, and the shipments were 3,006,532 head. There were also shipped during the same




PLAN OF CHICAGO.

year 1,061,868,376 ℔ of dressed beef, 505,834,067 ℔ of lard, 203,454 barrels of pork, and 863,363,437 ℔ of other hog products. The receipts of sheep were 3,682,832. The Union stock-yards include 475 acres of land, of which 320 acres are floored with planks or brick. Within the yards are 13,000 pens, 8500 of which are covered, for housing hogs and sheep. These covered pens occupy 75 acres. There are also within the yards 25 miles of streets, 38 miles of water troughs, 90 miles of water pipes, and 50 miles of sewerage. The receipts of grain and of flour in the grain equivalent were 320,670,440 bushels, and the shipments were 246,369,099 bushels. The port of Chicago showed 8048 arrivals, with a tonnage of 6,281,355, and 8126 clearances, with a tonnage of 6,317,884. The duties collected on imported goods at the Chicago custom-house amounted to $7,551,400. The greater part of these imports came by rail in bond. The bank clearings were $6,612,311,611, as against $60,761,791,901 for New York, $7,086,285,271 for Boston, and $4,811,079,611 for Philadelphia. The gross receipts of the post office for the fiscal year ending 30th June 1899 were $6,131,123, as against $8,881,547 for New York, $3,143,929 for Philadelphia, and $2,920,383 for Boston.

*Government.*—The constitution of the state of Illinois forbids the legislature to grant special charters for municipal corporations, and requires that all such incorporations shall be in accordance with a general law. The government of Chicago, therefore, is framed by the statute which provides for all cities in the state alike. The city is divided into thirty-five wards. Each of these elects two members of the city council, one being chosen each year for a term of two years. Thus the council is a continuous body, one half of its seventy members being renewed annually. The powers of the council are very extensive, including the granting of franchises for the supplying of light and locomotion. The supreme executive officer is a mayor, elected by the qualified voters of the city for two years. Legislation requires his assent to be valid, unless a two-thirds vote of the council adopts the measure notwithstanding his veto. The mayor has large power of appointment and removal of officers, and it is his duty to enforce the laws. The administrative departments are organized in general on the plan of a single head for each, appointed by the mayor with the approval of the council, the subordinates being appointed by the head with the approval of the mayor. These departments are those of finance, law, public works, fire, police, health, and buildings. The department of education and the public library are administered by boards, whose members are appointed by the mayor with the approval of the council. The courts of law are courts of the state of Illinois, but a certain number of justices of the peace are designated by the mayor to act as police magistrates.

*Local Works.*—The *water supply* is derived from Lake Michigan, there being a series of pumping stations from one mile to five miles from the shore. The system belongs to the city, and is maintained and operated by the department of public works. The main *drainage* of the city has been into the lake. In order to preserve the lake water from pollution a drainage canal has been constructed from the south branch of the Chicago river to the Desplaines river, a total distance (including the improved portion of the river) of 34 miles. By this means the water flows from the lake into the Desplaines, and thence by way of the Illinois river into the Mississippi. The water was turned into the channel on 2nd January 1900. The present flow is limited to 360,000 cubic feet per minute, but the canal is designed to have a maximum capacity of 600,000 cubic feet per minute. The entire cost (1st January 1900) was $34,000,000. The cost is defrayed from taxes paid by the owners of property in the sanitary district, which includes the greater part of the city and certain suburban areas, a total of 185 square miles. The work is in the hands of a board of trustees elected by the people of the district.

*Parks.*—An extensive system of parks and connecting drives girdles the city from the shore of the lake on the north to the shore on the south. There are three distinct divisions of the system, known as the north, west, and south parks, each being managed by a board of trustees. The trustees of the north parks and those of the west parks are appointed by the governor of Illinois, while the south park trustees are appointed by the judges within Cook county. There are also several minor parks, which are controlled by the city government. The entire park area comprises 2232·1 acres—323·7 on the north side, 627·3 on the west side, and 1281·1 on the south side. Lincoln Park on the north side, and Jackson Park on the south side, are on the lake shore. The parks contain some interesting monuments—especially noteworthy being the bronze statue of Lincoln, the equestrian statue of Grant, and the memorials of Lassalle, Schiller, and Linnæus in Lincoln Park, and the equestrian statue of Logan in Lake Front Park. The monument dedicated to the Ottawa Indians, in Lincoln Park, and that commemorating the Indian massacre of 1812, are also of interest. In the Oakwoods cemetery is a monument to the memory of the Union soldiers of the Civil War, and also one to the memory of the Confederate soldiers who died while prisoners in Camp Douglas in the suburbs of Chicago between 1861 and 1865.

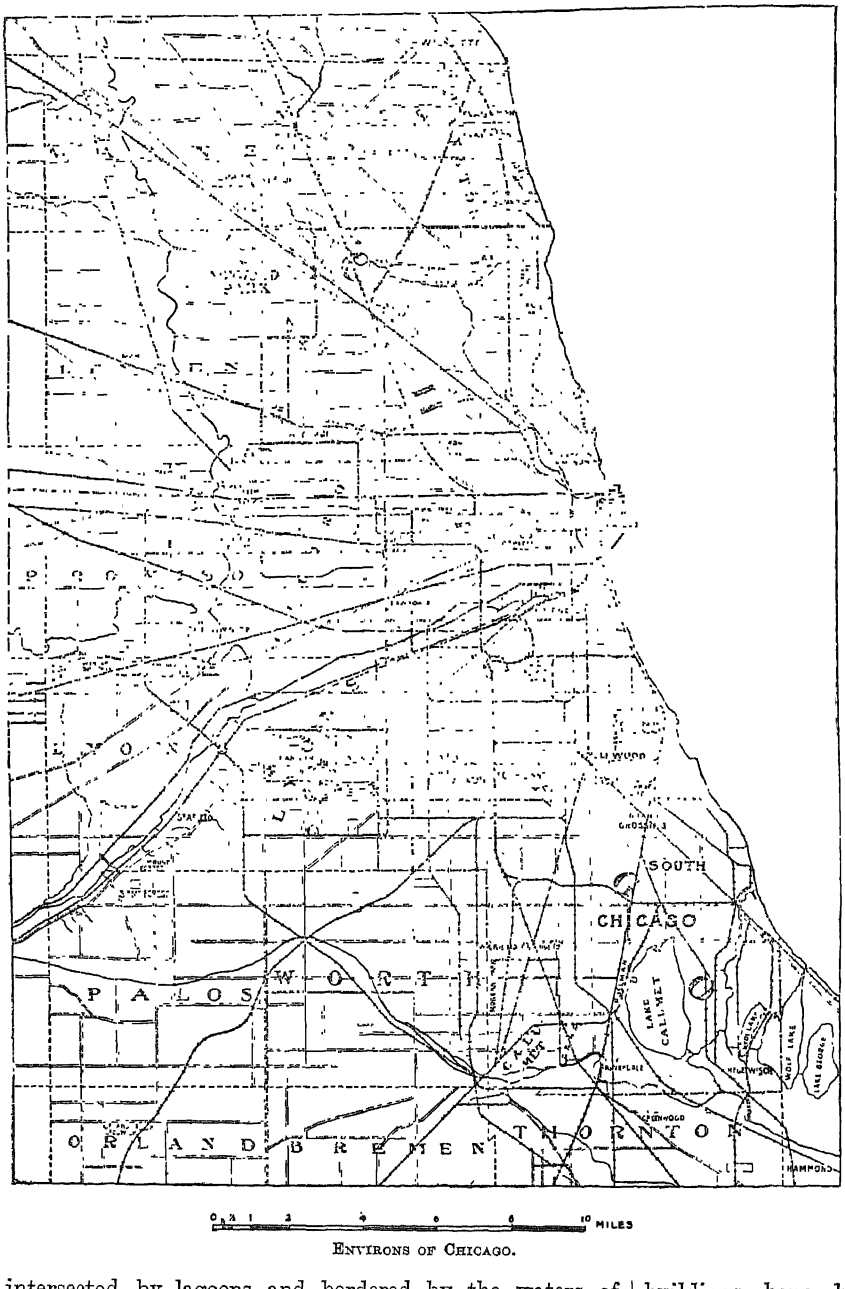
*Finance.*—The total receipts of the city for the fiscal year 1900 were $34,962,473. They were derived from taxation on real estate and on personal property, and from various other sources. The main items of the receipts, in addition to $2,956,734 cash on hand at beginning of the year, were—property tax, $14,295,829; liquor licenses, $3,174,003; other licenses, $538,092; special assessments, $3,246,124; water-works, $3,292,759; loans, $5,138,000.

The total expenditures for the year were $28,733,848, of which the expenditures for construction and other capital outlay amounted to $9,215,772, and those for maintenance and operation to $19,518,076. The main items of the former class of expenditures were—schools, $608,109; streets, $898,699; and loans repaid, $6,060,511. The main items of the latter class were—police department, $3,773,423; fire department, $1,617,225; schools, $6,200,433; parks and gardens, $643,089; street cleaning and sprinkling, $588,662; water-works, $1,240,001; and interest on debt, $1,313,916. The assessed valuation of real property in 1900, on a basis of about 20 per cent. of the full value, was $202,884,012; of personal property, on the same basis, $73,681,868. The general tax-rate was $74·87 per $1000. The net debt was $32,989,819.

By an anomaly in the laws, the rural towns over which the city has extended retain their political structure and some of their functions. It is also true that the dual system of city and county government—the city area paying nine-tenths of the city taxes—is clumsy and burdensome. The rapid growth of the city makes it necessary to provide public improvements on a large scale, and under the laws of the state the income heretofore has been insufficient to cover necessary expenses. How to provide an adequate income without an excessive burden on taxpayers, and without incurring a crushing debt, is one of the grave problems of the near future.

*The World's Fair, 1893.*—The four-hundredth anniversary of the discovery of America was commemorated

by a World's Fair at Chicago (see article EXHIBITIONS). The site was at Jackson Park, on the lake shore, and included 666 acres. On 21st October 1892 (corresponding to 12th October, o.s.), the date of the discovery, occurred the formal dedication of the grounds. The fair was opened on 1st May 1893, and was continued until 15th November. The buildings, planned by a commission of architects, formed a collection of rare beauty, while the grounds, intersected by lagoons and bordered by the waters of the lake, gave an appropriate setting. The principal nations of the world, and nearly all the states of the Union, had appropriate buildings, and the exhibits were on an extensive scale. A notable feature was the series of congresses on important subjects, of which the parliament of religions was perhaps the most successful. The total number of paid admissions was 27,529,401. Two permanent results of the fair remain in Chicago. The Field Columbian Museum found the nucleus of its great collection in many exhibits which were presented to it. The Chicago Art Institute was given by the World's Fair board $200,000 towards the permanent building on the lake front, used during the fair as a place of meeting for the various congresses.




ENVIRONS OF CHICAGO.

*Municipal Reform.*—In the spring of 1893 the Civic Federation was organized by a number of public-spirited citizens, and through that agency, as well as by other means, much has been accomplished in the direction of giving Chicago better government and better civic conditions. In 1895 the state adopted a municipal civil service law, which might be put in force by any city on affirmative vote of the people. It was ratified in Chicago by a majority of over 50,000. Later an improved revenue law and a law for the protection of primary elections have been enacted. All these measures were secured by the efforts of Chicago reformers. In 1896 the Municipal Voters' League was organized. This body has devoted itself to securing a better common council. The league examines and publishes the record of each candidate, no matter by what party nominated, and recommends election or defeat, as the case may be. As a result the council has been largely redeemed from the corrupt element which at one time controlled it.

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(H. P. J.)

**Chicago, University of,** situated at Chicago, Ill., U.S.A., was founded by John D. Rockefeller, and opened its doors in October 1892. In 1899-1900 it had 223 teachers and 3183 students. It occupies eight blocks in the city of Chicago, upon which seventeen stone buildings have been erected; seven additional ones are now being built. The library contains 305,000 volumes. The value of grounds, buildings, and equipment is nearly $4,000,000, and the invested funds approximate $6,500,000. The only professional school is in divinity, but fully one-third of the students are engaged in graduate work in arts, literature, and science. The university extension division is important, and the university press publishes twelve scientific periodicals. By a system of affiliation close relationship is sustained with a number of colleges and secondary schools. Students of both sexes are admitted on equal terms. The Yerkes observatory of

the university, which contains the largest telescope in the world, is situated on Lake Geneva in Wisconsin, 60 miles from Chicago. (W. R. H.)

**Chicago Heights,** a village of Cook county, Illinois, U.S.A., a few miles S. of Chicago, of which it is a suburb. Population (1900), 5100, of whom 1530 were foreign-born and 47 were negroes.

**Chichester,** an ancient Roman city and municipal borough in the Chichester parliamentary division of Sussex, England, about 14 miles N.E. of Portsmouth by rail. In 1897 a tramway to Selsey Beach was completed, and the town was thoroughly drained in 1894 at a cost of £33,000. The restoration of the cathedral, which was commenced in 1830, is still in progress, the cloisters being the portions most recently restored (1890-91). The city and borough has been twice extended, and in 1901 had an area of 1595 acres. Population (1881), 8149; (1901), 12,241

**Chickamauga Creek,** a small branch of Tennessee river, joining it about 6 miles above Chattanooga. It gave the name to a desperate battle during the Civil War, fought on 19th and 20th September 1863, between the Federal forces under Rosecrans and the Confederates under Bragg; and after terrible fighting Rosecrans was repulsed. The Union loss was reported at 16,000, that of the Confederates 18,000. The site of this battle has been converted into a national park by the general Government.

**Chicopee,** a city of Hampden county, Massachusetts, U.S.A., situated in 42° 10′ N. lat. and 72° 31′ W. long., on Connecticut river, which is here not navigable, and on the Boston and Maine railway, 6 miles N. of Springfield. It was chartered as a city in 1890, with an area of 26 square miles of level surface, in which there are the three villages of Chicopee Center, Chicopee Falls, and Willimansett. It has fine water-power in Chicopee river, which joins the Connecticut within the city limits, and has extensive cotton mills and factories for iron and steel goods, especially for bicycles, arms, cutlery, and agricultural tools. Population (1880), 11,286; (1890), 14,050; (1900), 19,167, of whom 8139 were foreign-born and 10 were negroes.

**Chidambaram,** or CHELUMBRUM, a town of British India, in the South Arcot district of Madras, 7 miles from the coast and 151 miles S. of Madras by rail. The population in 1881 was 19,837, and in 1891 it was 18,634; the municipal income in 1897-98 was Rs.23,690. Its temples are among the most famous in Southern India, and attract 60,000 pilgrims every December. The great temple has a court of 1000 pillars, each a solid block of granite, and its roof is covered with copper and gold. There are a high school and three printing-presses.

**Chieng Mai** (Burm. *Zimmê*), the capital of the Lao state of the same name and the residence of a Siamese high commissioner appointed from Bangkok. This official has jurisdiction over the neighbouring less important states of Lampun, Lakawn-Lampang, Pre, and Nan, each of which, like Chieng Mai itself, retains its hereditary chief, or *chao muang*, and other hereditary officers. The town, surrounded by the remains of long ineffectual fortifications, is situated on the right bank of the river Meping, one of the chief branches of the Menam, in E. long. 99° 0′ and N. lat. 18° 46′, in a plain about 800 feet above sea-level, and surrounded by densely forested hill ranges. The population of the town consists chiefly of Lao, with a number of Chinese, Siamese, Shâns, and Ka hillmen, and about fifty Europeans, and numbers from 12,000 to 15,000. The place is growing fast, and a considerable population, probably over 100,000 in number, inhabits the plain in the neighbourhood of the capital. Situated as it is, midway between Moulmein and Yunnan and between the valley of the Menam and the northern Shân states, it has long been of commercial importance; while as the centre of the principal teak forests of Siam it has since 1880 attracted a considerable number of British, Shân, and Burmese foresters. By the treaty of 3rd September 1883 between Siam and Great Britain a British consul resides at Chieng Mai, and an International Court has been constituted, with civil and criminal jurisdiction in all cases in which British subjects are parties. Surveys have been made for railways from both Bangkok (500 miles) and Moulmein (230 miles). The total value of the annual import and export trade with Burma, China, and Bangkok of the consular district of Chieng Mai, is approximately £1,000,000 sterling, excluding teak. The output of teak will probably be somewhat restricted by the conservancy regulations enforced by the Siamese Forest Department.

**Chihuahua,** a state of Mexico, bounded on the N. by the United States, on the W. by Sonora, on the E. by Coahuila, and on the S. by Sonora, Sinaloa, and Durango. It has an area of 87,820 square miles. The population in 1879 was 225,541, and in 1895 it was 262,771, or 3·0 per square mile. It is divided politically into eighteen departments. Mining and stock-raising are the principal industries, though the agricultural interests are also considerable. The state contains some 200 towns and villages. The exports are principally gold and silver, lead, copper, cattle, sheep, and hides. It is estimated that $90,000,000 (gold) represents the American capital invested in mining. The value of the agricultural products in 1896 was $2,381,565. The capital, CHIHUAHUA, had a population in 1895 of 18,279, and an estimated one in 1898 of 24,000. It is on the Mexican Central railway, 226 miles south of El Paso (Texas) and 6400 feet above sea-level. It is lighted by electricity, has tramways and good sewerage. The principal public buildings are the cathedral, the state palace, and the Hospital Porfirio Diaz. Other important towns are Parral (7269), Ciudad Juarez (6917), and Jimenez (5381).

**Chilas,** an insignificant hill village, dominated by a fort, on the left bank of the Indus, about 50 miles below Bunji. It is situated in 35° 27′ N. lat. and 34° 8′ E. long., 4100 feet above sea-level. It was occupied by a British force early in 1893, when a determined attack was made on the place by the Kohistanis from the Indus valley districts to the south-west, aided by contingents from Darel and Tangir west of Gilgit and north of the Indus. Its importance consists in its position with reference to the Kashmir-Gilgit route *viâ* Astor, which it flanks. It is now connected with Bunji by a metalled road. Chilas is also important from its command of a much shorter and more direct route to Gilgit from the Punjab frontier than that of Kashmir and the Burzil pass. By the Kashmir route Gilgit is 400 miles from the rail-head at Rawal Pindi. By the Khagán route it would be brought 100 miles nearer, but the unsettled condition of the country through which the road passes is at present a bar to its general use.

**Child, Francis James** (1825-1896), American scholar and educationalist, was born in Boston, 1st February 1825. He graduated at Harvard University in 1846, taking the highest rank in his class in all subjects; at once became tutor in mathematics (1846-48); and in 1848 was transferred to a tutorship in history, political economy, and English, serving in that capacity for one

year. After two years of study in Europe, in 1851 he succeeded Edward T. Channing, who had helped to shape the style of so many Harvard authors during his occupancy of the chair of the Boylston professorship of rhetoric and oratory. He studied the English drama (having edited *Four Old Plays* in 1848) and Germanic philology, the latter at Berlin and Göttingen during a leave of absence, 1849-51; and took general editorial supervision of a large collection of the British poets, published in Boston in 1853 and following years. Spenser was newly and thoroughly edited, with life and notes, by him. At one time he planned an edition of Chaucer in the same series, but contented himself with a treatise, in the Memoirs of the American Academy of Arts and Sciences for 1863, entitled *Observations on the Language of Chaucer's Canterbury Tales*, which did much to establish Chaucerian grammar, pronunciation, and scansion as now generally understood. His largest undertaking, however, grew out of an original collection, in his British Poets series, of *English and Scottish Ballads*, selected and edited by himself, in eight volumes (Boston, 1857-59). Thenceforward the leisure of his life—much increased by his transfer, in 1876, to the professorship of English—was devoted to the comparative study of British vernacular ballads. He accumulated, in the university library, one of the largest folk-lore collections in existence, studied manuscript rather than printed sources, and carried his investigations into the ballads of all other tongues, meanwhile giving a sedulous but conservative hearing to popular versions still surviving. At length his final collection was put to press, as *The English and Scottish Popular Ballads*, at first issued in parts (1882-98), and then gathered into five folio volumes, which remain the authoritative treasury of their subject. Professor Child worked—and overworked—to the last, dying in Boston, 11th September 1896, having completed his task save for a general introduction and bibliography. A full and sympathetic biography was prefixed to the work by his pupil and successor George L. Kittredge.

**Childers, Hugh Culling Eardley** (1827-1896), British statesman, was born in London on 25th June 1827. On leaving Cambridge he went out to Australia (1850), and became a member of the Government of Victoria, but in 1857 returned to England as Agent-General of the colony. Entering Parliament in 1860 as Liberal member for Pontefract (a seat that he continued to hold till 1885), he became Civil Lord of the Treasury in 1864, and in 1865 Financial Secretary to the Treasury. A devoted admirer of Gladstone, Childers occupied a succession of prominent posts in the various Gladstone Ministries. He was First Lord of the Admiralty from 1868 to 1871, and as such inaugurated a policy of retrenchment. Ill-health compelled his resignation of office in 1871, but next year he returned to the Ministry as Chancellor of the Duchy of Lancaster. From 1880 to 1882 he was Secretary for War, a post he accepted somewhat unwillingly; and in that position he had to bear the responsibility for the reforms which were introduced into the War Office under the parsimonious conditions which were then part of the Liberal creed. During his term of office the Egyptian war occurred, in which Childers acted with creditable energy; and also the Boer war, in which he and his colleagues showed to less advantage. From 1882 to 1885 he was Chancellor of the Exchequer, and the beer and spirit duty in his budget of the latter year was the occasion of the Government's fall. Defeated at the general election at Pontefract, he was returned as a Home Ruler (one of the few Liberals who adopted this policy before Mr Gladstone's conversion) in 1886 for South Edinburgh, and was Home Secretary in the Ministry of 1886. When the first Home Rule Bill was introduced he demurred privately to its financial clauses, and their withdrawal was largely due to his threat of resignation. He retired from Parliament in 1892, and died on 29th January 1896, his last piece of work being the drafting of a report for the Royal Commission on Irish Financial Relations, of which he was chairman. Childers was a capable and industrious administrator of the old Liberal school, and he did his best, in the political conditions then prevailing, to improve the naval and military administration while he was at the Admiralty and War Office. His own bent was towards finance, but no striking reform will be associated with his name. His most ambitious effort was his attempt to effect a conversion of Consols in 1884, but the scheme proved a failure, though it paved the way for the subsequent conversion by Mr Goschen in 1888. The *Life* of Mr Childers, published by Murray in 1901, throws some interesting side-lights on the inner history of more than one Gladstonian Cabinet.

**Children, Cruelty to.**—English law has always in theory given to children the same remedies as to adults for ill-usage, whether by their parents or by others, and has never recognized the *patria potestas* as known to earlier Roman law; and while powers of discipline and chastisement have been recognized as necessarily incident to paternal authority, the father is civilly liable to his children for wrongs done to them. The only points in which infancy created a defect in civil status were that infants were subject to the restraints on complete freedom of action involved in their being in the legal custody of the father, and that it was and is lawful for parents, guardians, employers, and teachers to inflict corporal punishment proportioned in amount and severity to the nature of the fault committed and the age and mental capacity of the child punished. But the Court of Chancery, in delegated exercise of the authority of the sovereign as *parens patriæ*, has always asserted the right to take from parents, and if necessary itself to assume the wardship of children where parental rights were abused or serious cruelty was inflicted; while abuse of the power of correction is regarded as giving a cause of action or prosecution for assault; and if attended by fatal results renders the parent liable to indictment for murder or manslaughter.

The conception of what constitutes cruelty to children has undoubtedly changed considerably with the relaxation of the accepted standard of severity in domestic or scholastic discipline and the growth of new ideas as to the duties of parents to children, which in their latest developments tend enormously to enlarge the parental duties without any corresponding increase of filial obligations.

Starting from the earlier conception, which limited ill-treatment legally punishable to actual threats or blows, the common law came to recognize criminal liability in cases where persons, bound under duty or contract to supply necessaries to a child, unable by reason of its tender years to provide for itself, wilfully neglected to supply them, and thereby caused the death of the child or injury to its health, although no actual assault had been committed. Questions have from time to time arisen as to what could be regarded as necessary within this rule; and quite apart from legislation, popular opinion has influenced courts of justice in requiring more from parents and employers than used to be required. But Parliament has also intervened to punish abandonment or exposure of infants under two years (24 and 25 Vict. c. 100, § 27), and the neglect or ill-treatment of apprentices or

servants (24 and 25 Vict. c. 100, § 26; 38 and 39 Vict. c. 86, § 6); and by the Poor Law Amendment Act, 1868, parents were rendered *summarily* punishable who wilfully neglected to provide adequate food, clothing, medical aid, or lodging for their children under 14 in their custody, whereby the health of the child was or was likely to be seriously injured. This enactment made no express exception in favour of parents who had not sufficient means to do their duty without resort to the poor law, and was construed as imposing criminal liability on parents whose peculiar religious tenets caused them advisedly to refrain from calling in a doctor to a sick child.

But the chief gain in the direction of adequate protection of children prior to 1889 lay less in positive legal enactment on the subject than in the institution of an effective system of police, whereby it became possible to discover and repress cruelty punishable under the ordinary law. It is quite inaccurate to say that children had very few rights in England, or that animals were better protected. But before the constitution of the present police force, and in the absence of any proper system of public prosecution, it is undeniable that numberless cases of neglect and ill-treatment went unpunished and were treated as nobody's business. In 1889 a special statute was passed to prevent cruelty to children, which was superseded in 1894 by the Prevention of Cruelty to Children Act, which now regulates the matter and specifically deals with the offence of "cruelty" to children. This offence can only be committed by a person over 16 in respect of a child under 16 of whom he has "custody," "charge," or "care." The Act presumes that a child is in the custody of its parents, step-parents, or a person cohabiting with its parent, or of its guardians; that it is in the charge of a person to whom the parent has committed such charge (*e.g.*, a schoolmaster), and that it is in the care of a person who has actual possession or control of it. Cruelty is defined as consisting in assault, ill-treatment (falling short of actual assault), neglect, or abandonment of the child in a manner likely to cause *unnecessary* suffering or injury to health, including injury to or loss of sight, hearing, or limb, or any organ of the body or any mental derangement; and the act or omission must be wilful, *i.e.*, deliberate and intentional, and not merely accidental or inadvertent. Though medical aid is not specified, it has been decided that for a member of the sect of Peculiar People not to call in a doctor may amount to an offence under the Act. The offence may be punished either summarily or on indictment, and the offender may be sent to penal servitude if it is shown that he was pecuniarily interested in the death of the child, *e.g.*, by having taken out one of these pernicious policies permitted under the Friendly Societies Acts. By § 23 (2) parents may be guilty of cruelty by neglect if they fail to apply for poor relief for their children in the event of their inability otherwise to maintain them.

This enactment overlaps the common law and the statutes already mentioned. Its real efficacy lies in the main in the provisions which facilitate the taking of evidence of young children, in permitting boards of guardians to prosecute at the expense of the rates, and in permitting a constable on arresting the offender to take the child away from the accused, and the court of trial on conviction to transfer the custody of the child from the offender to some fit and willing person. The Act has been utilized with great zeal and on the whole with much discretion by various philanthropic societies, whose members make it their business to discover the ill-treated and neglected children of all classes in society.

Besides the provisions above indicated directly dealing with cruelty to children, there was during Queen Victoria's reign much legislation in the interests of children, requiring their parents to procure their elementary education, forbidding the employment of children under 10 in business or trade for gain (except in the case of children licensed by justices to perform in public), and restricting the employment of children of school age unless they have attained a certain standard of proficiency, which in practice prevents children under 13 from being put to work (the Elementary Education Act, 1876). The labour of boys under 12 underground in mines is forbidden. And where children may legally be employed in factories or shops limitations are imposed with respect to their hours of labour and other matters. The special legislation against the employment of children in agricultural gangs and in sweeping chimneys is virtually obsolete, owing to changes in the conditions of these occupations and the subsequent enactments above indicated.

The Act of 1894 also prohibits custodians, &c., of children from taking them, or letting them be, in the street to beg or receive alms, or to sing, play, perform, or sell in the street or in public-houses between 9 P.M. and 6 A.M. These provisions apply to boys under 14 and girls under 16. There are further prohibitions (1) on allowing children under 11 to perform, &c., for gain in public-houses or places of public amusement at any hour without a license from a justice, which is granted only as to children over 7 and under stringent conditions; (2) on allowing children under 16 to be trained as acrobats or for any dangerous performance except by their parents or legal guardians. (W. F. C.)

# CHILE.

*Geography and Statistics.*—Chile, or Chili, extends along the S.W. coast of South America, from the Peruvian frontier at 17° 57′ S. lat. to Cape Horn at 55° 59′ S. lat.; total area about 266,460 square miles. After controversies extending over many years, the boundaries have been within recent years settled by treaties concluded with Bolivia, Peru, and the Argentine Republic. Of Northern Chile, the portion extending from 23° S. lat. to the river Loa, comprising the province of Antofagasta, formerly belonged to Bolivia; it was occupied by Chile in accordance with the truce agreement of 4th April 1884, and was definitely ceded by Bolivia by treaty of 1st May 1896. The province of Tarapacá, extending from the river Loa northwards to the river Camarones, 19° 12′ S. lat., was formerly Peruvian. It was occupied by Chile in 1880, and was definitely relinquished by Peru by agreement of 28th March 1884. Between the Camarones and the Sama rivers lies the province of Tacna, consisting of the departments of Tacna and Arica. Under the treaty of 20th October 1883 this province was to be held by Chile for ten years, after which a popular vote was to decide whether it should be definitely incorporated with Chile or should revert to Peru, the country retaining it to pay a sum of 10,000,000 pesos to the other. In consequence of disagreement as to the manner of voting and the persons entitled to vote, no action was taken at the end of the ten years' term; and a convention, signed at Santiago on 16th April 1898, for the taking of the plebiscite was in 1900 rejected by the Chilian Congress.

***Boundaries.***

The coast of Chile, especially towards the south, is broken by islands. Opposite the province of Atacama is Easter or Pascua Island; facing the coast of Concepcion is the small island of Quirquina; farther south are Santa Maria and Mocha; more important are the Chiloé archipelago, consisting of about 96 islands, the Chonos archipelago with over 1000 islands, and, in the extreme south, the archipelago of which the most important islands are Tierra del Fuego, Desolation, Santa Ines, Clarence, Dawson, and Diego Ramirez islands. The island of Juan Fernandez is 390 miles west of Valparaiso.

*Population.*—The population of Chile, according to census enumerations from 1875 to 1895, is given as follows:—

| Year. | Population. | Increase. |
|---|---|---|
| 1875 | 2,075,971 | 256,748 |
| 1885 | 2,527,320 | 451,349 |
| 1895 | 2,712,145 | 184,825 |

For the purpose of comparison these figures are of little value. Prior to 1885 the provinces of Antofagasta, Tarapacá, and Tacna were not included, and the returns for 1885 are imperfect. The area of the provinces and their population, according to the census of 1885 and of 1895, with the population per square mile in 1895, are given as follows:—

| Provinces. | Area, Sq. Miles. | Population, 1885. | Population, 1895. | Pop. per Sq. Mile, 1895. |
|---|---|---|---|---|
| Magallanes Territory | 75,270 | 2,085 | 5,170 | 0·06 |
| Chiloé | 4,008 | 73,420 | 77,750 | 19·40 |
| Llanquihué | 7,820 | 62,809 | 78,315 | 10·01 |
| Valdivia | 8,313 | 50,938 | 60,687 | 7·30 |
| Cautin | 3,127 | 33,291 | 78,221 | 25·01 |
| Malleco | 2,856 | 59,492 | 98,032 | 34·29 |
| Bio-Bio | 4,157 | 101,768 | 88,749 | 21·35 |
| Arauco | 4,246 | 73,658 | 59,237 | 13·95 |
| Concepcion | 3,534 | 182,459 | 188,190 | 53·25 |
| Nuble | 3,555 | 149,871 | 152,935 | 43·02 |
| Maule | 2,930 | 124,145 | 119,791 | 40·88 |
| Linares | 3,488 | 110,652 | 101,858 | 29·20 |
| Talca | 3,677 | 133,472 | 128,961 | 35·07 |
| Curicó | 2,912 | 100,002 | 103,242 | 35·45 |
| Colchagua | 3,794 | 155,687 | 157,566 | 41·53 |
| O'Higgins | 2,523 | 87,641 | 85,277 | 33·80 |
| Santiago | 5,221 | 329,753 | 415,636 | 79·60 |
| Valparaiso | 1,659 | 203,320 | 220,756 | 13·30 |
| Aconcagua | 6,225 | 144,125 | 113,165 | 18·18 |
| Coquimbo | 12,869 | 176,344 | 160,898 | 12·50 |
| Atacamá | 28,371 | 76,566 | 59,713 | 2·10 |
| Antofagasta | 47,918 | 21,213 | 44,085 | 0·92 |
| Tarapacá | 19,300 | 45,086 | 89,751 | 4·65 |
| Tacna | 8,685 | 29,523 | 24,160 | 2·78 |
| Total | 266,458 | 2,527,320 | 2,712,145 | 10·18 |

It is estimated that in the enumeration of 1895, 10 per cent. of the population, or about 271,214, were omitted. The total population at the date of the census would therefore be 2,983,359. The population on 31st December 1898 was officially estimated at 3,082,178. The foreign population of Chile in 1885 was returned at 65,000; in 1895 at 72,812. Of the number in 1895, 42,105 were European, 29,687 were American, 1020 were from Asiatic and other countries. Of the Europeans 8269 were Spanish, 7809 were French, 7587 Italian, 7049 German, 6241 British, 1570 Swiss, 1490 Austro-Hungarian.

The marriages, births, and deaths registered in the 277 registration circumscriptions in 1897 and 1898 were:—

| | 1897. | 1898. |
|---|---|---|
| Marriages | 13,454 | 13,921 |
| Births | 109,057 | 104,536 |
| Deaths | 88,456 | 83,919 |

The civil marriage law of 10th January 1884 and the civil registration law of 17th July 1884 came into force on 1st January 1885. The cost of registration is borne by the State. The registration of deaths is required before burial, so that it is fairly trustworthy; but the registration both of marriages and births is stated to be frequently eluded. The death-rate is high. In the cities of Santiago and Valparaiso it is stated to be little under 60 per 1000, the mortality among children being very great. With a view to remedy this evil an Act was passed in February 1896 making drainage compulsory in the centres of population. Immigration goes on under the care of colonization agencies, which in 1896 introduced 988 agricultural and 1114 industrial immigrants from Europe. In 1897 the total number introduced was 807. In 1898 the Government voted the sum of £46,300 to the assistance of immigration, and in 1899 £38,680 to the same purpose. The result, however, proved so unsatisfactory that the Government have discontinued their direct subsidies for the encouragement of immigration. The agricultural portion of Chile is in the south, where rain is almost incessant, the forest growth dense, and the labour of clearing a few acres out of all proportion to the profits. Moreover, roads are wanting, and there is no adequate protection for life and property against outlaws and other dangerous characters. The Government has therefore turned its attention to the improvement of existing settlements, and for this purpose a sum of money is provided in the budget of 1900. The enumerated population in 1895 consisted of 1,240,353 inhabitants of towns and 1,471,792 of rural districts. The principal cities and towns, with the census population of 1895 and the estimated population on 31st December 1898, are:—

| | 1895 | 1898. |
|---|---|---|
| Santiago | 256,413 | 311,704 |
| Valparaiso | 122,447 | 140,262 |
| Concepcion | 39,837 | 51,781 |
| Talca | 33,232 | 40,237 |
| Chillan | 28,738 | 32,769 |
| Iquique | 33,031 | 30,000 |
| Antofagasta | 13,530 | 16,795 |
| Curicó | 12,669 | 14,325 |
| Talcahuano | 10,431 | 14,284 |

**Constitution.** The political constitution of 1833 is, with some amendments, in force. The principal amendments were made by laws of 9th August 1888, 11th August 1890, 20th August 1890, 22nd December 1891, 7th July 1892. The Chamber of Deputies consists of members elected for three years directly by the registered electors of each department—one deputy for 30,000 inhabitants. The republic is divided into electoral districts and subdivided into sections of 150 inscriptions, the registers of which are kept by the municipal authorities. On the basis of the census returns of 1885, the number of deputies was fixed at ninety-four. Senators are similarly elected, but for six years, and they are chosen, not in departments, but in the provinces—one senator for every three deputies. For the Chamber of Deputies and for the Senate there are triennial elections, the Chamber being renewed entirely and the Senate to the extent of one-half every three years. For the Chamber and for the Senate the system of voting is cumulative. Senators and deputies are unpaid.

At the head of the executive power is the President of the Republic, chosen for five years indirectly by the nation, the electors being specially chosen by the provinces—three electors for each deputy. The election of the president takes place on 25th June of the last year of the presidential term, and the new president is inaugurated on 18th September following.

*Local Government.*—The Republic is divided into provinces, departments, and 282 municipal districts. Each municipal district has, by law of 22nd December 1891, a municipality or council of at least nine members chosen by popular election. At the sessions of the municipalities or councils the *intendentes*, governors, or sub-governors of the national government preside. In the municipal districts assemblies of electors are held under the presidency of the first mayor for the election of councillors, the sanctioning of the local budget or of local loans (which are limited in amount), and for other business. The total municipal revenues in 1896 amounted to 8,767,780 pesos, and the expenditure to 9,010,730 pesos. If the peso is taken at 1s. 6d., the revenues were equivalent to £657,580 and the expenditure to £675,800 sterling. The principal police force, the fiscal police, is maintained and commanded by the national government, but the municipal force is still under the control of the municipalities. In Tacna municipal administration is carried on conjointly by the political heads of the departments and by councils (juntas) of three members appointed for three years by the president of the republic. There is a similar system in the territory of Magallanes.

*Education.*—Public education is free (at the cost of the State), but not compulsory. It is directed by a council, at the head of which is the minister of public instruction. Higher and secondary education are given in the university and the national institute at Santiago, and in the provincial colleges or *liceos*. In 1899 there were 573 university degrees and diplomas conferred. Besides the State university, there is a Catholic university giving instruction

in theology, in law, and in mathematical and physical science. In 1899 the national institute had 1168 pupils. There are in Chile six clerical seminaries which receive a small government subvention. Three colleges for girls are maintained by the State, and many schools for girls receive subventions. There are, besides, normal, agricultural, technical, and commercial schools. The estimates for 1898 provided a sum of £150,000 for higher and secondary education. In 1899 there were in Chile 1403 public primary schools (435 for boys, 276 for girls, and 692 mixed), with 2299 teachers (748 male and 1551 female); the enrolled pupils numbered 115,535 (56,278 boys and 59,257 girls), and the average attendance 70,607 (33,746 boys and 36,861 girls). The cost of primary instruction was £156,000. There were also, in 1899, 445 private elementary schools (148 for boys, 50 for girls, and 247 mixed) with 26,294 enrolled pupils (15,885 boys and 10,409 girls). Private schools devoted solely to popular education are assisted by the State. The German colonies of Valdivia and Llanquihué have excellent schools.

*Crime.*—The penal establishments of Chile, 87 in number (including the two penitentiaries at Santiago and Talca), have been under direct government administration since 1891. On 1st January 1900 they contained 7051 criminals (6219 men and 832 women). The total number of prisoners they received during the year 1899 was 34,429, of whom 28,037 were male and 6392 female. In 1899, 432 boys were sent to the two correctional schools.

*Charity.*—In Chile there are numerous charitable institutions supported by endowments, legacies, donations, subscriptions, and government contributions. In 1897 State assistance was given to 79 hospitals to the amount of £65,000; to two lunatic asylums to the amount of £18,400; and to other institutions, £17,015. In Santiago in 1898 over £15,000 was spent in enlarging and improving the hospitals, but in many of the provinces the distress and poverty are very great, and the hospital accommodation is insufficient.

*Finance.*—The ordinary revenue and expenditure of Chile in 1892 and in the last four years were as follows (1 peso = 18d.):—

| Years | Revenue. | Expenditure. |
|---|---|---|
| | £ | £ |
| 1892 | 4,680,000 | 4,567,500 |
| 1896 | 6,099,600 | 6,271,000 |
| 1897 | 6,407,900 | 6,346,000 |
| 1898 | 6,635,300 | 6,579,500 |
| 1899 | 6,475,450 | 6,059,500 |

The estimated revenue and expenditure for 1900 were as follows (pesos at 18d.):—

| Revenue | | Expenditure. | |
|---|---|---|---|
| Ordinary— | £ | Ordinary— | £ |
| Export duties | 3,486,320 | Interior | 758,100 |
| Import duties | 1,537,500 | Finance | 1,531,680 |
| Railways | 937,500 | War, marine | 1,450,870 |
| Posts, telegraphs | 90,000 | Railways | 1,542,770 |
| Various | 333,750 | Justice, instruction | 793,960 |
| | | Various | 365,900 |
| Total | 6,385,070 | | |
| Extraordinary | 1,525,830 | Total | 6,443,280 |
| | | Extraordinary | 1,125,000 |
| Grand total | 7,910,900 | | |
| | | Grand total | 7,568,280 |

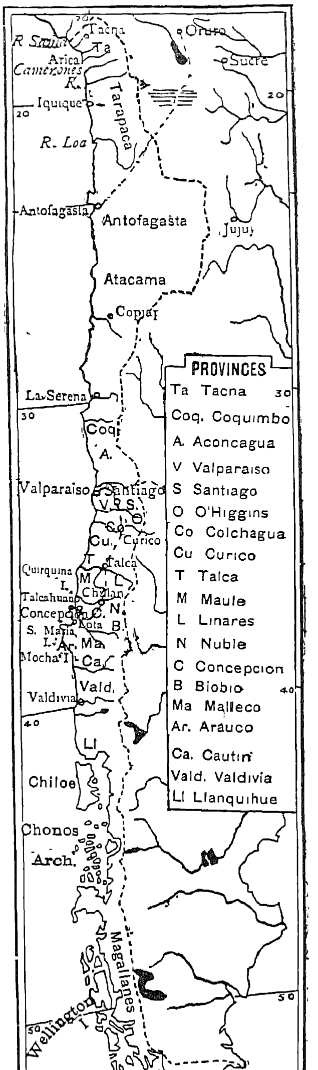
The export duties are levied mainly on nitrate and iodine.

Recent additions to the external debt of Chile have been incurred mainly for the satisfaction of claims arising out of the occupation of Peru, for railway construction, and other public works, and for the payment of floating and municipal debts. The internal debt consists of municipal debts, annuities ("censos"), a 3 per cent. debt, and the debt arising from the issue of notes under the law of 7th July 1898, amounting to 46,691,400 pesos. There is due also a balance on treasury bills discounted in London. The debt outstanding on 31st December 1899, and the debt charge were as follows:—

| Description of Debt. | Capital. | Charge. |
|---|---|---|
| External debt | £17,541,785 | £965,405 |
| Internal obligations— | | |
| Amount, 72,892,118 pesos | 5,466,908 | |
| Charge, 1,343,485 ,, | ... | 100,261 |
| Treasury bills, due in 1900 | 166,666 | 166,666 |
| Total | £23,175,359 | £1,232,332 |

To be set off against this debt is the value of government property, which (exclusive of government buildings) was estimated in 1897 to amount to 371,290,258 pesos or £27,846,800 sterling. A more recent estimate, based on actual prices, puts the value as follows in sterling: Nitrate fields, £3,000,000; guano deposits, £100,000; State railways, £12,000,000; State telegraphs, £50,000; State lands, £2,500,000; Talcahuano dock, £450,000; movable property, £80,000—total, £18,180,000.

The value of the real property held in 1896 by corporations was returned at 55,875,021 pesos (£4,190,630), and that held by private persons at 1,436,125,688 pesos (£107,709,430)—total, 1,492,000,709 pesos (£111,900,060). The mortgages on private estates amounted to 200,236,400 pesos (£15,018,730). In 1899, however, the price of land had fallen 30 or 40 per cent., so that the value of real estate in private ownership did not exceed 950,000,000 pesos (£71,250,000), while the mortgages had risen to 215,000,000 pesos (at par £16,125,000). The total value of real property (exclusive of government property) in 1899 may be put at about 1,000,000,000 pesos (£75,000,000 at par, or about £63,000,000 at the current rate of exchange).




SKETCH MAP OF CHILE.

*Defence.*—The army of Chile, according to the law of 24th November 1897, must not exceed 9000 men. The strength for 1900 was fixed at 5885, with 913 officers. This force is organized in 1 regiment (2 battalions) of coast artillery, 5 regiments of field artillery, 10 of infantry, 8 of cavalry, 1 corps of engineers (4 companies), 2 corps of pensioners, and the whole is distributed among the four military zones into which Chile is divided. For the last ten years German drill instructors have been employed; Mauser and Mannlicher rifles are used, and the batteries have Krupp guns of the newest type. By law of 12th February 1896 the National Guard consists of three branches—the active, comprising all citizens of 20 and 21 years of age; the passive, all over 21 years of age who have completed their service in the active; the sedentary, all from 30 to 40 years of age who are married. The total number in the National Guard is about 513,000, with 2400 officers. The Territorial Guard, numbering 19,862, organized in 1896 to defend the passes of the Andes, was disbanded in 1898. In Chile there are three military schools, a military museum, a cartridge factory, and other military establishments. The navy in 1899 consisted of 3 battleships, launched respectively in 1890, 1874, and 1865; 2 armoured cruisers; 2 second-class and 2 third-class cruisers; 11 gunvessels and gunboats; 4 destroyers, launched at Birkenhead in 1896, and all of a speed of more than 30 knots; 15 first-class and 4 second-class torpedo-boats. There are also training and school ships, and craft for special service. In order to reduce expenditure, several vessels were laid up in 1899. In 1898 the navy had 368 commissioned and staff officers and 3794 warrant officers and men. Naval schools were founded in 1893. A number of steamers of the South American Steamboat Company are subventioned and held at the disposal of the Government for transport service.

*Agriculture.*—The region most favourable for agriculture extends from Santiago to Concepcion, where large quantities of wheat are grown, and barley, maize, oats, and rye are also cultivated. Many industrial plants prosper in this region, notably the sugar beet, flax, colza, sorghum, hops, and tobacco. The grape thrives well, and nearly 15,000 acres are planted with vines. South of the agricultural region the climate is rainy, but the forest growth is luxuriant, and a great timber traffic is carried on. Stock-raising has considerable importance in Chile, more especially the rearing of sheep, vicuña, and hogs. The country is estimated to contain

about 3 million head of cattle and $3\frac{1}{2}$ million sheep, but there are no official statistics on the subject. About $1\frac{1}{2}$ millions of the population are dependent on agriculture, and the country produces annually some $28\frac{1}{2}$ million bushels of wheat and $8\frac{1}{2}$ million bushels of other cereals, apart from fruits, vegetables, &c. Bee-keeping has some importance in the south, the annual export of honey being about 2800 tons.

*Nitrate Production.*—By the acquisition of the provinces of Tarapacá and Antofagasta (1880-84) and the occupation of the province of Tacna, Chile obtained a vast addition to its mineral resources. The guano deposits lying on the coast of this region are nearly exhausted, but farther inland lies the nitrate zone, stretching, with a breadth of about three miles, from the Azapa valley in the province of Tacna, through the province of Tarapacá and into the desert of Atacamá, a total length of about 250 miles. In the provinces of Tarapacá and Antofagasta there are many refineries for purifying the crude [illegible], the centre of the industry being at Iquique.

The weight (metric tons) and value of nitrate of soda exported from 1879 onwards were as follows:—

| Years. | Tons. | Value. | Years. | Tons. | Value. |
|---|---|---|---|---|---|
| 1879 | 59,348 | £751,690 | 1889 | 921,380 | £5,771,220 |
| 1880 | 226,090 | 2,290,710 | 1890 | 1,026,290 | 5,950,470 |
| 1881 | 358,100 | 3,624,530 | 1891 | 891,720 | 5,174,500 |
| 1882 | 489,340 | 4,543,900 | 1892 | 797,820 | 5,030,630 |
| 1883 | 584,790 | 5,073,560 | 1893 | 947,020 | 6,208,650 |
| 1884 | 559,640 | 3,984,140 | 1894 | 1,081,330 | 7,018,680 |
| 1885 | 429,660 | 3,191,040 | 1895 | 1,220,420 | 7,208,680 |
| 1886 | 452,780 | 3,044,750 | 1896 | 1,111,750 | 6,955,850 |
| 1887 | 712,760 | 4,456,070 | 1897 | 1,057,630 | 5,928,290 |
| 1888 | 784,240 | 5,361,730 | 1898 | 1,294,220 | 6,800,650 |

The output for export in 1899 was estimated at 1,360,000 tons, worth about £9,375,000 at the prices quoted in October.

From the saline waters iodine is extracted in large quantities. The quantity of iodine exported in 1897 was 535,430 lb, and in 1898, 517,460 lb.

*Other Minerals.*—Copper is found in abundance, notably in the provinces of Taracapá, Antofagasta, Atacamá, Coquimbo, Aconcagua, Santiago, and Maule. In 1876 the quantity of bar copper exported reached 41,766 tons, and in 1878, 40,894 tons; but since then the output and the exportation have declined. During the eight years 1891-98 the export was as follows:—

| Years. | Tons. | Years. | Tons. |
|---|---|---|---|
| 1891 | 17,464 | 1895 | 20,042 |
| 1892 | 19,144 | 1896 | 20,592 |
| 1893 | 19,328 | 1897 | 19,011 |
| 1894 | 19,640 | 1898 | 20,600 |

Copper is exported in other forms in small quantities. In 1898, 3078 tons of copper ingots, 419 tons of copper and silver ingots, and 20,301 tons of copper ore were sent abroad. The production of copper in 1899 was estimated at 25,000 tons.

Gold and silver mining are carried on in various parts of Chile. Gold mining prospers at Taltal in the north, at several places in the central region, in the Magallanes territory, and in Tierra del Fuego. Rich alluvial deposits have been found at Lonquimai, in the province of Temuco, and the future output will probably show a large increase. The exact amount of silver produced is not easily ascertained, as the official statement includes a quantity of Bolivian silver passing through Chilian ports as if it were Chilian. The export of bar gold and silver from 1893 to 1898 was—

| Years. | Gold. Ounces. | Silver. Ounces. |
|---|---|---|
| 1893 | 24,224 | 4,512,850 |
| 1894 | 47,435 | 4,942,200 |
| 1895 | 38,082 | 4,782,210 |
| 1896 | 34,321 | 4,861,930 |
| 1897 | 36,383 | 4,614,850 |
| 1898 | 52,420 | 4,493,170 |

The value of gold exported in 1897 was £160,000, and of silver £540,000. Iron, manganese, lead, cobalt, nickel, zinc, bismuth are abundant in various provinces. The city of Coronel is the centre of the coal industry; in 1898 the coal output amounted to 282,600 tons.

The most important industries are connected with the mineral output. There are about 55 nitrate refineries in the nitrate district, the chief being at Lagunas; and there are works for the extraction of iodine. There are silver works at Playa Blanca; copper works at Lota, in Concepcion, and other places; sulphur works at Valparaiso, Santiago, and Concepcion. In Valdivia there are iron-foundries for the manufacture of saws and other tools for forest work. Other industries are distilling from native produce, brewing, flour-milling, and sugar-refining.

The distribution of the industries and the number of hands employed in the several groups are shown thus:—

| Localities. | Industries. | Number of Workers. |
|---|---|---|
| Northern Chile | Nitrate | 55,000 |
| North and Central Chile | Mining | 30,000 |
| Central and South Chile | Manufacturing | 44,704 |
| ,, ,, | Agricultural | 400,000 |
| ,, ,, | Stock-raising | 12,000 |

*Commerce.*—The annual value of the imports and exports, at intervals of five years from 1886 and in the years 1897-99, is shown in the subjoined table. Conversions have been made for years up to and including 1896 at the rate of 38d. to the peso, for 1897-99 at 18d. to the peso:—

| Years. | Imports. | Exports. |
|---|---|---|
| 1886 | £6,993,600 | £[illegible],113,100 |
| 1891 | 10,005,700 | 10,401,800 |
| 1896 | 11,729,800 | 11,773,500 |
| 1897 | 10,365,800 | 10,217,300 |
| 1898 | 7,669,700 | 12,605,200 |
| 1899 | 7,969,500 | 12,232,960 |

Of the imports in 1898, 71 per cent. in value, and of the exports 56 per cent. in value were subject to duty. The import duties amounted to £1,602,770; the export duties to £3,106,100. The most important article of export is nitrate, the value of the shipments of which amounted in 1886 to £3,044,760; in 1891, to £5,122,900; in 1896, to £6,955,900; in 1897, to £5,943,700; in 1898, to £6,800,650. The value of the iodine exported in 1891 was £671,342; in 1896, £326,790; in 1897, £384,617; in 1898, to £270,720. Of metals, the most important exports are copper in bars, amounting in 1886 to £1,296,18[illegible]; in 1891, to £771,600; in 1896, to £815,100; in 1897, to £893,780; in 1898, to £1,248,396. Bar silver was exported in 1886 to the value of £1,039,410; in 1891, £713,670; in 1896, £662,300; in 1897, £598,680; in 1898, to £523,986. Of agricultural produce the chief export is wheat, amounting in 1886 to the value of £773,360; in 1891, to £1,146,290; in 1896, to £653,450; in 1897, to £411,400; in 1898, to £575,234. The chief imports and exports in 1899 were as follows (conversion for both being made at 18d. to the peso):—

| Imports. | | Exports. | |
|---|---|---|---|
| Food articles | £1,327,250 | Mineral | £10,322,800 |
| Textiles | 2,179,350 | [illegible] | 794,850 |
| Raw materials | 1,626,700 | [illegible] | 289,650 |
| Watches, jewellery, &c. | 156,850 | Animals and animal products | 378,750 |
| Machinery, &c. | 952,130 | Wines, &c. | 24,946 |
| Domestic articles | 426,460 | | |
| Paper, &c. | 220,600 | | |
| Drugs, &c. | 126,800 | | |

Of the value of imports in 1899, 41 per cent. were from Great Britain, 28 per cent. from Germany, 8 per cent. from the United States. Of the exports, 67 per cent. in value went to Great Britain, 13 per cent. to Germany, 5 per cent. to France, 4 per cent. to the United States. Of the imports in 1899, 63 per cent. in value was landed at Valparaiso, 12 per cent. at Talcahuano, 10 per cent. at Iquique. Of the exports in 1899, 43 per cent. in value was shipped from Iquique, 11 per cent. from Valparaiso, 9 per cent. from Pisagua. During 1899 trade was hampered by the depreciation of the currency and the fluctuation in the exchange value of the peso consequent on the suspension of the conversion law.

*Shipping.*—In 1898, 7691 vessels of a total tonnage of 10,152,443 entered, and 7671 of 10,032,661 tons cleared. Of the vessels entered, 1923 of 3,167,579 tons, and of those cleared, 1831 of 2,944,209 tons were engaged in foreign trade. British vessels numbering 1004, with a total tonnage of 1,738,362, entered from, and 947 with a tonnage of 1,578,325 cleared for, ports outside of Chile. In the coasting trade 2057 British vessels with a tonnage of 3,164,515 entered, and 2081 of 2,246,230 tons cleared. In 1899, in the foreign and coasting trade, 7267 vessels of altogether 10,016,704 tons entered and 7154 of 9,738,769 tons cleared at the ports of Chile. At the end of 1899 the merchant marine of Chile consisted of 142 vessels with an aggregate tonnage of 71,214 tons, including 39 steamers with a total of 27,387 tons. Chile is in regular communication with other American countries and with Europe by Chilian, English, German, and French lines of steamers.

*Communications.*—Chile has about 43,500 miles of public highways, with 25,000 miles of less important roads, and the length of navigable rivers is put at 2800 miles.

The total extent of railway line within the republic in 1899 reached 2886 miles, of which 1458 miles belonged to the State and the remainder to companies. The projected trans-continental railway has been constructed on the Chilian side as far as Salto del Soldado, but 46 miles of line are still required to unite it with the Argentine section. The capital invested in the State railways up to the end of 1899 was approximately 85,907,165 pesos, which (at

18d. = 1 peso) would be equivalent to £6,443,440. The gross revenue in 1899 amounted to 13,997,799 pesos (£1,049,840) and the expenditure to 13,911,782 pesos (£1,043,280).

At Santiago there are 65 miles of tramway in process of conversion so as to be worked by electric traction. At Valparaiso the tramways are worked by horse-power.

*Post, Telegraph, and Telephone.*—In 1899 the Chilian post-office despatched 13,033,608 letters and post-cards, and 18,907,252 printed and other packets; the gross postal revenue amounted to 1,023,377 pesos (£76,750), and the expenditure to 1,065,612 pesos (£79,920). In the same year the State had 9970 miles of telegraph and telephone line, with 11,200 miles of wire, by which during the year 1,183,691 telegrams were sent and 17,831,234 conversations held, the total telegraph receipts having amounted to 613,003 pesos (£45,975). There were, besides, about 2610 miles of railway and private telegraph line. Telephonic communication has been established in all the principal towns, and two companies, one British, the other Chilian, furnish connexion between Santiago and Valparaiso, and between these cities and many smaller towns.

*Money and Credit.*—In Chile there are 23 joint-stock banks of issue, with an aggregate registered capital of 40,689,665 pesos (£3,051,720) and a note issue in July 1898 of 12,733,160 pesos (or, at par, £954,990). On 31st July 1898 the national government advanced to the banks notes amounting to 27,989,929 pesos (£2,099,240) at 2 per cent. interest per annum—the total note issue for which the banks were responsible being thus raised to 40,723,089 pesos (£3,054,230). In addition, the treasury put in circulation at the same date notes amounting to 17,693,890 pesos (£1,327,040), and is also responsible for notes for 1,193,641 pesos (£89,520), issued before 1896. There are four banks not banks of issue, and also 15 mortgage banks. The latter issue bonds on real property for, professedly, not more than half its value, and these bonds are sold in open market. The value in circulation in 1899 was officially stated to amount to 155,827,119 pesos (£11,687,030); but as the price of land has recently fallen, several estates having been sold at 40 per cent. of their nominal value, while large arrears of interest (probably not less than 3,000,000 pesos, or £225,000) are due to the banks, the condition of landed property seems unsatisfactory.

*Monetary System.*—The monetary unit of Chile is the uncoined gold peso. Under the law of 11th February 1895 the gold coins are the *condor* of 20 pesos, the *doblon* of 10 pesos, and the *escudo* of 5 pesos. All gold coins are eleven-twelfths fine. The doblon weighs 5·99103 grammes or 92·4536 grains. The gold peso is of the value of 18d., or 13⅓ pesos are equivalent to £1 sterling. The peso is equivalent also to 36½ United States cents. Under the same law silver coins are ·835 fine. The silver peso weighs 20 grammes or 308·64 grains, and the fractional coinage is of corresponding weight. By law of 10th January 1899, however, the coinage of fractional silver money only five-tenths fine to the amount of 5,000,000 pesos within two years was authorized.

Specie payments and the exchange of gold for silver by the mint resumed on 1st June 1895 were suspended by Act of 31st July 1898, which authorized the issue of 50,000,000 pesos in paper money with a forced circulation, and empowered the president to raise a loan of £4,000,000 sterling for the ultimate withdrawal of the notes. The immediate result was the withdrawal of gold and silver from circulation and a rapid fall in the value of the notes, which at the end of 1899 were still at a discount of 18 per cent. In 1901 the conversion scheme was postponed till October 1903.

*Weights and Measures.*—The metric system of weights and measures is the legal standard of Chile, but the old Spanish methods are still widely used, especially in reference to mining and farm produce. Nitrate of soda, even in official reports, is almost invariably calculated by the quintal (101·40 English pounds). In silver and copper mining the *marc* (8 ounces) is commonly used to express the richness of the metal. Farm produce is generally sold by the *arroba* or *fanega*, whilst the *vara* in lineal measurement, and the *cuadra* for indicating the superficial area of land, are customary amongst the country people.

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(W. W. R.; C. E. A.)

*Political History since 1881.*—At the opening of 1881 the war between Chile and Peru had reached a stage when the final struggle was close at hand. On 13th January of that year the Chilian forces under command of General Baquedano attacked the entrenched positions of the Peruvians at daybreak in the vicinity of Chorillos, a village some few miles from Lima and forming the outer line of defence for the capital. The fight was a very severe one—the defenders, posted behind loop-holed mud walls, offering a most stubborn resistance to the advance of the invading army. The day ended in victory for the attacking forces, but with a loss of 800 killed and 2500 wounded; the Peruvian casualties were 5000 killed, 4000 wounded, and 2000 officers and men taken prisoners. On the following day negotiations for peace were attempted by the representatives of the foreign powers in Lima, the object being to avoid, if possible, any further bloodshed. This attempt to end the conflict proved, however, abortive, and on 15th January at 2 P.M. hostilities recommenced in the neighbourhood of Miraflores. After severe fighting for some four hours the Chilians again proved victorious, and drove the Peruvians from the second line of defence back upon the city of Lima. In this battle the invaders lost 500 men killed and 1625 wounded, the Peruvians about 3000 killed and wounded. Lima, the capital of Peru, was at the mercy of the Chilians after this last action, and on 17th January a division of 4000 men of all arms, under the command of General Cornelio Saavedra, was sent forward to occupy the Peruvian capital and restore order within the town limits. A portion of the Chilian forces was shortly afterwards withdrawn from Peru, and the army of occupation remaining in the conquered country was in charge of Admiral Patricio Lynch, an officer who had been specially promoted for distinguished services during the war. President Anibal Pinto of Chile now set about to find means to conclude a treaty of peace with Peru, but his efforts in this direction were frustrated by the armed resistance offered in the country districts to the Chilian authorities by the remainder of the Peruvian forces under command of General Cáceres. So matters continued—the Chilians administering on the seaboard and in the principal towns, the Peruvians maintaining a guerilla warfare in the mountainous districts of the interior. In September 1881 the term of office of President Pinto expired, and he was succeeded in the post of chief executive of Chile by President Domingo Santa Maria. Ex-President Pinto died three years later in Valparaiso, leaving a memory respected and admired by all political parties in his country. The name of Pinto will always occupy a prominent place in the annals of Chilian history, not only because the war with Peru took place during his term of office, but also on account of the fact that it was largely due to the intelligent direction of all details by the President during the struggle that the Chilian arms proved so absolutely successful by land and sea.

**Close of the war with Peru.**

Señor Domingo Santa Maria, who now acceded to the presidency of Chile, was a Liberal in politics, and had previously held various important posts under the Government. Under the rule of President Montt he had been

an active member of the Opposition and involved in various revolutionary conspiracies; for his participation in these plots he was at one time exiled from the country, but returned and received official employment under President Perez. The principal task confronting President Santa Maria on assuming the presidency was to negotiate a treaty of peace with Peru and provide for the evacuation of the Chilian army of occupation. The presence of the Peruvian General Cáceres and his forces in the interior of Peru prevented for some two years the formation of any Peruvian national administration in Lima with which the Chilian authorities could deal. In August of 1883 the Peruvians were defeated by the forces commanded by Admiral Lynch, and a Government was then organized under the leadership of General Iglesias. A provisional treaty of peace was then drawn up and signed by General Iglesias and the Chilian representative, and this was finally ratified by the Chilian and Peruvian Congresses respectively in April 1884. By the terms of this treaty Peru ceded to Chile unconditionally the province of Tarapacá, and the provinces of Tacna and Arica were placed under Chilian authority for the term of ten years, the inhabitants having then to decide by a general vote whether they remained a part of Chile or elected to belong once more to Peru. In the event of the decision being favourable to Peru a sum of 10,000,000 dollars was to be paid by Peru to Chile. On the ratification of this treaty the Chilian forces were immediately withdrawn from Lima and other points of occupation in Peruvian territory. The Government of Bolivia also attempted to negotiate a treaty of peace with Chile in 1884, and for this purpose sent representatives to Santiago. No satisfactory terms, however, could be arranged, and the negotiations ended in only an armistice being agreed to, by which Chile remained in occupation of the Bolivian seaboard pending a definite settlement at some future period.

*President Santa Maria.*

The administration of President Santa Maria met with violent opposition from the Conservatives, who included the Clerical party in their ranks, and also from a certain section of the Liberals. The dislike of the Conservatives to President Santa Maria was occasioned by his introduction of the law of civil marriage, the civil registration of births and deaths, and the freeing of the cemeteries. Hitherto no marriage was legal unless celebrated according to the rites of the Roman Catholic religion, and all registers of births and deaths were kept by the parish priests. Civil employees were now appointed under the new laws to attend to this work. Formerly the cemeteries were entirely under the control of the Church, and, with the exception of a few places specially created for the purpose, were reserved solely for the burial of Roman Catholics. Under the new régime these cemeteries were made common to the dead of all religions. Under President Perez, in 1865, a clause in the law of constitution had been introduced permitting the exercise of all creeds of religion, and this was now put into practice, all restrictions being removed. On several occasions, notably in 1882 and 1885, President Santa Maria used his influence in the elections of senators and deputies to Congress for the purpose of creating a substantial majority in his favour. He was induced to take this course in consequence of the violent opposition raised in the Chambers by the liberal policy he pursued in connexion with Church matters. This intervention caused great irritation amongst the Conservatives and dissentient Liberals, and the political situation on more than one occasion became so strained as to bring the country to the verge of armed revolution. No outbreak, however, took place, and in 1886 the five years of office for which President Santa Maria had been elected came to an end, and another Liberal, Señor Balmaceda, then succeeded to power.

The election of Balmaceda was bitterly opposed by the Conservatives and dissentient Liberals, but was finally successfully carried by the official influence exercised by President Santa Maria. On assuming office President Balmaceda endeavoured to bring about a reconciliation of all sections of the Liberal party in Congress and so form a solid majority to support the administration, and to this end he nominated as ministers representatives of the different political groups. Six months later the Cabinet was reorganized, and two most bitter opponents to the recent election of President Balmaceda were accorded portfolios. Believing that he had now secured the support of the majority in Congress on behalf of any measures he decided to put forward, the new President initiated a policy of heavy expenditure on public works, the building of schools, and the strengthening of the naval and military forces of the republic. Contracts were given out to the value of £6,000,000 for the construction of railways in the southern districts; some 10,000,000 dollars were expended in the erection of schools and colleges; three cruisers and two sea-going torpedo boats were added to the squadron; the construction of the naval port at Talcahuano was actively pushed forward; new armament was purchased for the infantry and artillery branches of the army, and heavy guns were acquired for the purpose of permanently and strongly fortifying the neighbourhoods of Valparaiso, Talcahuano, and Iquique. In itself this policy was not unreasonable, and in many ways extremely beneficial for the country. Unfortunately corruption crept into the expenditure of the large sums necessary to carry out this programme. Contracts were given by favour and not by merit, and the progress made in the construction of the new public works was far from satisfactory. The opposition in Congress to President Balmaceda began to increase rapidly towards the close of 1887, and further gained ground in 1888. In order to ensure a majority favourable to his views, the President threw the whole weight of his official influence into the elections for senators and deputies in 1888; but many of the members returned to the Chambers through this official influence joined the Opposition shortly after taking their seats. In 1889 Congress became distinctly hostile to the administration of President Balmaceda, and the political situation became grave, and at times threatened to involve the country in civil war. According to usage and custom in Chile, a ministry does not remain in office unless supported by a majority in the Chambers. Balmaceda now found himself in the impossible position of being unable to appoint any ministry that could control a majority in the Senate and Chamber of Deputies and at the same time be in accordance with his own views of the administration of public affairs. At this juncture the President assumed that the Constitution gave him the power of nominating and maintaining in office any ministers he might consider fitting persons for the purpose, and that Congress had no right of interference in the matter. The Chambers were now only waiting for a suitable opportunity to assert their authority. In 1890 it was stated that President Balmaceda had determined to nominate and cause to be elected as his successor at the expiration of his term of office in 1891 one of his own personal friends. This question of the election of another President brought matters to a head, and Congress refused to vote supplies to carry on the Government. To avoid trouble Balmaceda entered into a compromise with Congress, and agreed to nominate a ministry to their liking on condition that the supplies for 1890 were voted.

*Balmaceda elected President.*

This Cabinet, however, was of short duration, and resigned when the ministers understood the full amount of friction between the President and Congress. Balmaceda then nominated a ministry not in accord with the views of Congress, and, to prevent any expression of opinion upon his conduct in the matter, refrained from summoning an extraordinary session of the legislature for the discussion of the estimates of revenue and expenditure for 1891. When 1st January 1891 arrived, the President published a decree in the *Diario Oficial* to the effect that the budget of 1890 would be considered the official budget for 1891. This act was illegal and beyond the attributes of the executive power. As a protest against the action of President Balmaceda, the Vice-President of the Senate, Señor Waldo Silva, and the President of the Chamber of Deputies, Señor Ramon Barros Luco, issued a proclamation appointing Captain Jorje Montt in command of the squadron, and stating that the navy could not recognize the authority of Balmaceda so long as he did not administer public affairs in accordance with the constitutional law of Chile. The majority of the members of the Chambers sided with this movement, and on 7th January Señores Waldo Silva, Barros Luco, and a number of senators and deputies embarked on board the Chilian warship *Blanco Encalada*, sailing out of Valparaiso harbour and proceeding northwards to Tarapaca to organize armed resistance against the President. It was not alone this action of Balmaceda in connexion with Congress that brought about the revolution. He had alienated the sympathy of the aristocratic classes of Chile by his personal vanity and ambition. The oligarchy composed of the great landowners have always been an important factor in the political life of the republic; when President Balmaceda found that he was not a *persona grata* to this circle he determined to endeavour to govern without their support, and to bring into the administration a set of men who had no traditions and with whom his personality would be all-powerful. The Clerical influence was also thrown against him in consequence of his radical ideas in respect of Church matters.

*Outbreak of the revolution of 1891.*

Immediately on the outbreak of the revolution President Balmaceda published a decree declaring Montt and his companions to be traitors, and without delay organized an army of some 40,000 men for the suppression of the insurrectionary movement. Meanwhile the squadron under Montt had obtained possession of Iquique after some severe fighting, the garrison of that district offering a stout resistance to the landing of the rebel forces from the men-of-war. Tarapacá was the key of the position in Chile at this moment, the possession of that district and the port of Iquique meaning that money could be obtained freely from the export duties on nitrate of soda. A lull now occurred in the struggle while both sides were preparing for the final shock. President Balmaceda administered the government under dictatorial powers with a Congress of his own nomination. In June 1891 Balmaceda ordered the presidential election to be held, and Señor Claudio Vicuña was duly declared chosen as President of the republic for the term commencing in September 1891. The resources of Balmaceda were running short on account of the heavy military expenses, and he determined to dispose of the reserve of silver bullion accumulated in the vaults of the Casa de Moneda in accordance with the terms of the law for the conversion of the note issue. The silver was conveyed abroad in a British man-of-war, and disposed of partly for the purchase of a fast steamer to be fitted as an auxiliary cruiser and partly in payment for other kinds of war material.

The organization of the revolutionary forces went on slowly. Much difficulty was experienced in obtaining the necessary arms and ammunition. A supply of rifles was bought in the United States, and embarked on board the *Itata*, a Chilian vessel in the service of the rebels. The United States authorities refused to allow this steamer to leave San Diego, and a guard was stationed on the ship. The *Itata*, however, slipped away and made for the Chilian coast, carrying with her the representatives of the United States. A fast cruiser was immediately sent in pursuit, but only succeeded in overhauling the rebel ship after she was at her destination. The *Itata* was then forced to return to San Diego without landing her cargo for the insurgents. The necessary arms and ammunition were arranged for in Europe; they were shipped in a British vessel, and transferred to a Chilian steamer at Fortune Bay, in Tierra del Fuego, close to the Strait of Magellan and the Falkland Islands, and thence carried to Iquique, where they were safely disembarked early in July 1891. A force of 10,000 men was now raised by the *junta* of the revolution, and preparations were rapidly pushed forward for a move to the south with the object of attacking Valparaiso and Santiago. Early in August a portion of the revolutionary squadron, comprising the *Blanco Encalada* and other ships, was sent to the southward for reconnoitring purposes, and put into the port of Caldera. During the night, and whilst the *Blanco Encalada* was lying quietly at anchor, a torpedo boat called the *Almirante Lynch*, belonging to the Balmaceda faction, steamed into the bay of Caldera and discharged a torpedo at the rebel ship. The *Blanco Encalada* sank in a few minutes, and 300 of her crew perished.

*Civil war.*

In the middle of August 1891 the rebel forces were embarked at Iquique, numbering in all about 9000 men, and sailed for the south. On 21st August the insurgent army was disembarked near Concon, about twenty miles north of Valparaiso. A severe fight ensued, in which the troops of President Balmaceda were defeated with heavy loss. This reverse roused the worst passions of the President, and he ordered the arrest and imprisonment of all persons suspected of sympathy with the revolutionary cause. The population generally were, however, distinctly antagonistic to Balmaceda; and this feeling had become accentuated since 17th August 1891, on which date he had ordered the execution of a number of youths belonging to the military college at San Lorenzo on a charge of seditious practices. The shooting of these boys created a feeling of horror throughout the country, and a sensation of uncertainty as to what measures of severity might not be practised in the future if Balmaceda won the day. After the victory at Concon the insurgent army, under command of General Campos, marched in a southerly direction towards Viña del Mar, and thence to Placilla, where the final struggle in the conflict took place. Balmaceda had massed his troops in the vicinity, and confidently expected a victory on account of the superior number of his forces. The fighting was fierce, but the rebel artillery was well directed and thoroughly prepared the way for an assault of the positions. The rebels drove their opponents at the point of the bayonet from one line of trenches to another, until they remained absolute masters of the field and the Balmacedist army was in full flight without attempting to preserve any sort of order or discipline. Three days later the victorious insurgents entered Santiago and assumed the government of the republic. After the battle of Placilla it was clear to President Balmaceda that he could no longer hope to find a sufficient strength amongst his adherents to maintain himself in power, and in view of the rapid approach of the rebel army he abandoned his official duties to seek an asylum in the Argentine Legation.

*Defeat and suicide of Balmaceda.*

The President remained concealed in this retreat until 18th September. On the evening of that date, when the term for which he had been elected President of the republic terminated, he committed suicide by shooting himself. The excuse for this act, put forward in letters written shortly before his end, was that he did not believe the conquerors would give him an impartial trial. The death of Balmaceda finished all cause of contention in Chile, and was the closing act of the most severe and bloodiest struggle that country had ever witnessed. In the various engagements throughout the conflict more than 10,000 lives were lost, and the joint expenditure of the two Governments on military preparations and the purchase of war material exceeded £10,000,000 sterling. (See also the section on the war below.)

An unfortunate occurrence soon after the close of the revolution brought strained relations for a short period between the Governments of the United States and Chile. A number of men of the U.S.S. *Baltimore* having been given liberty on shore, an argument arose between some of them and a group of Chilian sailors in a drinking den in Valparaiso. Words led to blows. The Americans were badly handled, one of their number being killed and others severely hurt. The United States Government characterized the affair as an outrage, demanding an indemnity of $1,000,000 as satisfaction. The Chilian authorities demurred at this attitude, and attempted to argue the matter. Mr Blaine, then Secretary of State, refused peremptorily to listen to any explanations. In the end Chile paid an indemnity as asked, but the affair left bad feeling in its train.

***President Montt.***

The close of the revolution against Balmaceda left the government of Chile in the hands of the *junta* under whose guidance the military and naval operations had been organized. Admiral Jorje Montt had been the head of this revolutionary committee, and he acted as President of the provisional Government when the administration of the country changed hands after the victory of the Congressional party. An election was now immediately ordered for the choice of a President of the republic and for representatives in the Senate and Chamber of Deputies. Admiral Montt, as head of the executive power, staunchly refused to allow official influence to be brought to bear in any way in the Presidential campaign. The great majority of the voters, however, required no pressure to decide who was in their opinion the man most fitted to administer the affairs of the republic. For the first time in the history of Chile a perfectly free election was held, and Admiral Montt was duly chosen by a nearly unanimous vote to be chief magistrate for the constitutional term of five years. The Senate and Chamber of Deputies were formally constituted in due course, and the Government of the republic resumed normal conditions of existence. The new President showed admirable tact in dealing with the difficult problem he was called upon to face. Party feeling still ran high between the partisans to the two sides of the recent conflict. Admiral Montt took the view that it was politic and just to let bygones be bygones, and he acted conscientiously by this principle in all administrative measures in connexion with the supporters of the late President Balmaceda. Early in 1892 an amnesty was granted to the officers of the Balmaceda *régime*, and they were freely permitted to return to Chile without any attempt being made to molest them. The first political act of national importance of the new Government was the grant of control to the municipalities, which hitherto had possessed little power to direct local affairs, and were not even permitted to dispose of the municipal revenues to any important amount without first obtaining the consent of the central Government. Almost absolute power was now given these corporations to manage their own concerns, and the organization of the police was placed in their hands; at a later period, however, it was found necessary to modify this latter condition.

President Montt next turned his attention towards the question of how best to repair the damage occasioned to the country by eight months of civil warfare. The plan of public works authorized in 1887 was reconsidered, and the construction of portions of the various undertakings recommenced. The army and navy were reorganized. Additional instructors were brought from Germany, and all arms of the military service were placed on a thoroughly efficient footing in matters of drill and discipline. Several new and powerful cruisers were added to the navy, and the internal economy of this branch of the national defence was thoroughly inspected and many defects were remedied. President Montt then took in hand the question of a reform of the currency, the abolition of inconvertible paper money, and the re-establishment of a gold basis as the monetary standard of the republic. This reform of the currency became the key-note of the President's policy during the remainder of his term of office. Great opposition was raised by the representatives of the debtor class in Congress to the suppression of the inconvertible paper money, but in the end President Montt carried the day, and on 11th February 1895 a measure finally became law establishing a gold currency as the only legal tender in Chile. In July 1896 the Conversion Act was put in force, a dollar of 18d. being the monetary unit adopted. In 1895 relations with the neighbouring republic of Argentina began to become somewhat strained in regard to the interpretation of the treaty concerning the boundary between the two countries. The treaties of 1881, 1893, and 1895 left doubts in the minds of both Chilians and Argentines as to the position of the frontier line. On 17th April 1896 another protocol was drawn up, by which the contending parties agreed to submit any differences to the arbitration of Great Britain, at the instance of one or both Governments. President Montt had now fulfilled his term of office, and on 18th September 1896 he handed over the presidential power to his successor, Señor Federico Errazuriz, who had been duly elected in the month of June previously.

***President Errazuriz.***

The election for the position of President of the republic was closely contested in 1896 between Señor Errazuriz and Señor Reyes, and ended in the triumph of the former candidate by the narrow majority of one vote. The father of the new President had been chief magistrate of Chile from 1871 to 1876, and his administration had been one of the best the country had ever enjoyed; his son had therefore traditions to uphold in the post he was now called upon to fill. At the commencement of 1897 the public attention was absorbed by foreign political questions. The problems to be solved were the frontier difficulty with Argentina, the question of the possession of Tacna and Arica with Peru, and the necessity of fulfilling the obligation contracted with Bolivia to give that country a seaport on the Pacific coast. The treaty made in 1896 with the Argentine Government, referring to the arbitration of disputed points concerning the boundary, became practically for the moment a dead letter, and both Argentines and Chilians began to talk openly of an appeal to arms to settle the matter once for all. The Governments of both countries began to purchase large supplies of war material, and generally to make preparations for a possible conflict. In these circumstances no final settlement with Peru and Bolivia was possible, the authorities of those republics holding back to see the issue of the Chile-Argentine

dispute, and Chile being in no position at the time to insist on any terms being arranged. So matters drifted until the beginning of 1898. In July of that year the crisis reached an acute stage. Both Chile and Argentina put forward certain pretensions to territory in the Atacama district to the north, and also to a section of Patagonia in the south. Neither side would give way, nor was any disposition exhibited to refer the matter to arbitration under the protocol of 1896. The cry of an acute financial crisis emanating from the fear of war with Argentina was now raised in Chile. The President was advised that the only way of averting the financial ruin of the banking institutions of the republic was to suspend the conversion law and lend from the national treasury inconvertible notes to the banks. Señor Errazuriz weakly gave way, and a decree was promulgated placing the currency once more on an inconvertible paper money basis until 1902.

***Crisis with Argentina.***

In August of 1898 the Chilian Government determined to insist upon the terms of the protocol of 1896 being acted upon, and intimated to Argentina that they demanded the fulfilment of the clause relating to arbitration on disputed points. This was practically an ultimatum, and a refusal on the part of the Argentine Government to comply with the terms of the 1896 agreement meant a declaration of war by Chile. For a few days the issue hung in the balance, and then the Argentine Government accepted the provisions made in 1896 for arbitration. The dispute concerning the Atacama district was submitted to an arbitration tribunal, consisting of the representative of the United States in Argentina, assisted by one Argentine and one Chilian commissioner. This tribunal, after due investigation, gave their decision in April 1899, and the verdict was accepted unreservedly by both Governments. The dispute regarding the Patagonian territory was submitted to the arbitration of Great Britain, and a commission (consisting of Lord Macnaghten, Sir John Ardagh, and Sir T. H. Holdich) was appointed in 1899 to hear the case.

The Argentine difficulty was ended, but Chile still had to find a settlement with Peru and Bolivia. The treaty made with the former country in 1893 was not ratified, as it was thought to concede too much to Peru, and the subsequent *ad referendum* treaty was rejected on account of Peru claiming that only Peruvians, and not all residents, should have the right to vote in the plebiscite to be taken by the terms of the treaty of 1883 for the possession of Tacna and Arica. By the terms of the armistice of 1883 between Chile and Bolivia, a three years' notice had to be given by either Government wishing to denounce that agreement. By the protocol of 1895 Chile agreed to give to Bolivia the port of Arica, or some other suitable position on the seaboard. On these lines a settlement was proposed. Vitor, a landing-place a little to the south of Arica, was offered by the Chilian Government to Bolivia, but refused as not complying with the conditions stated in the protocol of 1895; the Bolivians furthermore preferred to wait and see if Arica was finally ceded by Peru to Chile, and if so to claim the fulfilment of the terms of the protocol.

After the accession to office of President Errazuriz there was no stability of any ministry. Political parties in Congress were so evenly divided that a vote against the ministry was easy to obtain, and the resignation of the Cabinet immediately followed in accordance with the so-called parliamentary system in vogue in Chile. The President of the republic has no power to dissolve the Chambers, to endeavour to remedy the evil by one or another political party obtaining a substantial working majority, but must wait to see the results of the triennial elections. As a consequence of these conditions Conservative, Liberal, and coalition ministries held office at short intervals. These unsettled political circumstances checked any continuity of policy, and tended to block the passage of all useful legislation to help forward the economic development of the country and inhabitants; on the other hand, the financial situation was better by the end of 1899 than in the previous year, since all proposals for a fresh paper issue had been vetoed; and the elections for Congress and municipal office at the opening of 1900 returned a majority favourable to a stable currency policy.

In September 1900 a fresh outburst of hostile feeling against Chile was created in Argentina by a note addressed by the Chilian Government to Bolivia, intimating that Chile was no longer inclined to hand over the port of Arica or any other port on the Pacific, but considered the time ripe for a final settlement of the questions connected with the Chilian occupation of Bolivian territory, which had now been outstanding for sixteen years. The foreign policy of Chile, as indicated by this note, was considered by Argentina to be grasping and unconciliatory, and there were rumours of an anti-Chilian South American federation. Chile disclaimed any aggressive intentions; but in December the Bolivian Congress declined to relinquish their claim to a port, and refused to conclude a definite treaty of peace. The year closed with a frontier incident between Chile and Argentina in the disputed territory of Ultima Esperanza, where some Argentine colonists were ejected by Chilian police; but both Governments signed protocols agreeing not to take aggressive action in consequence.

At the opening of 1901 the country was chiefly interested in the forthcoming Presidential election, for which the candidates were Don Pedro Montt (Conservative and Clerical) and Señor Ferman Riesco (Liberal).

***President Riesco.***

The relations between President Errazuriz and Congress became rather strained, owing to the former's inclination to retain in office a ministry on which Congress had passed a vote of censure; but Errazuriz had been in ill-health for more than a year, and on 1st May he resigned, and died in July. At the ensuing election Riesco was elected President. The attitude of Chile towards the Pan-American Congress at Mexico became a matter of interest in the autumn, particularly in connexion with the proposal for compulsory arbitration between all American Governments. The Chilian Government made it quite clear that they would withdraw from the Congress if this proposal was meant to be retroactive; and their unyielding attitude testified to the apprehensions felt by Chile concerning United States interference. In October the Chilian Government announced that the contemplated conversion scheme, for which gold had been accumulated, would be postponed for two years (till October 1903), the gold being held as a reserve fund pending the result of the arbitration over the Argentine frontier. This was generally considered to be a reasonable and statesmanlike course. Unfortunately, a recrudescence of the excitement over the boundary dispute was occasioned by the irritation created in Argentina by the fact that, pending a decision, Chile was constructing roads in the disputed territory. During December 1901 relations were exceedingly strained, and troops were called out on both sides. But at the end of the month it was agreed to leave the question to the British arbitrators, and the latter decided to send one of their number (Sir T. H. Holdich) to examine the territory (C. E. A.)

*The Civil War of 1891.*—The military aspects of the conflict between President Balmaceda and Congress of the Chilian republic, which began in 1890, and led, early in the following years, to civil war, are worth considering separately. The merits of the original dispute

are not by any means clear, but powerful foreign interests were arrayed on the side of Congress, and financial support was forthcoming in defence of those interests. The geographical conditions of Chile are such as to render sea power the dominating factor in any internal or external conflict. The country is practically a long strip of sea-board, with few or no longitudinal communications on shore. Sea transport was therefore vital to military operations. On 7th January 1891 the Chilian fleet, which included the armour-clads *Blanco Encalada*, *Cochrane*, and *Huascar*, declared for Congress. The army, consisting at this time of about 6000 men, adhered to the President. One side was thus driven to create an army, while the other sought to improvise a fleet. The Congressionalists determined therefore to seize Iquique as a base and to carry on their preparations in the province of Tarapacá. Hostilities commenced by the bombardment and capture of Pisagua, a coast town about 35 miles to the north of Iquique. Pisagua was retaken by the President's forces, and again occupied by the Congressionalists after a heavy naval bombardment. Colonel Robles, the commander-in-chief of the army, endeavouring to recapture Pisagua, was defeated, and the garrison of Iquique being withdrawn to his assistance, the Congressionalists occupied the place. Collecting part of his forces, Colonel Robles succeeded in retaking Iquique, which was then heavily bombarded on 17th February, and was surrendered upon terms arranged on board H.M.S. *Warspite*, the British flagship. The Congressionalists, under Colonel Canto, made great preparations to hold their position, and Colonel Robles, without waiting to concentrate a sufficient force, attacked them at Pozo al Monte. The troops, about 1400 in number, were disastrously defeated and the commander-in-chief was killed. The rest of the President's forces in this district then crossed the Andes and made their way southwards under great difficulties. The effect of these preliminary operations was to give the Congressionalists a good base at Iquique and a firm footing in the province of Tarapacá, which is isolated by desert country from the rest of Chile. Time was on their side, and, moving gradually south, they occupied Caldera and set about the creation of an army. Mannlicher repeating rifles and large stores of ammunition were purchased in Europe, and the services of Colonel Körner, a German expert, were obtained. By August about 10,000 men had been armed, organized, and drilled.

Meanwhile the 700-ton torpedo gunboats *Condell* and *Lynch* had arrived at Valparaiso from Europe, and the *Imperial*, a mail steamer of 3300 tons and 15 knots, had been chartered by the President and was armed to serve as an extemporized cruiser. These three vessels went to sea on 18th April, and on the night of the 22nd the *Condell* and *Lynch* found and attacked the *Blanco Encalada* at anchor in Caldera Bay. Many of the Congressionalist officers were dining on shore, and a bad look-out was kept. The *Condell* discharged three torpedoes at about 100 yards' distance without result; but the *Lynch*, closing the armour-clad on the other side, succeeded in striking her amidships. The *Blanco Encalada* sank in a few minutes, the *Condell* and *Lynch* escaping without much damage to either, and with a loss of one killed and ten wounded. This was a striking achievement, carried out with great gallantry; but the attack would probably have failed if a proper watch had been kept on board the *Blanco Encalada;* and although the gunboats made other cruises, nothing further was effected.

On 20th August the Congressionalist forces, 9280 strong, disembarked in Quinteros Bay, about 28 miles north of Valparaiso. On the following day the President's troops holding the southern bank of the Aconcagua river were attacked and defeated. The position was a strong one, and the defenders were greatly superior in field artillery, but suffered somewhat from the fire of the Congressionalist vessels. The troops were, however, badly handled, and both flanks were turned. The battle of Concon was the first in which one side was armed wholly with repeating rifles. The Congressionalists took 1500 prisoners, "most of whom asked for and obtained leave" to change their flag. The advance on Valparaiso continued, and it was intended to attack the position of Viña del Mar, about 4 miles from the town, on the 23rd. The attack was not delivered, as the Congressionalist troops did not reach their appointed positions in time and two of the brigade commanders considered the entrenchments impregnable. After an ineffective artillery engagement the plan was abandoned in favour of a flank march with a view to approach Valparaiso from the south. This offered a great opportunity, which the Balmacedist forces totally neglected. On 27th August the Congressionalist army arrived in front of the heights of La Placilla, where the enemy, about 14,000 strong, were attacked on the following day. The left flank of the position was turned and the victory was complete, the loss of the defending and attacking forces being about 3400 and 1800 respectively. The Männlicher rifles doubtless contributed to the victory, but the waste of ammunition was great, and the imported arms showed some weakness. The Balmacedist troops were, however, badly commanded throughout this brief campaign, which affords few military lessons. After the battle of La Placilla, Valparaiso at once surrendered, and the triumph of the Congressionalist party was complete.

The Chilian civil war supplies a remarkable example of the influence of sea power. The revolt of the navy proved fatal to President Balmaceda's cause. Unable to reinforce his troops in the north, he lost Iquique, the province of Tarapacá, and the nitrate revenues. It was thus open to the Congressionalists to raise and equip an army at leisure and to disembark it wherever they chose. Military success, for which the way was prepared by the navy, produced decisive results, and the Chilian civil war conformed exactly to the teaching of history. (G. S. C.)

**Chillan,** a town of Chile, capital of the province of Nuble and of the department of Chillan, 248 miles S. of Santiago by rail. It is reputed to be one of the most picturesque cities of Chile, with fine streets and public squares. Population (1898), 32,769.

**Chillicothe,** capital of Livingston county, Missouri, U.S.A., situated in the northern part of the state, on Grand river, at an altitude of 765 feet. It has three railways, the Chicago, Burlington, and Quincy, the Chicago, Milwaukee, and St Paul, and the Wabash. Population (1880), 4078; (1890), 5717; (1900), 6905, of whom 255 were foreign-born and 538 were negroes.

**Chillicothe,** capital of Ross county, Ohio, U.S.A., situated in 39° 8′ N. lat. and 82° 52′ W. long., in the southern part of the state, at an altitude of 620 feet. It has a regular plan with broad streets, on a level plain on the right bank of Scioto river, which here is not navigable. It is at the intersection of three great railways, the Baltimore and Ohio South-Western, the Cincinnati, Hamilton, and Dayton, and the Norfolk and Western. Population (1880), 10,938; (1890), 11,288; (1900), 12,976, of whom 910 were foreign-born and 986 were negroes.

**Chimkent,** a district town of Russian Central Asia, province Syr-dari-insk, on the mountain stream Badam. It has seven cotton-cleaning mills and soapworks, and its trade is mainly in cattle, hides, wool, raw cotton, grain, oil, and leather. Population, 10,756.

# CHINA.

## I. Geography and Statistics.

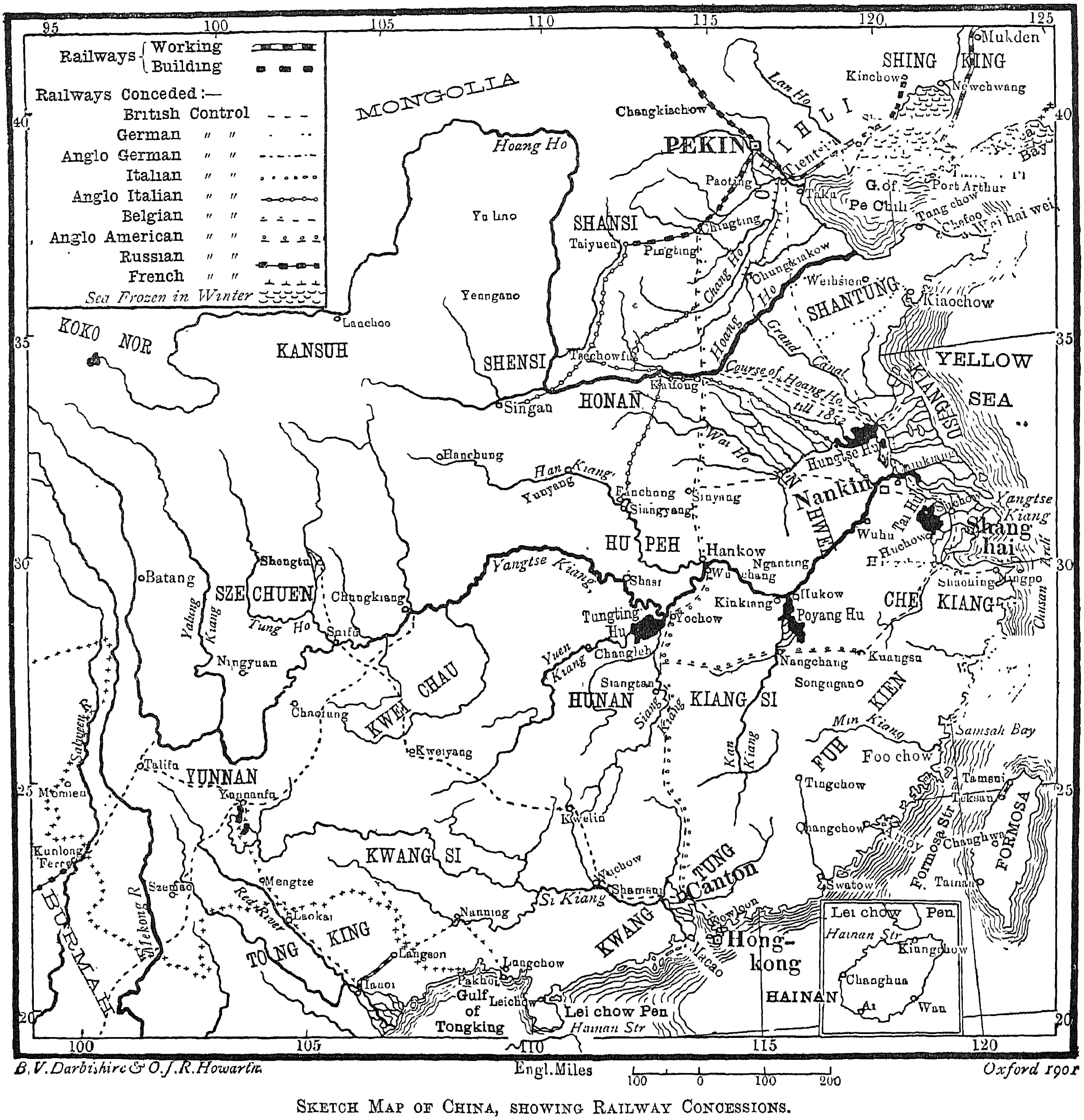
*Physical Geography.*—Important additions to our knowledge of the physical geography of China were made within the period 1875-1900. Chief among these is the work of Baron F. von Richthofen, published at Berlin in 1882, including his geological maps of the northerly part of the empire. The hitherto unknown tracks of western and south-western China have attracted numerous travellers, and the trade routes and markets of Szechuen and Yunnan have been explored and described by officers of the British consular service. And within the last year or two of the 19th century private enterprise undertook a survey of the whole route from the Burma frontier to the Yangtse at Chungking, with a view to the construction of a through line of railway. Several eminent French explorers have traversed the same region with the like object of finding a feasible route from Tongking into Szechuen. For details reference should be made to the works cited at the close of this article, but the following general remarks on the country as a whole are submitted.

The ancient stratified rocks of China form beds of stupendous thickness. Of these the most widely diffused is a characteristic limestone to which von Richthofen gives the name "Sinian," its prevalence being so universal that it deserves to take its name from the whole country. In the provinces bordering on the lower Yangtse this limestone belt occupies the centre of a group of formations,—the lower being quartzose sandstone and argillite schists, and the upper again argillaceous sandstone often locally altered into quartzite. In Szechuen the limestone attains a thickness of upwards of 11,000 feet in some parts. Extending, as the formations do, over nearly the whole of China, they vary indefinitely in their relations to one another, but the whole points to a long period of quiescence when the central and northern parts of China were submerged under deep water. The period corresponds to the Silurian and Devonian epochs in the geology of Europe. Outflows of granitic rock and other violent disturbances brought the period of quiescence to a close. Over the limestone formations there is next found a series of Carboniferous strata almost equally widely diffused. This also varies greatly in various parts of the country. In some parts, as in Shansi, the seams of pure coal are of great thickness, as much as 30 feet or more, in others the beds are thin, and separated by layers of limestone and argillaceous strata. These conditions point to a general elevation of the ocean bed alternating with periods of subsequent depression. The Coal Measures are in turn overlain by sedimentary deposits of sandstone, shales, and conglomerates, to a depth of many thousand feet. A general elevation then took place probably soon after the close of the Carboniferous epoch, and there is no evidence to point to any subsequent depression beneath the level of the sea. The Jurassic and Cretaceous series of rocks do not appear to be represented in China. The dominant feature in the geography of China is the existence of the enormous mountain masses on which her western frontier abuts. From these main ranges, spurs or outliers run into China, having generally an east or west trend, and these have determined the courses of the great rivers. Having their sources at a great height, and draining very extensive basins, these rivers have for ages been bringing down quantities of silt which have been deposited on the beds of ancient lakes, and on the sea bottom, thus forming the Great Plain of China, which is now so large and important a part of the empire. It fills an area of about 200,000 square miles, and is still growing. Denudation has thus been the principal agency in giving to Chinese scenery its characteristic features. In Hunan and in Szechuen, where a soft red sandstone abounds, it has converted what at one time was probably a uniform plateau into a thoroughly hilly country.

Although large masses of eruptive granite and other igneous rocks are to be found in various parts, it does not appear that volcanic energy has for many ages had any part in determining the configuration of the country. There is no trace anywhere of recent active volcanoes. Intrusive dykes of granite, porphyry, &c., are frequent, more especially in the northerly provinces and Shantung, and in a few places metamorphic action has altered the character of the rocks, but on the whole the sedimentary deposits have not been greatly disturbed by subterraneous activity. In the province of Shansi a plateau stands out above the plain where the several strata can be traced in a nearly horizontal position over a superficial area of 30,000 square miles. Looking from the plain westwards there is seen to be, first, a rugged barrier made up of very ancient formations; second, a general substructure of limestone of 2000 feet in thickness; third, a series of coal-bearing strata of 500 feet; fourth, the post-Carboniferous strata of 3000 feet; and, lastly, a general cover of loess. This is the largest coal field in China, and probably in the world, but a similar sequence of strata is found prevailing generally. Though no recent volcanic agency has been traced, there have been, subsequent to the limestone and carboniferous periods, very considerable upheavals, due either to subterranean forces or to the puckering consequent on lateral compression. The ridges thus thrown up have taken generally a north-east and south-west trend. They do not rise to any great height, seldom reaching 5000 feet, nor does any one ridge stand out as the predominant mountain chain, but the result is to give a general mountainous character to large areas of the country. One such belt of hills runs through all the south-eastern provinces from Tongking to Hangchow Bay, terminating in the rocky islands of the Chusan Archipelago. Another runs through Szechuen, and is cut transversely by the Yangtse river, which there flows between limestone cliffs forming the picturesque scenery of the Yangtse gorges. A third series starts from the Mongolian plateau and runs through Chihli and Shansi, forcing the Yellow river to take a long sweep southwards until it finds its way through a similar series of gorges at Lungmen. In the provinces of Kweichow and Yunnan the north-east and south-west system meets the outlying spurs of the central Asian system, which run nearly at right angles to the former, thus causing a confused mass of lofty mountain peaks which defies description. Along such ridges the limestone strata are tilted up and exposed to view, and in a few cases the still deeper strata of ancient plutonic rocks, granitic gneiss, and schists are also exposed. At one of the gorges in the Yangtse, where the river has cut its way across the ridge, the formation is well seen. There is, first, a central core of granite, then a thin bed of metamorphic schist, then the limestone inclined at a high angle on each side, then carboniferous strata, and, lastly, the superincumbent layer of sandstone and other recent deposits,—the latter, however, being often eaten away by erosion down to the limestone. This north-east south-west system, however, is on the whole subordinate to the dominant east and west ranges, stretching

from the highlands of central Asia, which have determined the main watersheds. The general course of the rivers is thus from west to east, and whenever they meet these subordinate ranges they ultimately break across, though occasionally diverted for a time. Their course is thus sometimes a series of zigzags, now flowing parallel with the trend, and now breaking through at right angles, flowing in a deep rocky gorge. The formation of these gorges—some of which on the upper Yangtse, and also on the west or Canton river, are 2000 feet in depth—points to immense antiquity, and probably was preceded by a series of inland lakes. The extensive areas now filled with red sandstone such as exist in Hunan and Szechuen were doubtless the beds of such lakes.

A specially characteristic feature of north China is the deposit termed *loess*, which not merely imparts to the




SKETCH MAP OF CHINA, SHOWING RAILWAY CONCESSIONS.

country the physical character of the scenery, but also determines the agricultural products, the transport, and general economic life of the people. It is peculiar to north China, and is not found south of the Yangtse. The loess is a solid, but friable earth of brownish yellow colour, and when triturated with water is not unlike loam, but differs from the latter by its highly porous and tubular structure. Among its constituents, next to the argillaceous basis, fine sand and carbonate of lime predominate. It spreads alike over hills and valleys, smoothing over the irregularities, and has a depth, in many places, of over 1000 feet. It is not stratified, and has a tendency to vertical cleavage. It is full of fossil land shells, and contains bones of quadrupeds, but has no remains of either marine or fresh-water shells. From its porous nature water never lies on the surface. The rainfall is at once absorbed as by a sponge. On the other hand, moisture is retained in the lower portions for long periods. The drainage is consequently not carried on the top. Whatever streams or rivulets there are, at once cut their way through the friable earth to the subsoil, carrying down the débris to be deposited as alluvium on the plains. As the cleavage is

vertical the banks fall in, in perpendicular slabs, leaving a vertical wall on each side, often hundreds of feet in height. This is always the case in the newly-formed small affluents of the larger streams, and even in the older rivers the valley never slopes gradually down to the river bed, but approaches by a series of terraces, each backed by a vertical wall separating it from the next above. The consequence of this is that communication in a loess-covered country is extremely difficult. Seen from a distance, the valley may present a gentle undulating appearance, but as it is approached it shows a perfect labyrinth of deep cuts with perpendicular walls, among which the traveller without a guide may wander indefinitely, vainly seeking an exit. The loess soil is extremely favourable to agriculture. It bears excellent crops, and not merely on the lower grounds, but at altitudes of 6000 and 8000 feet. Wherever loess is found the peasant can live and thrive. Only one thing is essential, and that is the annual rainfall. As no artificial irrigation is possible, if the rain fails the crops must necessarily fail. Thus seasons of great famine alternate with seasons of great plenty. It appears, also, that the soil needs little or no manuring, and very little tillage. From its extremely friable nature the soil is easily broken up, and thus a less amount of labour is required than in other parts. The extreme porosity of the soil probably also accounts for the length of time it will go on bearing crops without becoming exhausted. The rainfall penetrating deeply into the soil in the absence of stratification, comes into contact with the moisture retained below, which holds in solution whatever inorganic salts the soil may contain, and thus the vegetation has an indefinite store to draw upon. Another peculiarity of loess in China is that it lends itself readily to the excavation of dwellings for the people. In many places whole villages live in cave dwellings dug out in the vertical wall of loess. They construct spiral staircases, selecting places where the ground is firm, and excavate endless chambers and recesses which are said to be very comfortable and salubrious dwellings.

With respect to its origin, Baron von Richthofen is of opinion that loess is a subaërial formation. The entire absence of stratification, except in what he calls regenerated loess, *i.e.*, original loess washed down and deposited in lake bottoms, and the entire absence of marine or freshwater shells, forbid the supposition that it is an aqueous deposit. The only other agency that can be suggested is air currents combined with rainfall. The latter carries down certain débris, while the former carries the fine dust and sand from the steppes among the herbaceous vegetation, where it is retained and mixed with the decaying leaves and roots. No stratification can take place, and any approach to it will be completely effaced by the roots which descend vertically, and are probably the chief agents in producing the vertical cleavage.

*Meteorology.*—The figures in the Table are taken from the observations recorded at the French mission station at Shanghai. They give the average of eight years' observations. The absolute maximum and minimum temperatures during the period were 102° and 12·2° respectively.

| | Minimum Temperature Fahr. | Maximum Temperature Fahr. | Rainfall, Inches. |
|---|---|---|---|
| January | 17°·8 | 57°·2 | 2·27 |
| February | 24·3 | 61·0 | 2·88 |
| March | 30·2 | 75·9 | 2·87 |
| April | 36·7 | 84·2 | 3·59 |
| May | 46·9 | 89·2 | 2·87 |
| June | 57·7 | 92·8 | 7·86 |
| July | 67·8 | 97·2 | 3·56 |
| August | 65·3 | 95·5 | 4·65 |
| September | 55·8 | 90·7 | 5·72 |
| October | 40·1 | 82·6 | 2·84 |
| November | 28·9 | 72·7 | 1·96 |
| December | 21·2 | 65·3 | 1·39 |

*Climate.*—The climate of Shanghai, which is that of the lower Yangtse valley generally, is on the whole favourable. The three months from July to September are somewhat trying to Europeans. The temperature is high and the air is often laden with moisture. The prevailing winds during this season are south-easterly, caused by heat and the ascending current of air over the sandy deserts of central Asia, thus drawing in a current from the Pacific Ocean. In the winter the converse takes place, and the prevailing winds are north and north-west, which are cold and dry. During the eight or nine months from October to May the climate is bracing and enjoyable. The rainfall is moderate and regular, and a failure of the crops owing to prolonged droughts is very rare. Farther north, however, this is not the case. The provinces of Shantung and Shansi are peculiarly liable to prolonged periods of drought, with consequent severe famines such as that of 1877-78, when many millions died for sheer want of food. In these regions the air is generally extremely dry, and the daily variations of temperature consequent on excessive radiation are much greater than farther south. Dust storms are also prevalent during the spring months. In the southern and south-western provinces, especially Szechuen, the rainfall is much greater than that above recorded, and the summer heat, though not higher as a maximum than that of Shanghai, is naturally more prolonged and more enervating. But as a whole the climate of China compares favourably with that of any other part of the world lying between the same parallels of latitude. The greater part of it is what may be called a White Man's land, and in no part is it specially trying for Europeans. Certain areas of the province of Yunnan have a reputation among Chinese for unhealthiness, being mostly those lying at the bottom of deep valleys of the Mekong and Salween rivers, where malarial fever abounds, and it may be mentioned that certain areas in this province are the home of the bubonic plague, an epidemic which has recently been attracting so much attention. On the other hand, the plateaus of Yunnan, and notably the plain of Talifu, have the reputation of an excellent climate, the latter, according to Indian travellers, comparing favourably with Kashmir.

*Area and Population.*—The only change in area since 1875 is the annexation to Japan of the island of Formosa, with a population of about 2,000,000. In regard to population no accurate statistics are yet forthcoming. The Chinese Government continues from time to time to print in the *Peking Gazette* returns of the population made by one or other of the various provincial authorities, but, so far as is known, no systematic attempt has been made to take a general census on European principles. The method of numeration is to count the households, and from that to make a return of the total inhabitants of each province. As every province is divided for administrative purposes into so many *hsien* or districts, and every district into so many hundreds, there would be no great difficulty, as the population is nearly all rural and taxpaying, in obtaining fairly accurate returns if sufficient care were taken. It does not appear, however, that much care is taken. The standing orders are that the returns are to be made every three years, but as no allowance is made to meet the expenses, it is probable that in the majority of cases the last return is taken, and a round sum is added or subtracted to meet the supposed facts of the case. Mr E. H. Parker published in the number of the *Statistical Society's Journal* for March 1899 a series of tables translated from Chinese records, giving

the population from year to year between 1651 and 1860. These tables show a gradual rise, though with many fluctuations, up till 1851, when the total population is stated to be 432 millions. From that point it decreases till 1860, when it is put down at only 261 millions. The following table gives as nearly as can be ascertained the actual population at the present time :—

| Provinces. | Area Square Miles. | Population. | Population per Square Mile. |
|---|---|---|---|
| Anhwei | 53,000 | 20,600,000 | 388 |
| Chekiang | 34,700 | 11,600,000 | 334 |
| Chihli | 57,800 | 17,900,000 | 30 |
| Fuhkien | 41,300 | 23,500,000 | 568 |
| Honan | 61,300 | 22,100,000 | 360 |
| Hunan | 74,400 | 21,000,000 | 295 |
| Hupeh | 65,900 | 33,500,000 | 508 |
| Kansuh | 131,000 | 9,400,000 | 72 |
| Kiangsi | 67,500 | 24,000,000 | 355 |
| Kiangsu | 36,900 | 25,000,000 | 568 |
| Kwangsi | 80,100 | 5,100,000 | 63 |
| Kwangtung | 79,300 | 30,000,000 | 378 |
| Kweichow | 58,800 | 4,800,000 | 80 |
| Shansi | 66,700 | 11,800,000 | 177 |
| Shantung | 55,500 | 36,000,000 | 649 |
| Shensi | 74,000 | 8,300,000 | 112 |
| Szechuen | 160,000 | 67,100,000 | 418 |
| Yunnan | 155,000 | 6,200,000 | 40 |
| Total for eighteen provinces | 1,353,200 | 377,900,000 | |
| Manchuria | 362,310 | 12,500,000 | 34 |
| | 1,715,510 | 390,400,000 | |

*Constitution and Government.* — The Government of China is in theory an absolute monarchy. The Emperor is the sole and supreme head of the state. His will is absolute alike in the highest affairs of state and in the humblest details of private life. The highest form of legislation is an imperial decree, whether promulgated in general terms or to meet a special case. In either form it is the law of the land, and no privilege or prescriptive right can be pleaded against it. All officers of state, all judges and magistrates, hold their offices entirely at the imperial pleasure. They can be dismissed, degraded, punished without reason assigned, and without form of trial—even without knowing by whom or of what they are accused. There are no constitutional checks upon the arbitrary acts of the monarch. He is provided with an advisory council, but he is not bound by their advice, nor need he pretend that he is acting by and with their advice and concurrence. In practice, however, this arbitrary power is tempered in several ways. Firstly, although the constitution confers this absolute and unchecked power on the Emperor, it is not for his gratification but that he may exercise it for the good of his people. He rules by divine authority, and as the vice-regent of Heaven upon earth. If he rules corruptly or unjustly Heaven will send disasters and calamity on the people as a reproof; if the rule becomes tyrannical Heaven may withdraw its favour entirely, and then rebellion may be justified. Though treason and rebellion are ordinarily the most heinous of crimes, yet history applauds a successful revolt as evidence of the iniquities of the fallen dynasty. The Manchu dynasty came to the throne as foreign conquerors, nevertheless they have adopted this theory, and base their right to rule, not on the power of the sword, but on divine approval. On this moral ground they claim the obedience of their subjects, and submit themselves to the corresponding obligations. A more effective check upon the caprice of the Emperor, however, is the second which we will notice, namely, that the constitution prescribes that the Emperor shall live in seclusion. He is consequently dependent for his facts on such information as the courtiers and high officers of state permit to reach him, and he is further dependent for the execution of his decrees on such means as these same officers supply him with. Though in theory he can command the services and money of his subjects to an unlimited extent, yet the crown as such has no revenues peculiarly its own. It is dependent for the pay of the troops, as well as for the ordinary expenses of the imperial household, on contributions levied through the high officials on the several provinces, and without their concurrence and co-operation nothing can be done. The power of the purse and the power of the sword are thus exercised mediately through the instruments recognized by the constitution, and it thus comes about that the autocratic power is in practice transferred to the general body of high functionaries, or to that clique of them who for the time being have the ear of the Emperor, and who are united enough and powerful enough to impose their will on the others. The high functionaries of state who thus really wield the supreme power are almost without exception civil officials who have risen from the ranks of the people. There is no hereditary aristocracy in the European sense of the term. Hereditary rank is indeed bestowed on a few public servants usually for a limited number of lives, and there are among the descendants of the Manchu chieftains, who helped to found the dynasty, a few who hold titles of nobility, but in either case the rank *per se* gives them no status in the constitution. Among the princes of the blood there are a small number who hold high office and take an important part in the Government, such as the late Prince Kung and Prince Ching, the former and the present head of the Tsung-Li-Yamen, but their right to have a voice in public affairs is in virtue of their holding office, not in virtue of their nobility. Practically all the high officials who now constitute the Government of China have risen through the junior ranks of the civil service, and obtained their high position as the reward—so it must be presumed—of long and distinguished public service.

The functions of Government are divided between (*a*) the central administration and (*b*) the provincial administration. The empire proper is divided into eighteen provincial governments, each of which has a complete administrative machinery of its own, and possesses a quasi-independence in financial and military affairs. In some cases two or three are grouped together under a governor-general, often called a viceroy, without, however, affecting their independent status. At the head of each province is a governor, whose main functions are to keep the peace and preserve order, to collect the taxes, to raise and pay his own troops, pay the salaries of the civil service, remit the regulation quota of the taxes in money and in kind, as the case may be, to Peking, and to find and remit the extra "squeezes" which the needs of the central Government may demand. If he does all that and things go smoothly, the central Government does not interfere with him. He renders *pro formâ* accounts to the Board of Revenue at Peking, but no effective scrutiny is maintained. He is not responsible for disorder beyond his own border, nor bound to send military aid to his neighbours even against foreign invasion. The functions of the central Government, on the other hand, are mostly confined to checking and registering the acts of the provincial governments, and seeing that things are done in conformity with precedent and with established rules. If the central authorities take the initiative, and issue orders, as they occasionally are forced to do, under foreign pressure, it by no means follows that they will be carried out. The orders, if unwelcome, are not directly disobeyed, but rather ignored, or specious pleas are put forward, showing the difficulty or impossibility of carrying them out at that particular juncture.

The central Government always wields the power of removing or degrading a recalcitrant governor, and no case has been known where such an order was not promptly obeyed. But the central Government being composed of officials, stand by their order, and are extremely reluctant to issue such a command, especially at the bidding of a foreign Power. Generally the opinion of the governors and viceroys has great weight with the central Government, and probably no great measure of policy would be entered upon without their advice and concurrence. The Boxer troubles and the flight of the court from Peking on the approach of the foreign expeditionary force (Aug. 1900) shook the whole governmental fabric of the Chinese Empire. This and the following sections must therefore be taken as representing the normal condition of things before the outbreak of disturbances in 1900.

*Central Administration.*—The following are the principal departments of the central Government :—

1. The Grand Secretariat (*Neiko*), consisting of four grand secretaries and two assistant grand secretaries, half of whom, according to a general rule applicable to nearly all the high offices in Peking, must be Manchu and half Chinese. This was originally the Supreme Council of the empire, but under the present dynasty it has ceased to be of active importance. It constitutes the Imperial Chancery or Court of Archives, and admission to its ranks confers the highest distinction attainable by Chinese officials, though with functions that are almost purely nominal. Members of the Grand Secretariat are distinguished by the honorary title of *Chung-tang.* The most distinguished viceroys are usually advanced to the dignity of grand secretary while continuing to occupy their posts in the provinces.

2. Grand Council (*Chun Chi Chu*).—This department, the actual Privy Council of the sovereign, in whose presence its members daily transact the business of the state, is composed of a small knot of men holding various high offices in the Government boards at Peking. The number is undetermined, but at present it is five. The literal meaning of the Chinese name *Chun Chi Chu* is "place of plans for the army," and the institution derives its name from the practice established by the early emperors of the dynasty of treating public affairs on the footing of a military council. The usual time of transacting business is, in accordance with Chinese custom, from 4 to 6 A.M.

3. Tsung-Li-Yamen.—This, the best known of all the Chinese departments, was created after the Anglo-Chinese war in 1860 as a Board for Foreign Affairs. Previously to that war, which established the right of foreign Powers to have their representatives in Peking, all foreign business was transacted by one of the provincial viceroys, chiefly the viceroy of Canton. The only department at Peking which dealt specially with foreign affairs was the *Li Fan Yuen*, or Board of Control for the dependencies, which regulated the affairs of Mongolia, Tibet, and the tributary states generally. With the advent of formally accredited ambassadors from the European Powers something more than this was required, and a special board was appointed to discuss and if possible settle all questions with the foreign envoys. The number was originally four, with Prince Kung, a brother of the late Emperor *Hsien Feng* at their head. It has since been raised to ten, another prince of the blood, Prince Ching, being now president. The members are spoken of collectively as the prince and ministers. For a long time the board had no real power, and was looked on rather as a buffer between the foreign envoys and the real Government. The importance of foreign affairs, however, especially since the Japanese war, has identified the Yamen more with the Grand Council, several of the most prominent men being members of both. At the same time that the Tsung-Li-Yamen was created two important offices were established in the provinces for dealing with foreign commercial questions, viz., the Superintendencies of Trade for the northern and southern ports, the former being given to the governor-general of Chihli, and the latter to the governor-general at Nanking. Li Hung-Chang held the former for a number of years, and this position, combined with his personal talents and his influence at court, made him practically minister for foreign affairs over the heads of the Tsung-Li-Yamen.

4. The six Boards (*Liu Pu*). — The administrative work of the Chinese Government is divided between six departments termed boards, viz., the Board of Civil Office, the Board of Revenue, the Board of Ceremonies, the Board of War, the Board of Punishment, and the Board of Works. Each board has two presidents and four vice-presidents, half being Manchu and half Chinese. The official constitution of each is practically the same. They control each in its own sphere, the nature of which is sufficiently indicated by the names, the execution of that system of minute regulation for the conduct of public business which is the special function of the central Government. The presidents and vice-presidents of the boards, together with the heads of the censorate and the Hanlin college, may be said to constitute the central Government. They have not all an equal voice in the decisions of questions of state, but they are all qualified to tender advice to the sovereign, and it is from their number that the smaller executive councils above mentioned, viz., the *Chun Chi Chu* and the Tsung-Li-Yamen, are selected.

5. The Censorate (*Tu Cha Yuen*).—This is an institution peculiar to China. As the Emperor is condemned to live in seclusion, and has no means of learning what may be going on in the various parts of his dominions, the constitution endeavours to supply a remedy by providing a paid body of men whose duty it is to keep him informed of all facts affecting the welfare of the people and the conduct of Government, and in particular to keep an eye on the malfeasance of his officers. These men are termed *Yu shih*, generally translated censors. There are fifty-six of them, divided into fifteen divisions, each division taking a particular province or area, so as to embrace the whole eighteen provinces, besides one metropolitan division. With the growth of a native press this institution loses its *raison d'être*, and will probably fall into desuetude. It seems at the present moment to be more powerful for mischief than for good.

6. The Hanlin College (*Hanlin Yuen*).—The only other institution of the metropolitan administration that need be noticed is the Hanlin College, and this chiefly because the heads of the college, who are presumably the most eminent scholars of the empire, have the right of advising the throne on all public affairs, and are eligible as members of the Grand Council, or of the Tsung-Li-Yamen. In other respects its functions are purely literary. The Chinese set fire to it during the fighting in Peking in June 1900 in the hope of burning out the adjoining British Legation. The whole of the valuable library, containing some of the most ancient manuscripts in the world, was destroyed.

*Provincial Administration.*—No change has been made in the provincial administration since the article in the ninth edition of this work was written, where its organization is briefly described (*Ency. Brit.* v. 668). The extension of the telegraph system and the growth of native newspapers enable the central Government to take a more active supervision in provincial affairs than it has hitherto been wont to do.

*Civil Service : how recruited.*—The bureaucratic element

is so vital a feature of the government of China, that a short notice of the public examinations whereby the ranks are recruited may not be out of place. As a general rule students preparing for the public examination read with private tutors. There are neither high schools nor universities where a regular training can be got. In most of the provincial capitals, and at some other places, there are indeed institutions termed colleges, supported to a small extent from public funds, where advanced students can prosecute their studies, and where both students and tutors receive a small stipend, but they hardly count as factors in the national education. The work is done by private tutors who, on the other hand, are plentiful and cheap. After a series of preliminary trials the student obtains his first qualification by examination held before the literary chancellor in the prefecture to which he belongs. This is termed the *Siutsai*, or licentiate's degree, and in itself confers no claim to office, but is merely a qualification to enter for the higher examinations. The number of licentiate degrees to be given is, however, strictly limited; those who have failed to get in are set back to try again, which they may do as often as they please. There is no limit of age. Those selected next proceed to the great examination held at the capital of each province, once in three years, before examiners sent from Peking for the purpose. Here again the number who pass are strictly limited. Out of 10,000 or 12,000 competitors only some 300 or 350 can obtain degrees. The others, as before, must go back and try again. This degree, termed *Chu jen*, or provincial graduate, is the first substantial reward of the student's ambition, and of itself, without more, qualifies for the public service, though it does not immediately nor necessarily lead to active employment. The third and final examination takes place at Peking, and is open to provincial graduates from all parts of the empire. About 6000 competitors enter for this final test, which is held triennially, of whom 325 to 350 succeed in obtaining the degree of *Tsin shih*, or metropolitan graduate. These are the finally selected men who in due course become the officials and administrators of the empire. Several other doors are, however, open by which admission to the ranks of bureaucracy can be obtained. In the first place, to encourage scholars to persevere, a certain number of those who fail to reach the *chu jen*, or second degree, are allowed, as a reward of repeated efforts, to get into a special class from which selection for office may be made. Further, the Government reserves to itself the right to nominate the sons and grandsons of distinguished deceased public servants without examination. And, lastly, by a system of "recommendation," young men from the institution termed the Imperial Academy, or from the Manchu schools, or men who have served as clerks in the boards, may be put on the roster for substantive appointment. But over and above the foregoing, which are all deemed fair and legitimate methods of entering the public service, the necessities of the Chinese Government have from time to time compelled it to throw open a still wider door, namely, admission by purchase. During the Taiping rebellion, when the Government was at its wits' end for money, formal sanction was given to what had previously been only intermittently resorted to, and since then immense sums of money have been received by the sale of patents of rank, either to secure admission to office, or more rapid promotion of those already employed. As a result of this policy, the country has been saddled with thousands of titular officials far in excess of the number of appointments to be given away. The more deserving men are thus kept waiting for years, while inferior and less capable officials are pushed ahead, because they have money wherewith to bribe their way. The evils of the purchase system are recognized, and efforts from time to time are made to check it, but with indifferent success. The evil, however, is not altogether unmixed, as it has admitted into the service a number of men who are free from that bigoted adherence to Confucian doctrine which characterizes the literary classes, and more in touch with modern progress. All candidates who thus succeed, whether by examination, recommendation, or purchase, in entering the official ranks are then eligible for active employment, but as the number of candidates is far in excess of the number of appointments a period of weary waiting ensues. A few of the best scholars get admitted at once into the Hanlin college, or into one or other of the boards at Peking. The rest are drafted off in batches to the various provinces to await their turn for appointment as vacancies occur. During this period of waiting they are termed "expectants," and draw no regular pay. Occasional service, however, falls in their way, as when they are commissioned for special duty in outlying districts, which they perform as *Wei yuens*, or deputies of the regular officials. The period of expectancy may be abridged by recommendation or purchase, and it is generally supposed that this last lever must invariably be resorted to to secure any lucrative local appointment. A poor but promising official is often, it is said, financed by a syndicate of relations and friends, who look to recoup themselves out of the illegal, but customary perquisites which attach to the post. The appointments to the junior provincial posts are usually left to the provincial Government, but the central Government can always interfere directly. Appointments to the lucrative posts of customs *taotai* at the treaty ports are usually made direct from Peking, and the officer selected is not necessarily nor usually from the provincial staff. It would perhaps be safe to say that this appointment is always the result of a pecuniary arrangement of greater or less magnitude.

*Religion.*—As stated in the ninth edition (v. 671), the three principal religions of China are Confucianism, Buddhism, and Taoism. To these should be added ancestor-worship, which is practised universally by all classes, and which as a guiding principle of life has a more potent influence over the Chinaman than any other doctrine. It may be regarded as a branch of Confucianism. It did not, indeed, originate with the philosopher, having been practised long before he flourished, but the duty was strongly inculcated by him. He enjoined also the due observance of the ritual prescribed by the state for the worship of all recognized deities, including the worship of heaven and earth by the Emperor, and the worship by state officials of local divinities and deceased worthies who may from time to time have been canonized by imperial decree. Confucianism has no priesthood. The acts of worship are performed by the Emperor in person, by the officials, and by the head of every household, each acting within his own prescribed sphere. But Confucianism has always been a tolerant and non-aggressive religion. While enjoining the performance of ancestor-worship, and the observance of the prescribed formalities to recognized deities, it does not at all object to devotion being paid to other possible divinities, so long as the followers do not profess corrupt and heterodox doctrine. The line of division between what is orthodox and heterodox is more political than religious. Any cult which preaches a doctrine subversive of the fundamental and sacred principles of the constitution is heterodox and unlawful, and its practice renders the followers liable to severe penalties as savouring of rebellion. But mere belief in gods not recognized by the state is harmless, so long as it does not lead to action likely to be subversive of the existing order of things. Thus a Confucianist may at the same time be a Buddhist or a Taoist, or he may be all three. The three religions are not mutually exclusive, but run into one another, and hence it is impossible to give any statistics of the respective numbers of each. The Christian religion was long deemed heterodox, but since the conclusion of the treaties it has officially been proclaimed to be permissible. A Confucianist might now, from the Chinese point of view, be also a Christian, and probably many would become so if the Christian religion would accept them on these terms. One of the powerful congregations of the Roman Catholic Church was in the last century prepared to do so, at least it was prepared to allow converts to continue ancestor-worship. The proposal was overruled by the Pope, but had it been permitted there would possibly have been by this time as many nominal Christians in China as there are professors of Buddhism, which was itself a foreign religion.

The state of religion in China may thus be summed up:—Confucianism in the wider meaning, as including ancestor-worship, is accepted universally. Ancestor-worship is practised by practically all classes. Confucianism, in the narrow sense of the worship of Confucius, is compulsory on all officials, and is voluntarily practised by all scholars and aspirants to literary honours. Buddhism is more or less practised, so far as occasional visits to the temples and to sacred shrines are concerned, by about half the population. Taoism is practised to a considerably smaller extent. The services of the priests of one or other sect are generally invoked for funeral ceremonies. The priests of both these sects live solely in temples and monasteries, and do not enter private houses except when invited, in which case their services are paid for. Neither class attempts to exercise any influence over the people, and both are held in low esteem. Mahommedanism in a modified form is professed by some thirty or forty millions scattered over the north and west of China. They usually perform ancestor-worship as well, and if officials, they take part in the Confucian ceremonies.

Christian missions, both Roman Catholic and Protestant, are now established in every province in China. Freedom to embrace the Christian faith is guaranteed by the Chinese Government, and as a rule the missionaries have free scope in teaching and preaching, though local disturbances are not infrequent. The number of Catholic converts is about one million, and that of all Protestant sects is reported to be slightly over 100,000.

An imperial decree which was made public in 1897, conferring a sort of official status on the hierarchy of the Roman Catholic Church in China, deserves a short notice. Since the conclusion of the treaties in 1860, permitting the practice and teaching of the Christian religion, the missionary question has been one of the most important which the Chinese Government has had to deal with. Though the average Chinaman is naturally tolerant and indeed indifferent in matters of religion, the preaching of Christianity has in many parts aroused fierce opposition, leading to attacks on mission stations with loss of life and property. These attacks have in turn given rise to serious diplomatic controversy, and questions connected with missions have formed no inconsiderable part of the work thrown upon the foreign legations in Peking. In general, a missionary is under the protection of his own Government, no matter what his creed may be; but France has from the first constituted herself the protector of Roman Catholic missions, irrespective of the nationality of the priest concerned, and she has thereby been able to bring pressure to bear on the Chinese Government out of all proportion to her commercial interests. An effort was made by the Chinese in 1886 to get rid of French domination by inducing the Pope to send a special legate to Peking as controller of Roman Catholic missions. The Vatican was disposed to consent; but the French Government made such strenuous opposition, threatening to withdraw the concordat in France, that the papal authorities were obliged to decline. France was unwilling to forgo the political influence which the position of protector of one or two thousand priests and about a million of converts gave her, and she has used that influence to obtain redress of grievances and to improve the position of the Roman Catholic missionaries. In 1896 formal permission was given for the missions to acquire and hold real estate in any part of China; but a still more important privilege is the one we have mentioned, namely, the giving a recognized official status to the several grades of the priesthood, and so placing them on terms of equality with the local officials. Bishops are to rank with governors of a province, pro-vicars with judges, *taotais*, and so on. International matters are to be discussed and settled locally, and in grave cases appeal is to be made to the minister of the nation "specially entrusted by the Pope with the protection of Roman Catholic missions." This last clause has been repudiated by the British Government as far as its own nationals are concerned. It is apprehended that the privilege, while enhancing the status of the priests, will tend to widen the breach already existing between converts and their fellow-countrymen. The interference of priests in matters of litigation where one of their converts is concerned has often been made matter of complaint, and the fact that they are in effect authorized to interfere is not likely to diminish the friction.

*Instruction.*—Very little was done by the Chinese Government during the period 1875-1900 for the better education of the people. Elementary education is still left to take care of itself. The most noteworthy fact to be noticed is the great number of mission schools that are now maintained in various parts of the Empire. Though insignificant as compared with the vast population, these schools are doing valuable service in imparting a knowledge of English to a small proportion of the youth, who in turn, not infrequently, become instructors to a wider class. But among the great mass of the people the densest ignorance prevails, even as regards their own language and history, and much more as to any knowledge of other countries. In respect of advanced education the Chinese Government has done a little better. There are in most provincial capitals institutions termed colleges, where tutors or professors are maintained at the public expense, and where a limited number of students are admitted. There are also in every district two or three paid officials who are termed directors of studies. Their function, however, is not to teach, but to examine, and they act as registrars of the students entering for the public examinations. The object aimed at is not the general education of the people, but to aid poor and deserving students to pass the examinations, and so enter the public service. The idea of educating the people so as to make them more capable citizens is nowhere to be found, and apparently has never been conceived as one of the duties of Government. At Peking, a college, termed the Tung Wen Kwan, was instituted about 1870. and is still maintained with a staff of foreign professors and teachers. It is mainly a school of languages to enable young Chinese to qualify as interpreters in English, French, etc. Similar schools have been established at Canton, Foochow, and one or two other places, with but indifferent results, and as a factor in the education of the nation they can hardly be said to count. A more promising plan was conceived in 1880, or thereabouts, by the then governor-general of Nanking, who sent a batch of thirty or forty young students to America to receive a regular training, on the understanding that on their return they would receive official appointments. The promise was not kept, however. A report went about that these students were becoming too Americanized. They were hastily recalled, and when they returned they were left in obscurity.

*Native Press.*—In connexion with the subject of education we may notice the growth of a native press, which promises to have an important influence on the development of the nation. The *Peking Gazette*, which is sometimes called the oldest paper in the world, is not a newspaper at all in the ordinary sense, but merely a court gazette for publishing imperial decrees and such public documents as the Government may wish to give out. It never contains original articles nor any discussion of public affairs. The first genuine native newspaper was published at Shanghai about 1870. It was termed the *Shen Pao*, or *Shanghai News*, and was issued under foreign auspices, the first editor being an Englishman. It was some years before it made much headway, but success came, and it was followed by various imitators, some published at Shanghai, some at other treaty ports, and at Hongkong. In 1895 there were eleven native newspapers in circulation, and since then the number has largely increased. There are now some thirty-five in circulation, almost all dailies, of which half are issued from Shanghai. Besides the dailies there are at least as many magazines or other periodicals, most of which are issued from the various mission presses, and several of which are exceedingly well written. The effect of this mass of literature on the public mind of China cannot but be of first-rate importance. It must tend, more than anything else, to dispel the darkness and to promote ideas of reform and progress. The attitude of the central Government towards the native press is somewhat undefined. There are no press laws, but as every official is a law unto himself in these matters, there is nothing to prevent him from summarily suppressing an obnoxious newspaper and putting the editor in prison. The Emperor, among other reform edicts which preceded and provoked the *coup d'état* of 1898, declared that newspapers were a boon to the public, and appointed one of them a Government organ. The Empress-dowager revoked this decree after the deposition of the Emperor, and declared that the public discussion of affairs of state in the newspapers was an impertinence, and ought to be suppressed. The existence of the press, however, is tolerated, and by some officials at least would seem to be encouraged. In any case no interference could be offered to those native papers which are published by foreigners, inasmuch as the latter are, by the extra-territorial clauses of the treaty, exempted from Chinese jurisdiction. The regulation of the press is one of those problems which the Chinese Government has yet to solve.

*Social Condition.*—The social condition of the people relative to European standards must be put as very low. Agriculture is the one great industry. Four-fifths of the population may be put down as peasant cultivators of the soil. Of these fully one-half are small peasant proprietors owning the land they till, subject to the payment of the state taxes. Nearly all the other half hold land on lease, paying rent; and only a comparatively small proportion are agricultural labourers. But whether as proprietors or farmers the holdings are always very small—so small that the condition of the holders is hardly above that of ordinary field labourers. The minute subdivision of the holdings is due to two causes—firstly, over-population; and, secondly, the land laws. As to the latter, the invariable rule of succession is equal division among all male children. Not only is there no primogeniture, but a parent cannot, even if he wished to do so, leave all his land to one son. There must be substantially an equal division, the will of the father notwithstanding. As early marriages and large families are the rule, this process of continual division and subdivision has brought things down to the irreducible minimum in many places. In the *Journal of the China Branch of the Royal Asiatic Society for*

1888 a series of short papers was printed, contributed by missionaries and others living in the interior of the country, describing the social condition of the peasantry. From these it appears that the irreducible minimum is, in the more fertile parts, as low as a sixth of an acre per head. In other words, a family of six persons can make a living out of a farm of one acre. This would make a possible population of 3840 to the square mile. As a matter of fact, the subdivision has in numberless cases been carried even below that limit. Small patches of one-tenth, or even one-twentieth, are to be found as the estate of an individual landowner, and the vast majority of holdings run between one and three acres. With three acres a family is deemed very comfortable, and the possession of ten acres or more means luxury. Three acres is about the largest quantity which one family can manage without employing hired labour. In the northern provinces, where wheat, maize, &c., which do not require irrigation, are grown, five acres can be worked by one household. If the family possesses more land than that the balance is almost invariably let, and always in similar small holdings. Nowhere is the system of farming by capitalists with hired labour to be found. The following is an instance given by one of the writers in the above-named journal, and may be taken as typical of the bulk of the rural population :—

"Pong Hia lives in a village of 300 persons, in which about 30 are landowners. Pong Hia owns more than any other man in his class, having 2 acres (12 mow). His family consists of 10 persons. He is 46 years old, his wife is 41, his son is 22, his son's wife is 22, his four daughters are from 10 to 17, and his two grandchildren are 3 and 8 years old. He and his son till the land, hiring help in harvest-time. The womenfolk weave and make clothing for the family, rear pigs and fowls, and do all the housework. The house in which these ten persons live is worth £12, including the site; the furniture is worth £4 : 10s., the clothing worth about £4. The family lives comfortably upon the produce of the land, and is reckoned affluent."

To this it may be added that land such as the foregoing will yield two, or sometimes three, crops in the year. The spring crop is wheat, sown in November and reaped in April; the summer or principal crop is rice, planted in May and reaped in August or September; and an autumn crop of cabbages, beans, or other green stuff can usually be got in, sometimes overlapping with the wheat. In the southern provinces two rice crops can be got in succession during the summer, besides the winter crop.

It will be gathered from the foregoing that there is no class of wealthy territorial magnates, corresponding to the aristocracy of this and other European countries. The only class which at all resembles them is the class of retired officials. As the bureaucracy monopolize all the power in the country, they generally contrive to monopolize a good deal of the wealth. This is not infrequently invested in land, and consequently there are to be found in most provinces several such families with a country seat and the usual insignia of local rank and influence. On the decease of the heads or founders such families would, in the natural course of things, be broken up and the land divided, but it is considered more dignified for the sons to refrain from dividing, and to live together, sharing the rents and profits in common. This is sometimes continued for several generations, until the country seat becomes an agglomeration of households and the family a sort of clan. A family of this kind, with literary traditions, and with the means to educate the young men, is constantly sending its scions into the public service, who in turn bring their earnings to swell the common funds, while the rank and dignity which they may earn add to the importance and standing of the group as a whole. The members of this class are usually termed the *literati*, or gentry. Though the constitution does not recognize them as having any share in the local government, yet they can exercise an enormous influence in public affairs. The peasantry who farm their lands are, of course, under their control. The official rank which most of the members have acquired by promotion or purchase enables them to resist, and perhaps browbeat, the local officials, while they further terrorize the latter by threatening to denounce them to the Emperor, which they can often manage to do through some one or other of their many relations or marriage connexions who may happen to have the ear of the court. Being usually intensely bigoted and conservative, they present a serious barrier to progress, especially if there is a foreign element in it, such as the introduction of railways, or making of roads, or renting of inland residences by foreign merchants or missionaries. Not infrequently have projects for the improvement of trade, assented to by the local officials, been blocked by the opposition of the gentry, the former not daring to incur their resentment. But such families, unless their wealth is kept up by continual accessions, tend, in course of time, to decline through the levelling operation of the law of succession. As the numbers among whom the wealth must be shared increase rapidly with every generation, a point is soon reached when the individuals of the family are no better off than the peasantry who till their land, and then a break-up is inevitable. If possible, however, the eldest branch preserves the family records and the ancestral hall, some portion of the domain being put in mortmain for this purpose. When scattered, the collateral branches of such a family contrive to keep in touch, the common bond being the ancestral hall and the right to join in the family ancestor-worship. Numerous instances can be found where families no better off than the commonalty can trace their descent back through twenty generations.

*Finance.*—In fiscal matters, as for many other purposes, the Chinese empire is an agglomeration of a number of quasi-independent units. Each province has a complete administrative staff, collects its own revenue, pays its own civil service, pays its own militia and naval forces, and out of the surplus contributes towards the expenses of the imperial Government a sum which varies with the imperiousness of the needs of the latter and with its own comparative wealth or poverty. The imperial Government does not collect directly any part of the revenues, unless we except the imperial maritime customs, though these, too, pass through the books of the provincial authorities. We may also except a few of the old native customs stations which are deemed perquisites of the imperial court, as, for instance, the native custom-house at Canton, Hwei Kwan on the Grand Canal, and various stations in the neighbourhood of Peking. The superintendent of these stations is a nominee of the court, always a Manchu, who makes his returns direct to the throne and not to the governors. But otherwise the court and the central Government in Peking are dependent upon the sums they can levy on the provinces. It has hitherto been extremely difficult to obtain anything like trustworthy figures for the whole revenue of China, for the reason that no statistics are published by the central Government at Peking. The only available data are, first, the returns published by the imperial Maritime Customs for the duties levied on foreign trade; and, secondly, the memorials sent to Peking by the provincial authorities on revenue matters, certain of which are published from time to time in the *Peking Gazette*. These are usually fragmentary, being merely reports which the governor has himself received from his subordinates, detailing, as the case may be, the yield of the land tax or the likin for his particular district, with a dissertation on the causes which have made it more or less than for the previous period. Or the return may be one detailing the expenditure of such and such a department, or reporting the transmission of a sum in reply to a requisition of the Board of Revenue, with a statement of the source from which it has been met. It is only by collating these returns over a long period that anything like a complete statement can be made up. And even then it is quite certain that these returns do not represent anything like the total of taxation paid by the people, but, as far as they go, they may be taken to represent the volume of taxation on which the Peking Government can draw revenue.

The following figures[1] give as nearly as can be done the actual revenue of the Chinese empire as returned by the responsible officers of Government :—

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| 1. Land tax in silver . . . . | Taels 25,000,000 |
| 2. ,, ,, (in grain) value . . | 6,500,000 |
| 3. Salt tax . . . . . | 13,500,000 |
| 4. Likin . . . . . . | 13,000,000 |
| 5. Foreign maritime customs . . | 22,500,000 |
| 6. Native customs . . . | 2,000,000 |
| 7. Duty on native opium . . . | 2,200,000 |
| 8. Miscellaneous . . . . | 5,500,000 |
| Total . . . . . | Taels 90,200,000 |

Equal to £13,530,000.

*Sources of Revenue.*—1. *Land Tax.*—In China, as in most Oriental countries, the land has from time immemorial been the mainstay of the revenue. In the early years of the present dynasty there was levied along with the land tax a poll tax on all adult males, but in 1712 the two were amalgamated, and the whole burden was thrown upon land, families not possessing land being thereafter exempted from taxation. At the same time it was decreed that the amount of the land tax as then fixed should be permanent and settled for all time coming. As a matter of fact it would appear from the records that this promise has been kept as far as the central Government has been concerned. In all its many financial difficulties it does not seem ever to have tried to increase the revenue by raising the land tax. The amount of tax leviable on each plot is entered on the title deed, and, once entered, it cannot be changed. The tax on almost all lands is thus stated to be so much in silver and so much in rice, wheat, or whatever the principal crop may be. Except in two provinces, however, the grain tax is now commuted and paid in silver. The exceptions are the provinces of Kiangsu and Chekiang, which still

[1] Throughout this article the tael spoken of is the Haikwan tael, the present value of which is about 3s. It fluctuates with the value of silver.

send forward their taxes in grain. This is despatched in bulk through a department of the Government to Peking, where it is distributed as rations among the Manchu soldiery and retainers in and about the capital. The value of the grain forwarded (generally called tribute rice) is estimated to amount to taels 6,500,000. The total collection in silver, as reported by the responsible officials, amounts in round numbers to taels 25,000,000. The total yield of the land tax, therefore, is taels 31,500,000, or say £4,725,000. It will readily be granted that for such a large country as China this is a very insignificant one. In India the land tax yields £17,000,000, and China has undoubtedly a larger cultivated area, a larger population, and soil that is on the whole more fertile; but it is certain that this sum by no means represents the amounts actually paid by the cultivators. It is the sum which the various magistrates and collectors have to account for and remit in hard cash. But as nothing is allowed them for the costs of collection, they add on a percentage beforehand to cover the cost. This they usually do by declaring the taxes leviable not in silver, but in copper "cash," which indeed is the only currency that circulates in country places, and by fixing the rate of exchange to suit themselves. Thus while the market rate is, say, 1500 cash to the tael, they declare by general proclamation that for tax-paying purposes cash will be received at the rate of 3500 or 4000 to the tael. Thus while the nominal land tax in silver remains the same it is in effect doubled or trebled, and, what is worse, no return is made or account required of the extra sums thus levied. Each magistrate or collector is in effect a farmer. The sum standing opposite the name of his district is the sum which he is bound to return under penalty of dismissal, but all sums which he can scrape together over and above are the perquisites of office less his necessary expenses. Custom, no doubt, sets bounds to his rapacity. If he went too far he would provoke a riot; but one may safely say there never is any reduction, what change can be effected being in the upward direction. What the actual sums may be which are thus levied and not accounted for it is impossible to tell, but a rough idea may be gathered from a calculation of the probable area under cultivation and the average actual payment. The area of the eighteen provinces constituting China proper is roughly 1,300,000 square miles, and assuming that one-fourth of this is under cultivation, we should have a taxable area of over 300,000 square miles, say 190,000,000 acres, which is probably under the mark. According to the best information obtainable a moderate estimate of the sums actually paid by the cultivators would give two shillings per acre. This for the eighteen provinces should give £19,000,000 as being actually levied, or more than four times what is returned.

2. *The Salt Duty.*—The trade in salt is a Government monopoly. Only licensed merchants are allowed to deal in it, and the import of foreign salt is forbidden by the treaties. For the purpose of salt administration China is divided into seven or eight main circuits, each of which has its own sources of production. Each circuit has carefully-defined boundaries, and salt produced in one circuit is not allowed to be consigned into or sold in another. There are great differences in price between the several circuits, but the consumer is not allowed to buy in the cheapest market. He can only buy from the licensed merchants in his own circuit, who in turn are debarred from procuring supplies except at the depot to which they belong. Conveyance from one circuit to another is deemed smuggling, and subjects the article to confiscation.

Duty is levied under two heads, the first being a duty proper payable on the issue of salt from the depot, and the second being likin levied on transit or at the place of destination. The two together amount on an average to about taels 1.50 per picul of 133⅓ ℔ or 3s. 9d. per cwt. The total collection returned by the various salt collectorates amounts to taels 13,500,000 (£2,025,000) per annum. The total consumption of salt for all China is estimated at 25 million piculs, or nearly 1½ million tons, which is at the rate of 9 ℔ per annum per head of the population. If the above amount of taels 1.50 were uniformly levied and returned, the revenue ought to be 37½ million taels instead of 13½.

3. *Likin on General Merchandise.*—By the term likin is meant a tax on inland trade levied while in transit from one district to another. It was originally a war tax imposed as a temporary measure to meet the military expenditure required by the Taiping and Mahommedan rebellions of 1850-70; but the Government has never been able to dispense with it since, and it is now one of the permanent sources of income. In the present disorganized condition of China it would perhaps be difficult to impose any other form of taxation which would yield a like return, but at the same time it is in form as objectionable as a tax can be, and is equally obnoxious to the native as to the foreign merchant. Tolls or barriers are erected at frequent intervals along all the principal routes of trade, whether by land or water, and a small levy is made at each on every conceivable article of commerce. The individual levy is small, but over a long transit it may amount to 15 or 20 per cent. The objectionable feature is the frequent stoppages with overhauling of cargo and consequent delays. By treaty foreign goods may commute all transit dues for a single payment of one-half the import tariff duty, but this stipulation is but indifferently observed, giving rise to frequent complaints on the part of foreign merchants. The difficulty in securing due observance of this treaty right lies in the fact that the likin revenue is claimed by the provincial authorities, and the transit dues when commuted belong to the central Government, so that the former are interested in opposing the commutation by every means in their power. As a further means of neutralizing the commutation they have devised a new form of impost, viz., a terminal tax which is levied on the goods after the termination of the transit. The amount and frequency of likin taxation are fixed by provincial legislation—that is, by a proclamation of the governor. The levy is authorized in general terms by an imperial decree, but all details are left to the local authorities, who in this, as in all other matters, have a general legislative power. The yield of this tax is estimated at present at taels 13,000,000 (£1,950,000), a sum which probably represents one-third of what is actually paid by the merchants, the balance being costs of collection.

4. *The Imperial Maritime Customs.*—The Maritime Customs is the one department of finance in China which is managed with probity and honesty, and this it owes to the fact that it is worked under foreign control. It collects all the duties leviable under the treaties on the foreign trade of China, and also all duties on the coasting trade so far as carried on by vessels of foreign build, whether Chinese or foreign-owned. It does not control the trade in native craft, the so-called junk trade, the duties on which are still levied by the native custom-house officials. By arrangement between the British and Chinese Governments, the foreign customs levy at the port of entry a likin on Indian opium of 80 taels per chest, in addition to the tariff duty of 30 taels. This levy frees the opium from any further duty on transit into the interior. The revenue of the Maritime Customs has risen from taels 11,000,000 in 1873, to taels 22,500,000 in 1898. In sterling figures, however, it would seem to have fallen, owing to the fall in the gold price of silver. The revenue of 1873, converted into gold at the exchange of the day, was about £3,666,000, whereas that of 1898 would only give £3,375,000. From the point of view of the Chinese Government, which values everything in silver, the revenue has satisfactorily increased.

5. *Native Customs.*—The administration of the Native Customs continues to be similar to what prevailed in the Maritime Customs before the introduction of foreign supervision. Each collector is constituted a farmer, bound to account for a fixed minimum sum, but practically at liberty to retain all he may collect over and above. If he returns more he may claim certain honorary rewards as for extra diligence, but he generally manages to make out his accounts so as to show a small surplus, and no more. Only imperfect and fragmentary returns of the native collectorates have been published, but the total revenue accruing to the Chinese Government from this source does not appear much to exceed two million taels (£300,000). It is believed that if this department were included in the purview of the foreign staff of the Maritime Customs the sum might easily be trebled.

6. *Duty on Native Opium.*—The growth and manufacture of opium was up till recent years forbidden by the laws of China. It was, however, openly connived at by the officials in several provinces, especially in the south-west, where indeed it seems to have been cultivated from time immemorial, and its taxation formed a main source of their income. The restrictions are now withdrawn, and the central Government have been endeavouring to appropriate the taxation to their own uses. The collection remains in the hands of the provincial officials, but they are required to render a separate account of duty and likin collected on the drug, and to hold the sum at the disposal of the Board of Revenue. Opium is pre-eminently a fit article of taxation, and if the levy were faithfully carried out at a rate corresponding, *ad valorem*, to that which is levied on Indian opium, it would give a revenue sufficient to enable the Government to remit the whole likin taxation on internal trade. The annual import into China of Indian opium amounts to about 50,000 chests, on which the Chinese Government receives from duty and likin combined about 5½ million taels (£825,000). The total amount of native-grown opium is estimated at about 400,000 chests (53,000,000 ℔), and if this were taxed at taels 60 per chest, which in proportion to its price is a similar rate to what is levied on Indian opium, it should give a revenue of 24 million taels. Compared with this the sums actually levied, or at least returned by the local officials as levied, are insignificant. The returns so far as published give a total levy for all the eighteen provinces of only taels 2,200,000 (£330,000).

7. *Miscellaneous.*—Besides the foregoing, which are the main and regular sources of income, the provincial officials levy sums which must in the aggregate amount to a very large figure, but which hardly find a place in the returns. The principal are land transfer fees, pawnbrokers' and other licenses, duties on reed flats, commutation of corvée and personal services, &c. The fee on

land transfers is 3 per cent., and it could be shown, from a calculation based on the extent and value of the arable land and the probable number of sales, that this item alone ought to yield an annual return of between one and two millions sterling. Practically the whole of this is absorbed in office expenses. Under this heading should also be included certain items which, though not deemed part of the regular revenue, have been so often resorted to that they cannot be left out of account. These are the sums derived from sale of office or of brevet rank, and the subscriptions and benevolences which under one plea or another the Government succeeds in levying from the wealthy. Raising money by sale of title or official rank has long been and still is a favourable device for special emergencies, such as the great famine in Shansi, the inundation of the Yellow river, and so forth, the sale being stopped when the emergency has passed. But excluding these, the Government is always ready to receive subscriptions, rewarding the donor with a grant of official rank entitling him to wear the appropriate "button." The right is much sought after, and indeed there are very few Chinamen of any standing that are not thus decorated, for not only does the button confer social standing, but it gives the wearer certain very substantial advantages in case he should come into contact with the law courts. The minimum price for the lowest grade is taels 120 (£18), and more of course for higher grades. The proceeds of these sales go directly to the Peking Government, and do not as a rule figure in the provincial returns. The total of the miscellaneous items accruing for the benefit of the Government is estimated at taels 5,500,000.

*Expenditure.*—In regard to expenditure, a distinction has to be drawn between that portion of the revenue which is controlled by the central Government, and that controlled by the several provincial authorities. In theory, no doubt, the imperial Government is supreme, and can spend the revenue of the nation in any way it chooses, but in practice it is not so. As the provinces collect the revenue, and as the authorities there are held responsible for the peace, order, and good government of their respective territories, it follows that the necessary expenses of the provinces form a sort of first charge on the revenue. If the Peking Government asks for more than the province can afford, they simply cannot get it. The order is not, in so many words, refused, it is simply disregarded, and the Peking Government have no means of enforcing it. The method of working is as follows:—The Board of Revenue at Peking, which is charged with a general supervision of finance matters all over the empire, makes up at the end of the year a general estimate of the funds that will be required for imperial purposes during the ensuing year, and apportions the amount among the several provinces and the several collectorates in each province. The estimate is submitted to the Emperor, and, when sanctioned, instructions are sent to all the viceroys and governors in that sense, who, in turn, pass them on to their subordinate officers. In ordinary times these demands do not materially vary from year to year, and long practice has created a sort of equilibrium between imperial and provincial demands. The remittances to the capital are, as a rule, forwarded with reasonable regularity, mostly in the form of hard cash, and though there are frequent complaints of the falling-off of revenue, yet, by good luck, some other fund is found to have a little to spare, and the amount can be made up. It would, indeed, appear to be the cue of every governor to minimize the resources of his own province as much as possible, so as to stave off importunate demands from Peking, and get them foisted on to some other province. Hence the frequent references to the Taiping rebellion (a favourite stalking-horse, though now a generation old), the lamentations over the falling-off of revenue, and the decaying state of the province—all for the most part fictions of the imagination. There is thus a constant pull going on between Peking and the provinces—the former always asking for more, the latter resisting and pleading impecuniosity, yet generally able to find the amounts required, or at all events a percentage. Whatever the provinces can retain can be spent practically as they choose. The Peking control over local expenditure is very feeble, though nominal accounts are rendered.

The expenses which the central Government has to meet are:—(1) Imperial household; (2) Pay of the Manchu garrison in and about Peking; (3) Costs of the civil administration in the capital; (4) Pay of the foreign drilled troops termed the army of the North as distinct from the provincial troops (*vide* "Army" below); (5) The admiralty so far as regards the northern squadron; (6) Naval dockyards, forts, guns, &c.; (7) Foreign loans—interest and sinking fund. To meet all these charges the Peking Government has, for some years past, drawn on the provinces for about taels 20,000,000 (£3,000,000), including the value of the tribute rice, which goes to the support of the Manchu bannermen. No estimates are furnished of the sums allowed under each heading. The imperial household appears to receive in silver about taels 1,500,000 (£225,000), but it draws besides large supplies in kind from the provinces, *e.g.*, silks and satins from the imperial factories at Soochow and Hangchow, porcelain from the Kiangsi potteries, &c., the cost of which is defrayed by the provinces. The imperial Government has also at its disposal the revenue of the Foreign Customs. Prior to the Japanese war this revenue, which, after allowing for the costs of collection, amounted to about 20,000,000 taels (£3,000,000), was nominally shared with the provinces in the proportion of four-tenths and six-tenths. It was from this fund mainly that means were found to equip and maintain the northern fleet (almost extinguished by the Japanese war), to build the forts of Port Arthur and Wei-hai-wei (now also lost to the nation), and to keep going the several arsenals recently established. But the whole of the customs revenue being now pledged to foreign bondholders (*vide* "External Debt"), and absorbed by the service of the several loans, funds for these and the like purposes must now be procured, if at all, elsewhere. An entire readjustment of revenue and expenditure is manifestly necessary, but what form it will take remains to be seen. But besides supplying its own wants the imperial Government has to provide for outlying portions of the empire which are unable to maintain themselves—(1) Manchuria; (2) Kansuh and the central Asian dominion; (3) the south-western provinces of Yunnan and Kwaichow. Manchuria, or, as it is termed, the north-east frontier defence, costs about 2,000,000 taels over and above its own resources. The central Asian territories have from time to time absorbed enormous sums, and even yet constitute a drain on the imperial Government of about 4,000,000 taels a year. This is met by subsidies from Szechuen, Shansi, Honan, and other wealthy provinces. Yunnan, Kweichow, and Kwangsi require aids aggregating 2,000,000 taels to keep things going.

A rough analysis of the expenditure of the Chinese empire, as it stood at the commencement of the Japanese war, would show the following division:—

*Expenditure* 1894.

| | Taels. |
|---|---|
| Imperial household | 1,500,000 |
| Central administration, pay of banner troops and foreign drilled forces | 19,500,000 |
| Board of Admiralty (Peiyang squadron) | 5,000,000 |
| Southern naval squadron | 5,000,000 |
| Forts, guns, and coast defence | 8,000,000 |
| Defence of Manchuria | 2,000,000 |
| Kansuh and Central Asia | 4,000,000 |
| Aids to Yunnan and Kweichow | 1,600,000 |
| Interest and repayment of foreign loans | 2,500,000 |
| Railway construction | 500,000 |
| Public works, river embankments, &c. | 1,500,000 |
| Customs administration, including maintenance of lighthouses, beacons, revenue cruisers | 2,500,000 |
| General administration of eighteen provinces | 36,600,000 |
| | 90,200,000 |

*External Debt.*—Prior to the Japanese war the foreign debt of China was almost nil. A few trifling loans had been contracted at 7 and 8 per cent., but they had been punctually paid off, and only a fraction of one remained. The expenses of the war, however, and the large indemnity of 230,000,000 taels (£34,500,000) which Japan exacted, forced China for the first time into the European market as a serious borrower. The foreign loans contracted up to 1900 amounted altogether to [illegible], bearing interest mostly at 5 per cent. Some of the earlier and smaller issues carry 6 and 7 per cent., and one of £16,000,000 guaranteed by the Russian Government carries 4 per cent. This last was raised in Paris, the others were all made in London through the Hongkong and Shanghai Bank. The charges for interest and sinking fund, which amount to over £3,000,000, are secured on the revenue of the Maritime Customs, and on the likin taxes of certain specified provinces. At present the net income from these two sources amounts to over taels 24,000,000, equivalent at present rate of exchange to £3,400,000, which is amply sufficient. Besides the foregoing, the Chinese Government recently borrowed £2,300,000 for railway extension, also at 5 per cent., the charges on which are secured on the revenue of the Imperial Northern Railway (*vide* "Railways.")

There is no internal debt worth mentioning. The Chinese Government have several times attempted to borrow money in their own country, offering Government bonds as security, but uniformly without success. It is felt that no reliance can be placed on the good faith of the Government towards its own subjects, and no machinery exists whereby payment could be enforced in case of default.

*Defence—Army.*—The Chinese constitution provides for two independent sets of military organizations—namely, the Manchu army and the several provincial armies. On the establishment of the dynasty in 1644, the victorious troops, composed mainly of Manchus, but including also Mongols and Chinese, were permanently quartered in Peking, and constituted a hereditary national army. The force was divided into eight banners, and under one

or other of these all Manchus and all the descendants of the members of other nationalities are yet enrolled. They form the bulk of the population of the "Tartar city" of Peking. Each adult male is by birth entitled to be enrolled as a soldier, and by virtue of his enrolment has a right to draw rations—*i.e.*, his allowance of the tribute rice, whether on active service or not. Detachments from one or other of the banners were also stationed as garrisons in the chief provincial centres, as at Canton, Foochow, and Hangchow, &c., and their descendants still occupy the same position. They are, like their kinsmen in Peking, entitled to draw a pittance from the provincial taxes as rations. Both in the capital and in the provinces the Manchu garrisons are exempt from the jurisdiction of the local authorities, and are justiciable only before their own officers. As a fighting force the Manchu garrisons both in the capital and in the provinces have long become quite effete. In the capital, however, the *élite* of the Manchu soldiery have been formed into a special corps termed the Peking Field Force. Its nominal strength is 20,000, the men are armed and drilled after the European fashion, and fairly well paid. There are other corps of picked Manchus better paid and better armed than the ordinary soldier, and it is computed that the Manchu army in or near Peking could muster 75,000, all more or less efficient. The second organization is termed the army of the Green Standard, being the Chinese provincial forces. The nominal strength is from 20,000 to 30,000 for each province, or about 500,000 in all; the actual strength is about one-third of this. They are enrolled for the purpose of keeping the peace within their own province, and resemble a militia or local constabulary rather than a national army. They are distributed in small camps or garrisons in the principal towns, and the most serious duty they are likely to be called on to perform is that of putting down a local rebellion. The bulk of each provincial army is under the command of a general-in-chief, but certain brigades are under the orders of the governor and the governor-general. They are generally poorly paid and equally badly drilled and armed. As a fighting force they are of no practical account.

The only real fighting force which China possesses is made up of certain special corps which are not provided for in the constitution, and which consequently used to be termed *yung*, "braves" or irregulars, but which have now acquired various distinctive names. They are enlisted for service generally, and have all had some smattering of foreign drill. They are also fairly well paid and armed. Since the Japanese war these corps have been quartered near Peking and Tientsin, and are generally spoken of as the army of the North. They are now grouped in five divisions under the command of Generalissimo Jung Lu, and are supposed to number 75,000 men. In addition to these the Government could count on 20,000 men more who are now scattered in garrisons in Manchuria.

*Navy.*—Since the destruction of the northern fleet by the Japanese at the capture of Wei-hai-wei in 1895, the Chinese navy may be said to be non-existent. It formerly consisted of two divisions, the northern and the southern, of which the former was by far the more formidable. The southern was under the control of the viceroy of Nanking, and took no part in the Japanese war. While the northern fleet was grappling in a death-struggle, the southern was lying snugly in the Yangtse waters, the viceroy of Nanking apparently thinking that as the Japanese had not attacked him there was no reason why he should risk his ships. Since the close of the war an attempt has been made to restore the northern fleet, which now consists of five small cruisers and a few torpedo boats. The southern squadron consists of seven small cruisers, old-fashioned, and four torpedo boats. The viceroys of Foochow and Canton possess a few gunboats meant to repress piracy, but of no fighting value.

*Arsenals and Dockyards.*—Since the loss of Port Arthur, China possesses no dockyard except a small one at Foochow, which cannot dock vessels over 3000 tons. Many years ago the Chinese Government established at Foochow a shipbuilding yard, placing it in the hands of French engineers. Training schools both for languages and practical navigation were at the same time organized, and a training ship was procured and put under the command of a British naval officer. Some twenty-five or thirty small vessels were built in the course of as many years, but gradually the whole organization was allowed to fall into decay. Except for petty repairs this establishment is valueless to the Chinese Government. Well-equipped arsenals have been established at Shanghai and at Tientsin, but as they are both placed up shallow rivers they are useless for naval repairs. Both are capable of turning out heavy guns, and also rifles and ammunition in large quantities. There are also military arsenals at Nanking, Wuchang, Canton, and Chengtu, besides smaller establishments at other provincial centres.

*Forts.*—A great number of forts and batteries have been erected along the coast and at the entrance to the principal rivers. Chief among these, now that the Taku forts formerly commanding the entrance to Tientsin have been demolished, are the Kiangyin forts commanding the entrance to the Yangtse, the Min forts at the entrance of the Foochow river, and the Bogue forts at the entrance to the Canton river. These are supplied with heavy armament from the Krupp and Armstrong factories, but the garrisons share the weakness common to all Chinese military establishments.

*Production and Industry: Minerals.*—The Chinese Government has hitherto shown a great repugnance to permitting foreign companies to work minerals in any part of the country. As a consequence very little is known of the actual resources of the empire, which, however, are believed to be very great. A Bureau of Mines, however, has been created with a view to granting concessions, and probably much progress will be made in the near future.

*Coal.*—This mineral is worked on foreign principles at only one place, viz., the Kaiping collieries in the north-east of the province of Chihli. The mines are connected with the seaport of Taku by a railway. The coal is a soft bituminous coal with a large proportion of dust. The output is about 1,500,000 tons per annum. A mine has also been opened in the province of Hupeh, about 60 miles below Hankow, and near the Yangtse, in connexion with the iron-works recently erected by the viceroy of that province. Numerous small mines have been worked for a long period by the natives in the province of Hunan. There are two principal local fields in this province, one lying in the basin of the Lui river and yielding anthracite, and the other in the basin of the Siang river yielding bituminous coal. Both rivers drain into the Yangtse, and there is thus an easy outlet by water to Hankow. The quality of the coal, however, is inferior, as the stratification has been much disturbed, and the coal seams have been in consequence crushed and broken. No statistics of the output are obtainable, but it is estimated to be over 300,000 tons per annum—mostly destined for local consumption. The largest coal-field in China lies in the province of Shansi. Coal and iron have here been worked by the natives from time immemorial, but owing to the difficulty of transport they have attained only a limited local circulation. The whole of southern Shansi, extending over 30,000 square miles, is one vast coal-field, and contains, according to the estimate of Baron von Richthofen, enough coal to last the world at the present rate of consumption for several thousand years. The coal seams, which are from 20 to 36 feet in thickness, rest conformably on a substructure of limestone. The stratification is throughout undisturbed and practically horizontal. As the limestone bed is raised some 2000 feet above the neighbouring plain the coal seams crop out in all directions. Mining is thus carried on by adits driven into the face of the formation, rendering the mining of the coal extremely easy. The coal-field is divided into two by a mountain range of ancient granitic formation running north-east and south-west, termed the Hoshan. It is of anterior date to the limestone and coal formations, and has not affected the uniformity of the stratification, but it has this peculiarity, that the coal on the east side is anthracite, and that on the west side is bituminous. A concession to work coal and iron in certain specified districts in this area has been granted to a British company, together with the right to connect the mines by railway with water navigation, and it is expected that important developments will follow on this grant. At present the mines, in default of railway facilities, are practically valueless. At the pit's mouth coal can be had for a shilling a ton, but as transport costs from 2½d. to 5d. per ton per mile, the price becomes prohibitive after a short distance. In spite of these drawbacks the present output must be considerable, considering the great area and the number of openings that are being worked, but it is impossible to state it with any degree of accuracy. There are various other sources of coal-supply, such as the western hills near Peking, many parts of Szechuen, and some districts in Shantung and Kwangtung, which, however, do not call for detailed notice. It may, indeed, be said generally that there is hardly a province which does not possess coal mines more or less valuable—the one drawback to their development being the absence of railways.

*Iron.*—Iron ore of various qualities is found almost as widely diffused as coal. The districts where it is most worked at present lie within the coal-field of Shansi, viz., at Tse-chou-fu and Ping-ting-chou. The ore is a mixture of clay iron ore and spathic ore, together with limonite and hematite. It is found abundantly in irregular deposits in the Coal Measures, and is easily smelted by the natives in crucibles laid in open furnaces. This region supplies nearly the whole of north China with the iron required for agricultural and domestic use. The out-turn must be very considerable, but no data are available for forming an accurate estimate. The province of Szechuen also yields an abundance of iron ores of various kinds. They are worked by the natives in numerous places, but always on a small scale and for local consumption only. The ores occur in the Coal Measures, predominant among them being a clay iron ore. Hunan, Fuhkien, Chekiang, and Shantung all furnish iron ores, but only a petty industry is carried on at any one place.

Of other minerals *copper* comes next in importance. It is found chiefly in the provinces of Kweichow and Yunnan, where a rich belt of copper-bearing ores is found running east and west

across both provinces, and including south Szechuen. The chief centres of production are at the cities of Tung-chuan-fu, Chao-tung, and Ning-yuan. The mines are worked as a Government monopoly, private mining being nominally prohibited. No concessions have so far been granted to foreign companies. The output is considerable, but no statistics are published by Government. The supply is not, however, enough to meet the requirements of the country, as foreign copper is imported to the extent of about 28,000 tons a year. It is generally supposed that if the mines were thrown open to foreign enterprise, not only would the home demand be met, but there would be a large available supply for export.

*Precious Metals.*—There is no known source of supply in China proper where gold and silver are worked to any appreciable extent. A little gold washing is done in the sandy beds of certain rivers, for instance, the Han river and the upper Yangtse, above Suifu, which here goes by the name of the "Goldsand" river. The amount so extracted is extremely small and hardly pays the labour of washing, but the existence of gold grains points, no doubt, to a matrix higher up. The whole of south-western China has the reputation of being highly metalliferous, and it is probable that valuable deposits may be found when permission to prospect has been granted by the Chinese Government. Gold is obtained, however, in some quantities on the upper waters of the Amur river, on the frontier between China and Siberia. The washings are carried on by Chinese, no foreigners so far having been allowed to participate. Gold has also been found in quartz veins at Ping-tu, in the province of Shantung, but hardly in paying quantities.

*Manufactures.*—In regard to manufactures the only point to be noticed is the recent establishment of cotton spinning and weaving mills by foreign companies at Shanghai. Permission to carry on this industry was refused to foreigners until the right was secured by the Japanese treaty following on the war. Some native-owned mills had been working before that date, and were reported to have made large profits. Eight mills with an aggregate of 300,000 spindles are now working, five of which are under foreign management. There are also four or five mills at one or other of the ports working 80,000 spindles more. These mills are all engaged in the manufacture of yarn for the Chinese market, very little weaving being done. Chinese-grown cotton is used, the staple of which is short, and only the coarser counts can be spun. So far these mills have not had the financial success which was predicted for them, but many of the initial difficulties were due to inexperience, and it is probable that the cotton manufacturing industry in China will attain considerable proportions. The only other manufacture that deserves mention is that of silk weaving. This is carried on solely by native looms, and chiefly in the cities of Hangchow, Soochow, and Nanking. The native looms have long been famous for their beautiful silks and brocades. The greater part is destined for home consumption, but there is now also a considerable export. In 1898 the export of silk piece goods amounted in value to £1,400,000. The reeling of silk cocoons by steam machinery has also come into vogue in recent years, and is gradually supplanting the native methods. Notwithstanding the large foreign importations the spinning and weaving of cotton on native hand-looms is still carried on almost universally. The whole of the large import of Indian yarn, as well as that locally manufactured, is worked up into cloth by the women of the household. Four-fifths of the clothing of the lower classes is supplied by this domestic industry.

*Commerce.*—The progress of the foreign trade of China is set out in the following table. The values are given both in currency and sterling, but it is to be remarked that during the period when silver was falling, that is from 1875 to 1893, the silver valuation represents much more accurately variations in the volume of trade than does the gold valuation. Gold prices fell continuously during this period, while silver prices were nearly constant. Since 1893 silver prices have tended to rise, and the gold valuation is then more accurate. The conversion from silver to gold is made at the rate of exchange of the day, and therefore varies from year to year

*Table of Imports and Exports, exclusive of Bullion.*

| Year. | Imports. | | Exports. | |
|---|---|---|---|---|
| | Value in Taels. | Equivalent in Sterling. | Value in Taels. | Equivalent in Sterling. |
| 1875 | 66,344,000 | £19,903,000 | 77,308,000 | £23,193,000 |
| 1880 | 76,689,000 | 22,368,000 | 87,694,000 | 25,582,000 |
| 1885 | 84,803,000 | 22,618,000 | 73,899,000 | 19,206,000 |
| 1890 | 113,082,000 | 29,213,000 | 96,695,000 | 24,980,000 |
| 1895 | 154,685,000 | 25,136,000 | 154,964,000 | 25,181,000 |
| 1896 | 184,897,000 | 25,816,000 | 141,685,000 | 23,114,000 |
| 1897 | 185,194,000 | 27,779,000 | 175,229,000 | 26,284,000 |
| 1898 | 189,991,000 | 28,498,000 | 170,743,000 | 25,612,000 |

The distribution of the trade among the various countries of the world is shown in the following table:—

*Imports into China.* (000's omitted.)

| Imports from | 1875. | 1880. | 1885. | 1890 | 1895. | 1898. |
|---|---|---|---|---|---|---|
| Un. Kingdom | £6,340 | £6,382 | £6,396 | £6,357 | £5,518 | £5,244 |
| Hongkong . | 8,282 | 8,829 | 9,404 | 18,615 | 14,331 | 14,582 |
| India . . . | 4,451 | 6,039 | 4,306 | 2,661 | 2,753 | 2,870 |
| Other British Possessions | 396 | 346 | 542 | 571 | 732 | 721 |
| United States | 304 | 351 | 884 | 949 | 827 | 2,574 |
| Continent of Europe (except Russia) | 230 | 671 | 671 | 638 | 1,227 | 1,410 |
| Russia in Europe . . | ... | ... | ... | 177 | 291 | 218 |
| Russia in Asia | 30 | 50 | 52 | 54 | 18 | 45 |
| Japan . . . | 746 | 1,021 | 1,404 | 1,909 | 2,794 | 4,156 |

*Exports from China.* (000's omitted.)

| Exports to | 1875. | 1880. | 1885. | 1890. | 1895. | 1898. |
|---|---|---|---|---|---|---|
| United Kingdom | £8,749 | £8,125 | £5,864 | £3,383 | £1,718 | £1,607 |
| Hongkong . . | 3,824 | 4,844 | 4,232 | 8,507 | 5,651 | 9,312 |
| India . . . . | 72 | 323 | 157 | 273 | 449 | 198 |
| Other British Possessions. . | 948 | 874 | 818 | 886 | 586 | 558 |
| United States . | 2,302 | 2,906 | 2,213 | 2,109 | 2,499 | 1,798 |
| Continent of Europe (except Russia) . . . | 2,524 | 3,760 | 1,948 | 3,004 | 3,440 | 3,889 |
| Russia in Europe | 411 | 8 | 252 | 959 | 727 | 751 |
| Russia in Asia . | 928 | 1,252 | 1,041 | 1,329 | 1,808 | 1,919 |
| Japan . . . . | 586 | 642 | 398 | 1,248 | 2,408 | 2,414 |

The principal exports from the United Kingdom to China are cotton piece goods, woollen manufactures, metals, and machinery. China is next to India the greatest consumer of Manchester goods. The export of plain cotton goods to China and Hongkong has for some years averaged 500,000,000 yards per annum. The only competitor which Great Britain has in this particular branch of trade is the United States of America, which within recent years has been supplying China with very large quantities of cotton goods. In [illegible] China imported 70,000,000 yards of American-made goods, but in 1898 the import had risen to 165,000,000 yards. The value in sterling of the total imports into China from the United Kingdom has remained nearly constant for the last 25 years, but inasmuch as the gold prices have been falling the volume of the export has been in reality steadily growing. The imports into England, however, of Chinese produce have fallen off enormously, mainly through the fact that China tea has been driven out of the English market by the growth of India and Ceylon, and also because the bulk of the China silk is now shipped directly to Lyons and other Continental ports instead of to London as formerly was the rule. The growth of the import of Indian yarn into China has been very rapid. In 1884 the import was 35,000,000 lb and in 1898 it reached 188,000,000 lb. Arranged in categories the imports into China from all foreign countries for the year 1898 were as follows:—

| | |
|---|---|
| Cottons and cotton yarn . . . | £11,012,000 |
| Woollen manufactures . . . | 440,000 |
| Metals and machinery . . . | 1,600,000 |
| Petroleum . . . . . . . | 1,600,000 |
| Opium . . . . . . . | 3,460,000 |
| Sundries . . . . . . . | 10,370,000 |
| Total . . . | £28,482,000 |

The principal exports from China are silk and tea. These two articles, indeed, up to 1880 constituted more than 80 per cent. of the whole export. Owing, however, mainly to the fall in silver, and partly also to cheap ocean freights, it has become profitable to place on the European market a vast number of miscellaneous articles of Chinese produce which formerly found no place in the returns of trade. The silver prices in China did not change materially with the fall in silver, and Chinese produce was thus able to compete favourably with the produce of other countries. The following table shows the relative condition of the export trade in 1880 and 1898:—

| Exports of | 1880. | 1898. |
|---|---|---|
| Silk . . . | £9,750,000 | £9,074,000 |
| Tea . . . | 11,774,000 | 4,178,000 |
| Miscellaneous . | 4,058,000 | 12,360,000 |
| Total . . | £25,582,000 | £25,612,000 |

In the miscellaneous class the chief items of export are beans and beancake, £1,524,000; raw cotton, £473,000; hides, £562,000; mats and matting, £552,000; oils, £475,000; furs and skin rugs, £461,000; sugar, raw, £311,000; tobacco, £576,000; strawbraid, £470,000; and wool, £214,000. The export of all cereals except pulse is forbidden.

*Movements of Bullion.*—The following table shows the export and import of the precious metals for the past eleven years. The *net* import or export only is given.

| | Imports, Value in H. Taels. | | Exports, Value in H. Taels. | |
|---|---|---|---|---|
| | Gold H. Tls. | Silver H. Tls. | Gold H. Tls. | Silver H. Tls. |
| 1888 | . | . . | 1,678,000 | 1,911,000 |
| 1889 | . . | 6,005,000 | 1,625,000 | |
| 1890 | ... | ... | 1,783,000 | 3,557,000 |
| 1891 | ... | ... | 3,693,000 | 3,113,000 |
| 1892 | ... | . . | 7,332,000 | 4,825,000 |
| 1893 | . | 9,873,000 | 7,459,000 | |
| 1894 | ... | 26,389,000 | 12,774,000 | |
| 1895 | . . | 36,685,000 | 6,624,000 | |
| 1896 | ... | 1,720,000 | 8,114,000 | |
| 1897 | ... | 1,641,000 | 8,512,000 | |
| 1898 | ... | 4,722,000 | 7,704,000 | |
| Total 11 years | ... | 87,035,000 | 67,298,000 | 13,406,000 |

There has thus been over the whole period a net import of silver of H. taels 73,629,000, equivalent to about 95,000,000 ounces. Nearly the whole of this, however, was imported during the years 1894-95, and was the proceeds of loans raised by the Chinese Government in Europe to meet the costs of the Japanese war. Very little comes into China in discharge of the annual balance of trade, inasmuch as the exports, including gold, and imports nearly counterbalance each other. There is a regular export of gold amounting on an average to about a million sterling per annum. A part of it would seem to be the hoardings of the nation brought out by the high price of gold in terms of silver, but a part is virgin gold derived from gold workings in Manchuria on the upper waters of the Amur river.

*Shipping and Navigation.*—All the foreign trade of China and a great part of the coasting trade is carried on by foreign-owned vessels. The only Chinese-owned steamers are those of the China Merchants' Steamship Company, which has its headquarters at Shanghai, and a few colliers belonging to the Kaiping Mining Company. The following table shows the nationality and tonnage of the vessels entering and clearing at the ports of China for 1898:—

| Flag. | Tonnage entered and cleared. | Percentage of total foreign. |
|---|---|---|
| British | 21,265,966 | 81·7 |
| German | 1,685,098 | 6·5 |
| Japanese | 1,569,134 | 6 |
| French | 420,078 | 1·6 |
| American | 239,152 | 0·9 |
| Russian | 178,768 | 0·7 |
| Other Powers | 686,812 | 2·6 |
| Total foreign tonnage | 26,045,008 | 100 |

In addition to the foregoing, 8,187,572 tons of Chinese-owned shipping entered and cleared at the open ports during 1898. These were wholly small vessels engaged in the coasting trade.

*Treaty Ports.*—In addition to the coast and river ports declared open to foreign trade under the treaty of Tientsin, the following places have since been thrown open at various times:—

On the Canton or West River, Samshui, Wuchow, and Nanning.

On the Yangtse, Wuhu, Shasi, Ichang, Chungking, and Yochow—the last being at the entrance to the Tungting lake.

On the Shanghai inland waters the cities of Soochow and Hangchow were opened by the Japanese treaty of 1895. They are connected with Shanghai by canal.

On the Tongking and Burma frontiers, the cities of Lungchow, Mengtze, Szemao, and Momien.

The German naval station in Kiaochow Bay (Tsingtao) is also open to trade, and it is understood that Talienwan, which was similarly acquired on lease by Russia, and which is to be the commercial terminus of the Russian Manchurian Railway, will in due course also be thrown open. An anchorage termed Chingwan-tao, near Shanhai-kwan, in the Gulf of Pe Chili, was opened in 1900. It lies close to the Imperial Northern Railway, and being ice-clear during the winter affords access to Peking when the other northern ports are closed.

*Internal Communication—Railways.*—The ninth edition article on China closed with the notice of the opening of a short line of railway between Shanghai and Woosung, and the writer hazarded the remark, that notwithstanding the fact that the trains were daily crowded with passengers, the approbation was that of the people only, and that the Government were more determined than ever to withstand the adoption of the iron road (v. 672). The fate of this pioneer railway may be mentioned as an introduction to what follows. It must be admitted that the officials had some justification for their opposition. The railway was really built without any regular permission from the Chinese Government, but it was hoped that once finished and working, the irregularity would be overlooked in view of the manifest benefit to the people. This might have been accomplished but for an unfortunate accident which happened on the line a few months after it was opened. A Chinaman was run over and killed, and this event, of course, intensified the official opposition, and indeed threatened to bring about a riot. The working of the line was stopped by order of the British minister, and thereupon negotiations were entered into with a view to selling the line to the Chinese Government. A bargain was struck sufficiently favourable to the foreign promoters of the line, and it was further agreed that, pending payment of the instalments which were spread over a year, the line should continue to be worked by the company. The expectation was that when the officials once got the line into their own hands, and found it a paying concern, they would continue to run it in their own interest. Not so, however, did things fall out. The very day that the twelve months were up the line was closed; the engines were dismantled, the rails and sleepers were torn up, and the whole concern was shipped off to the distant island of Formosa, where carriages, axles, and all the rest of the gear were dumped on the shore and left for the most part to disappear in the mud. The spacious area of the Shanghai station was cleared of its buildings, and thereon was erected a temple to the queen of Heaven by way of purifying the sacred soil of China from such abomination. This effectually put a stop to all efforts on the part of foreigners to introduce railways into China, and more than twenty years elapsed before the subject was taken up again. It is only within quite recent years that the Chinese Government have been induced to move in the matter. The first short line built was a mineral line, to connect the coal mines of Kaiping in North Chihli with the mouth of the Peiho river at Taku. The Government next authorized the formation of a Native Merchants' Company, under official control, to build a line from Taku to Tientsin, which was opened to traffic in 1888. It was not, however, till nine years later, viz., in 1897, that the line was completed as far as Peking. Meantime, however, the extension had been continued north-east along the coast as far as Shanhai-kwan, and a further extension will connect with the treaty port of Newchwang. The money for these extensions was mostly found by the Government, and the whole line is now known as the Imperial Northern Railway. A loan of £2,300,000 for the Newchwang extension was raised through the Hongkong and Shanghai Bank in 1899, and secured by a mortgage on the completed section as far as Shanhai-kwan. The length of the line is 340 miles, and, including the Newchwang extension, it will be when completed 600 miles in length. Meanwhile the high officials of the empire had gradually been brought round to the idea that railway development was in itself a good thing. Chang Chih-tung, then viceroy of the Canton provinces, memorialized strongly in this sense, coupled, however, with the condition that the railways should be built with Chinese capital and of Chinese materials. In particular, he urged the making of a line to connect Peking with Hankow for strategic purposes. The Government took him at his word, and he was transferred from Canton to Hankow with authority to proceed forthwith with his railway. True to his purpose he at once set to work to construct iron-works at Hankow. Smelting furnaces, rolling mills, and all the machinery necessary for turning out steel rails, locomotives, &c., were erected. Several years were wasted over this preliminary work, and over £1,000,000 sterling was spent only to find that the works after all were a practical failure. Steel rails could be made, but at a cost two or three times what they could be procured for in Europe. After the Japanese war the hope of building railways with Chinese capital was abandoned. A prominent official named Sheng Hsuan-hwai was appointed director-general of railways, and empowered to enter into negotiations with foreign financiers for the purpose of raising loans. It was still hoped that at least the main control would remain in Chinese hands, but the diplomatic pressure of France and Russia caused even that to be given up, and Great Britain insisting on equal privileges for her subjects, the future of railways in China will be in the hands of the various concessionaires, at least until their redemption by the Chinese Government.

The following is a list of the several railway concessions which have been granted up to date:—

(1) *English.*—1. (*a*) Shanghai to Nanking; (*b*) Shanghai to

Hangchow and Ningpo; (*c*) Pukou (on the north bank of the Yangtse opposite Nanking) to Siuyang, a station on the Luhan line. Total length 650 miles. 2. Hongkong to Canton, 100 miles. 3. In the provinces of Shansi and Honan, the Peking Syndicate, besides mining rights, have the right to connect mines with navigable waters. Lines not yet determined, but will probably extend to 300 or 400 miles.

(2) *Anglo-German.*—A trunk line from Tientsin to Chinkiang, 600 miles. Northern or Shantung half to be built and equipped by the German syndicate; the southern or Yangtse half by English syndicate. Total length 600 miles.

(3) *Anglo-American.*—A trunk line from Canton to Hankow, 600 miles.

(4) *German.*—Lines in Shantung. Kiaochow to Tsinanfu, and Kiaochow to Yihsien, 420 miles.

(5) *Russian.*—(*a*) Permission to carry the Siberian main line now in course of construction from Stretensk through Chinese territory *viâ* Petune to Vladivostock, 1000 miles. (*b*) A line to connect Port Arthur and Talienwan with the above, 400 miles. (*c*) A line from Taiyuenfu, the capital of the province of Shansi, to connect with the Luhan line at Chengting, 130 miles.

(6) *Belgian* or *Franco-Belgian.*—A trunk line from Hankow to Peking, generally termed the Lu-Han line, length 700 miles.

(7) *French.*—(*a*) From Tongking up the Red river to Yunnanfu, 200 miles. (*b*) Langson to Lungchow and Nanning, 100 miles. (*c*) Pakhoi to Nanning, 120 miles.

The British Government has also obtained the right to extend the Burma railway system through Yunnan and north to the Yangtse so soon as a company is prepared to take it up.

Many years will doubtless elapse before these lines are made, involving as they do an outlay of something like 60 or 80 millions of capital, and some of them will probably not be made at all. The Russian lines are being pushed on with activity, and the Belgian, or more properly Franco-Belgian syndicate, which has the Peking-Hankow, commonly called the Lu-Han line in hand, has commenced work from the Hankow end. The section Peking to Paotingfu has been already built, and has been transferred for operation to the Belgian syndicate. The lower Yangtse lines as well as the Hongkong-Canton line will no doubt be made, and passing as they do through the richest and most populous districts of China, they ought to pay well.

*Roads and Canals.*—In regard to these nothing new need be said. The Chinese Government spends nothing on these objects. Occasionally the local authorities make an effort by employing the corvée system to dig out the bed of a canal, but as a rule roads are left to take care of themselves. Even the Grand Canal has been suffered to silt up, so that for nearly half its length it is quite useless for through traffic. It is only employed by the annual fleet of tribute rice boats, which are still required by unyielding regulations to carry their freight by this route. They choose the time of high water, when the country is more or less flooded, and even then it is only by dint of sheer hauling for miles along a muddy bottom that they are got through. Pages are filled by the reports of the officer in charge, describing the superhuman exertions of himself and his men in getting the boats hauled through. It does not appear to occur to anyone that a moderate sum spent in dredging, with a few locks here and there, would make the passage cheap and easy.

*Telegraphs.*—Here the case is different. Every important city in China is now connected by wire with the capital, and the service is reasonably efficient. Connexion is also established with the English lines in Burma and the Russian lines in Siberia. The Great Northern Telegraph Co. (Danish) and the Eastern Extension Telegraph Co. (English) connect Shanghai by cable with Hongkong, Japan, Singapore, and Europe. An imperial *postal service* has also been recently established under the general control of the Maritime Customs. It serves all the open ports, and is gradually being extended to the interior. The treaty Powers, however, still maintain their separate post offices at Shanghai for the despatch and receipt of mails from Europe.

*Mining Concessions.*—The only mining concession of any value granted to a foreign company is that secured by the Peking Syndicate, which gives the right to work coal, iron, and petroleum in the province of Shansi. It is expected that this concession will lead to very important industrial developments. Several preliminary contracts have been entered into for mining concessions in other provinces, but they are clogged with conditions imposed by recent regulations issued by the Chinese Government, and for the present they seem of doubtful value.

*Banks and Banking.*—Native banks for purposes of inland exchange are to be found in most large cities. They are private banks using their own capital, and seldom receiving deposits from the public. The best known are the Shansi banks, which have branches all over the empire. They work on a small capital, seldom over £50,000 each, and do a small but profitable business by selling their drafts on distant places. None of these issue notes, although they are not debarred from doing so by law. They lend money on personal security, but do not advance against shipments of goods. In some places there are small local banks, usually called cash shops, which issue paper notes for small sums and lend money out on personal security. The notes never reach more than a very limited local circulation, and pass current merely on the credit of the institution. There is no law regulating the formation of banks or the issue of notes. *Pawnshops* occupy a prominent position in the internal economy of China. They lend on deposit of personalty at very high rates, 18 and 24 per cent., and they receive deposits of money from the public, usually allowing 6 to 10 per cent. They are the real banks of deposit of the country, and the better class enjoy good credit.

*Currency.*—The currency of China consists of:—(1) *Silver*, which may be either uncoined ingots passing current by weight, or imported coins, Mexican dollars and British dollars; and (2) *Copper* "cash," which has no fixed relation to silver. The standard is silver, the unit being the Chinese ounce or tael, containing 565 grains. The tael is not a coin, but a weight. Its value in sterling consequently fluctuates with the value of silver; in 1870 it was worth about 6s. 8d., it is now worth rather less than 3s. The name given in China to uncoined silver in current use is "sycee." It is cast for convenience sake into ingots weighing about 50 taels each. Its average fineness is 916·66 per 1000. When foreign silver is imported, say into Shanghai, it can be converted into currency by a very simple process. The bars of silver are sent to a quasi-public office termed the "Kung Ku," or public valuers, and by them melted down and cast into ingots of the customary size. The fineness is estimated, and the premium or betterness, together with the exact weight, is marked in ink on each ingot. The whole process only occupies a few hours, and the silver is then ready to be put into use. The Kung Ku is simply a local office appointed by the bankers of the place, and the weight and fineness are only good for that locality. The Government takes no responsibility in the matter, but leaves merchants and bankers to adjust the currency as they please. For purposes of taxation and payment of duties there is a standard or treasury tael, which is about 10 per cent. heavier than the tael of commerce in use at Shanghai. Every large commercial centre has its own customary tael, the weight and therefore the value of which differ from that of every other. Silver dollars coined in Mexico, and British dollars coined in Bombay, also circulate freely at the open ports of trade and for some distance inland, passing at a little above their intrinsic value. Carolus dollars, introduced long ago and no longer coined, are retained in current use in several parts of the interior, chiefly the tea-growing districts. Being preferred by the people, and as the supply cannot be added to, they have reached a considerable premium above their intrinsic value. Provincial mints in Canton, Wuchang, and other places, have recently been issuing silver coins of the same weight and touch as the Mexican dollar, but very few have gone into use. As they possess no privilege in debt-paying power over imported Mexican dollars there is no inducement for the people to take them up unless they can be had at a cheaper rate than the latter, and these are laid down at so small a cost above the intrinsic value that no profit is left to the mint. The coinage has in consequence been almost discontinued. Subsidiary coins, however, are coming largely into use, issued by the local mints. The only coin officially issued by the Government is the so-called *copper cash*. It is a small coin which by regulation should weigh $\frac{1}{10}$th of a tael, and should contain 50 parts of copper, 40 of zinc, and 10 of lead or tin, and it should bear a fixed ratio to silver of 1000 cash to one tael of silver. In practice none of these conditions are observed. Being issued from a number of mints, mostly provincial, the standard was never uniform, and in many cases debased. Excessive issues lowered the value of the coins, and for many years the average exchange was 1600 or more per tael. Within the last few years the rise in copper has led to the melting down of all the older and superior coins, and as for the same reason coining was suspended, the result has been an appreciation of the "cash," so that a tael now exchanges for only 1180 or 1200. Inasmuch as the "cash" bears no fixed relation to silver, and is moreover of no uniform composition, it forms a sort of mongrel standard of its own, varying with the volume in circulation at any particular time. It is, however, the universal medium of exchange for all retail transactions, and the quantities in circulation are enormous. The fluctuations in regard to silver give rise to great complaints among the people. The introduction of a uniform system of coinage is one of the most pressing wants of China.

## II. Recent History.

In the article in the ninth edition of the *Encyclopædia Britannica*, the history of China was carried down to the accession of the Emperor Kwang Su in January 1875. As an introduction to what

follows we shall first take a brief survey of the condition of the empire at that period. The decade 1854-64 had witnessed low-water mark in the political fortunes of the Manchu dynasty. The central provinces had been overrun and devastated by the Taiping rebels. Nanking, the ancient capital of the empire, was in their hands, and throughout the whole of the lower Yangtse valley, even down to Shanghai and Ningpo, bands of marauders burnt, pillaged, and murdered at their will. In the south-west the province of Yunnan was the scene of another rebellion. A Mahommedan tribe known as Panthays had risen in revolt, captured the city of Talifu, and proclaimed a chief Tu Win Siu as their sultan. In the north-west a similar Mahommedan rebellion broke out in the province of Kansuh. This was followed by a revolt of the whole of the central Asian tribes, which for 2000 years had more or less acknowledged the imperial sway. In Kashgaria, a native chief termed Yakoob Beg, otherwise known as the Atilik Ghazi, had made himself Ameer, and seemed likely to establish a strong rule. The fertile province of Kuldja or Ili, lying to the north of the Tien shan range, was temporarily taken possession of by Russia in order to put a stop to the prevailing anarchy, but with a promise that when China should have succeeded in re-establishing order in her central Asian dominions it should be given back. To add to all these misfortunes, and even when they were at their height, the Chinese Government embroiled itself in a foreign war. Redress being refused for long-standing grievances, a combined British and French expedition was sent to operate in the north. The emperor fled to Mongolia, Peking was surrendered, and terms of peace were dictated within the walls of the capital (24th October 1860). This last calamity, which might have seemed to some the worst of all, was in reality the salvation of the country. The foreign Powers had gone there for the sole purpose of establishing fair and equitable terms of trade—terms which would be just as advantageous to the people of China as to themselves. The treaty having once been made with the imperial Government, it was their interest to uphold its authority, and to see a speedy end to the forces of anarchy and disorder. No sooner, therefore, had the war with China been finished, than Great Britain and France proceeded to lend the Chinese active assistance. The services of General Gordon at this juncture are too well known to need further mention. With the first of his victories the tide began to turn, and from that time fortune smiled on the imperial arms. By degrees the Taiping rebellion was crushed; indeed the movement had for some years been collapsing through internal decay; and, with the fall of Nanking in 1864, it finally disappeared. The next ten years (1864-74) witnessed a general revival of the strength of the empire. The Panthay rebellion in Yunnan was put down in 1873, and order had been re-established somewhat earlier in the north-western provinces of Shensi and Kansuh. The central Asian states still remained under the rule of the Ameer Yakoob Khan, and China was at this time strongly counselled by many to leave things alone in that region. Russia had in the course of the disorder possessed herself of the khanate of Khokand, and it was pointed out that a strong state like that of Kashgaria under Yakoob Khan might be a convenient buffer against farther progress on that side from the great western Power. This counsel, however, as will be seen, did not prevail.

Such, briefly, was the state of affairs at the accession of the reigning emperor, Kwang Su, in January 1875. He was not then four years old, and his accession attracted little notice outside of China, as the supreme power continued to be vested in the two dowager empresses whose long regency had been only nominally determined in favour of the emperor Tung Chi when the latter attained his majority in 1873—the empress Tsu An, principal wife of the emperor Hsien Fung, and the empress Tsu Tsi, secondary wife of the same emperor, and mother of the emperor Tung Chi. Yet there were circumstances connected with the emperor Kwang Su's accession which might well have arrested attention. The emperor Tung Chi, who had himself succumbed to an ominously brief and mysterious illness, left a young widow in an advanced state of pregnancy, and had she given birth to a male child her son would have been the rightful heir to the throne. But even before she sickened and died—of grief, it was officially stated, at the loss of her imperial spouse—the dowager empresses had solved the question of the succession by placing Kwang Su on the throne, a measure which was not only in itself arbitrary, but also in direct conflict with one of the most sacred of Chinese traditions. The solemn rites of ancestor-worship, incumbent on every Chinaman, and, above all, upon the emperor, can only be properly performed by a member of a younger generation than those whom it is his duty to honour. The emperor Kwang Su, being a son of Prince Chun, brother to the emperor Hsien Fung, and thus first cousin to the emperor Tung Chi, was not therefore qualified to offer up the customary sacrifices before the ancestral tablets of his predecessor. So profound was the prejudice created against the young emperor on this score, that fifteen years later, when, having reached the age of manhood, he proceeded for the first time to the Temple of Heaven to perform the ancestral rites, one of the censors committed suicide in his presence as a protest against so grave a breach of the dynastic tradition. The accession of an infant in the place of Tung Chi achieved, however, for the time being what was doubtless the paramount object of the policy of the two empresses, namely, their undisturbed tenure of the regency, in which the junior empress Tsu Tsi, a woman of unquestionable ability and boundless ambition, had gradually become the predominant partner.

***Murder of Mr Margary.***

The first question that occupied the attention of the Government under the new reign was one of the gravest importance, and nearly led to a war with Great Britain. The Indian Government was desirous of seeing the old trade relations between Burma and the south-west provinces, which had been interrupted by the Yunnan rebellion, re-established, and for that purpose proposed to send a mission across the frontier into China. The Peking Government assented and issued passports for the party. Mr A. R. Margary, a young and promising member of the China consular service, was told off to accompany the expedition as interpreter. All went well until the mission, which was under the command of Colonel Browne, was nearing the Chinese frontier, when rumours of trouble ahead began to reach them. Mr Margary, who had a month previously crossed overland from Shanghai with no difficulty, made light of the reports, but offered to ride on ahead and ascertain the state of affairs. He left, accompanied only by his Chinese servants, and never returned. Two days afterwards news reached Colonel Browne that he had been treacherously murdered by Chinese at the small town of Manwyne, and almost simultaneously an attack was made on the expedition by armed forces wearing Chinese uniform (January 1875). Colonel Browne with difficulty made his way back to Bhamo and the expedition was abandoned. Demands were made on the Peking Government for a thorough inquiry on the spot in the presence of British officers. The Chinese reply was that the murder and the attack were alike the work of irresponsible savages and hillmen, animated with a desire for plunder. Enough evidence was collected on the Burma side to show that this was not true, and it could not be doubted that the orders for the attack emanated from the provincial government of Yunnan, if not from higher quarters. After infinite shuffling and delay an imperial commission was despatched to hold an inquiry, three British officers being sent at the same time to watch proceedings. The trial proved an absolute farce. Eleven half-naked savages were produced as the culprits, and the only evidence tendered was such as had manifestly been manufactured for the purpose. The British officials protested and withdrew from the burlesque. The trial, however, proceeded, and the eleven hillmen were sentenced to death. A report in that sense was addressed to the throne, and with this it was hoped the British sense of justice would be satisfied. Sir Thomas Wade, then British minister at Peking, promptly declared that if this report were published or acted on he would at once haul down his flag, rightly deeming that such a reparation was a greater insult than the original offence. Tedious negotiations followed, which more than once threatened to end in a rupture, but finally, more than eighteen months after the outrage, an arrangement was come to on the basis of guarantees for the future, rather than vengeance for the past. The arrangement was embodied in the Chefoo convention, dated 13th September 1876. The terms of the settlement comprised (1) a mission of apology from China to the British court; (2) the promulgation throughout the length and breadth of the empire of an imperial proclamation, setting out the right of foreigners to travel under passport, and the obligation of the authorities to protect them; and (3) the payment of an indemnity. The convention comprised besides a number of clauses which, though meant to improve commercial relations, were severely criticized by the mercantile communities. The stipulation most objected to was one by which the Chinese Government were debarred from levying likin within the area of the foreign concessions, thereby implying, it was argued, the recognition of the right to levy it *ad libitum* elsewhere. Ratification of this article was refused by the British Government, and additional articles were subsequently signed in London relative to the collection of likin on Indian opium and other matters.

While these events were going on the imperial authority had been re-established in the north-western provinces of Shensi and Kansuh under Tso Tsung-tang as governor-general, and preparations were made for the reconquest of Kashgaria. Money was supplied by a foreign loan for £1,600,000, being the first appearance of China as a borrower. It was a formidable expedition; not so much from the warlike nature of the enemy, as from the immense distances to be traversed and the extreme difficulty of transport. Nevertheless after two years of dogged perseverance China succeeded. Manas, the last stronghold of the Jungaris, was captured (November 1876), and the death of the Ameer Yakoob Khan in the following year greatly facilitated the com-

pletion of the task. By degrees the emperor's authority was established from the confines of Kansuh to Kashgar and Yarkand, and Chinese garrisons were stationed in touch with the Russian outposts in the region of the Pamirs (December 1877). There remained only the north-eastern province of Kuldja, occupied by Russia, but under a promise made in 1871 to restore it when China was in a position to maintain order. This promise Russia was now called upon to redeem. It is probable that, in making this promise, Russia calculated that the day was far distant when China would be in a position to fulfil the condition; at all events she showed no desire to comply with the request. China despatched Chung-how, a Manchu of the highest rank, who had been notoriously concerned in the Tientsin massacre of 1871, to St Petersburg to negotiate a settlement. After some months of discussion a document was signed (September 1879), termed the treaty of Livadia, whereby China recovered, not indeed the whole, but a considerable portion of the disputed territory, on her paying to Russia five million roubles as the cost of occupation. At first sight it was considered by Western diplomatists that, having regard to the small amount of pressure he could bring to bear, Chung-how had acquitted himself of his mission rather well. The treaty was, however, received with a storm of indignation in China. Li Hung-Chang and Tso Tsung-tang took up the cry. Chung-how was placed under arrest as soon as he returned. Memorials poured in from all sides denouncing the treaty and its author. Foremost among these was one by Chang Chih-tung, then occupying a subordinate post in the Hanlin, who has since become the most distinguished of the viceroys, and is actually governor-general of Hupeh and Hunan. Its publication raised him at once into eminence. He demonstrated *seriatim* the objections to the treaty, chief of which was that, under guise of trading facilities, it opened a way for the military aggression of Russia from the west, and he wound up with declaring, "If we do not alter this treaty we are not worthy to be called a nation." Prince Chun, the emperor's father, came into prominence at this juncture as an advocate for war, and under these combined influences the unfortunate Chung-how was tried and condemned to death (3rd March 1880). For some months warlike preparations went on, and the outbreak of hostilities was imminent. In the end calmer counsels prevailed; the foreign ministers interceded for Chung-how, and he was first reprieved and finally released. Li Hung-Chang, though he had been one of the first to raise the storm, became alarmed at the near prospect of war, for which he well knew China was unprepared, and threw in his voice with Prince Kung on the side of peace. A visit from General Gordon, and the sound, though probably unpalatable, advice which he gave, weighed in the same direction. It was decided to send the Marquis Tseng, who in the meantime had become minister in London, to Russia to negotiate a new treaty. With more adroitness he avoided his predecessor's mistakes, and produced a treaty which, though not very materially different from the old, inasmuch as it still left Russia in possession of part of the Ili valley, pleased everybody, and was universally accepted. This was ratified 19th August 1881. The Chinese Government could now contemplate with satisfaction the complete recovery of the whole extensive dominions which had at any time owned the imperial sway. The regions directly administered by the officers of the emperor extended from the borders of Siberia on the north to Annam and Burma on the south, and from the Pacific Ocean on the east to Kashgar and Yarkand on the west. But even that did not complete the tale, for outside these boundaries there was a fringe of tributary nations which still kept up the ancient forms of allegiance, and which more or less acknowledged the dominion of the central kingdom. As most of China's subsequent misfortunes have been in connexion with one or other of these tributary states, a brief notice may here be permitted of the actual relationship subsisting at this date. The principal tributary nations then were Korea, Liuchiu, Annam, Burma, and Nepaul. The dynastic records enumerate several others, including even England, Lord Macartney's mission of 1793 having been gravely described as bringing tribute, but these were more or less accidental. The tie which bound these states to their suzerain was of the loosest description. China accepted their homage with calm superiority, but conceived herself to be under no reciprocal obligation. It was usual for the kings, on succession, to seek investiture, which consisted in the grant of a patent and a seal, but even that was not invariably insisted on. In any case, it was no part of the duty of China to keep the king on his throne. If his subjects chose to depose him and set up another, they might do so, and she received a successful usurper and bestowed a new patent and a new seal with the same nonchalance as she had manifested to his predecessor. This happened more than once in Annam.

**Imperial consolidation.**

Such was the attitude which China still maintained when foreign nations first began to come into contact with these tributary states. She did not recognize that the position of suzerain involved responsibilities as well as rights, and to this non-perception are to be attributed all the vagaries of her diplomacy and the complications in which she became involved. Korea was the first of the dependencies to come into notice. In 1866 some Roman Catholic missionaries were murdered, and about the same time an American vessel was burnt in one of the rivers and her crew murdered. China refused satisfaction, both to France and America, and suffered reprisals to be made on Korea without protest. America and Japan both desired to conclude commercial treaties for the opening up of Korea, and proposed to negotiate with China. China refused and referred them to the Korean Government direct, saying she was not wont to interfere in the affairs of her vassal states. As a result Japan concluded a treaty in 1876, in which the independence of Korea was expressly recognized. This was allowed to pass without protest, but as other nations proceeded to conclude treaties on the same terms China began to perceive her mistake, and endeavoured to tack on to each a declaration by the king that he was in fact a tributary—a declaration, however, which was quietly ignored. Japan, however, was the only Power with which controversy immediately arose. In 1882 a faction fight, which had long been smouldering, broke out, headed by the king's father, the Tai Won Kun, in the course of which the Japanese legation was attacked and the whole Japanese colony had to flee for their lives. China sent troops, and by adroitly kidnapping the Tai Won Kun, order was for a time restored. The Japanese legation was replaced, but under the protection of a strong body of Japanese troops. Further revolutions and riots followed, in which the troops of the two countries took sides, and there was imminent danger of war. To obviate this risk, it was agreed in 1885 between Count Ito and Li Hung-Chang that both sides should withdraw their troops, the king being advised to engage officers of a third state to put his army on such a footing as would maintain order, and each undertook to give the other notice, should it be found necessary to send troops again. In this way a *modus vivendi* was established which lasted till the events which preceded the outbreak of war in 1894. Chinese influence continued predominant, but the unhappy kingdom was constantly disturbed by faction.

**Korea and Japan.**

We can only glance briefly at the domestic affairs of China during the period 1875-82. The years 1877-78 were marked by a famine in Shansi and Shantung, which for duration and intensity has probably never been equalled. For two successive seasons the crops failed. The population affected numbered 30 to 40 millions, the districts lay far from the coast, there was no water communication, and the roads were unfit for wheeled vehicles. Transport broke down, pack animals were not to be had, and sheer starvation stared the unfortunate people in the face. It was computed that 12 or 13 millions perished. It was hoped that this lamentable loss of life, due mainly to defective communications, would induce the Chinese Government to listen to proposals for railway construction, but even this argument had no effect. The fate of the experimental line at Shanghai has been already mentioned. The Russian scare had, however, taught the Chinese the value of telegraphs, and in 1881 the first line was laid from Tientsin to Shanghai. Further construction was continued without intermission from this date. A beginning also was made in naval affairs. The arsenal at Foochow was turning out small composite gunboats, a training ship was bought and put under the command of a British officer. Several armoured cruisers were ordered from Armstrong, and some progress was made with the fortifications of Port Arthur and Wei-hai-wei. Forts were also built and guns mounted at Foochow, Shanghai, Canton, and other vulnerable points. Money for these purposes was abundantly supplied by the customs duties on foreign trade, and China had learnt that at need she could borrow from the foreign banks on the security of this revenue. In all the elements of material strength she had grown enormously within the previous ten years, and her prestige had grown even more, for she was believed to be very much stronger than she really was.

In 1881 the senior regent, the empress Tsu An, was carried off by a sudden attack of heart disease, and the empress Tsu Tsi remained in undivided possession of the supreme power during the remainder of the emperor Kwang Su's minority. Li Hung-Chang, firmly established at Tientsin, within easy reach of the capital, as viceroy of the home province of Chihli and superintendent of northern trade, enjoyed a larger share of his imperial mistress's favour than is often granted by the ruling Manchus to officials of Chinese birth, and in all the graver questions of foreign policy his advice was generally decisive.

While the disputes with Japan were still going on regarding Korea, China found herself involved in a more serious quarrel in respect of another tributary state which lay on the southern frontier. By a treaty made between France and Annam in 1874, the Red river or Songkoi which, rising in south-western China, flows through the province of Tongking, was opened to trade together with the cities

**Tongking and Hanoi.**

of Haiphong and Hanoi situated on the delta. The object of the French was then, as it is now, to find a trade route to Yunnan and Szechuen from a base of their own, and it was hoped the Red river would furnish such a route. Tongking at the time, however, was infested with bands of pirates and cut-throats, many of whom were Chinese rebels or ex-rebels who had been driven across the frontier by the suppression of the Yunnan and Taiping rebellions, conspicuous among them being an organization called the Black Flags. The Annamese Government undertook by the treaty to restore order, and France had promised help. Some years having passed without any improvement, France, which meanwhile had kept a small guard at Haiphong, sent reinforcements (1882), nominally to assist the Annamese troops in putting an end to disorder. The Annamese officials, however, declined to receive them as friends, opposed their progress, and the expedition took the form of a military occupation. China, meanwhile, began to take alarm at the near approach of a strong military power to her southern frontier. When the treaty of 1874, which gave France trading privileges, was communicated to her, she seems to have treated it with indifference as she treated the Japanese treaty with Korea, and neither in the one case nor in the other took any steps to see that the provisions were carried out. Now, however, she began to protest, claiming that Annam was a vassal state and under her protection. France took no notice of the protest, declaring that the claim had merely an archæological interest, and that, in any case, China in military affairs was a *quantité négligeable*. France found, however, that she had undertaken a very serious task in trying to put down the forces of disorder in Tongking. The Black Flags were, it was believed, being aided by money and arms from China, and as time went on, her troops were more and more being confronted with regular Chinese soldiers. Several forts, well within the Tongking frontier, were known to be garrisoned by Chinese troops. Operations continued with more or less success during the winter and spring of 1883-84. Both sides, however, were desirous of an arrangement, and in May 1884 a convention was signed between Li Hung-Chang and a Captain Fournier, who had been commissioned *ad hoc*, whereby China agreed to withdraw her garrisons and to open her frontiers to trade, France agreeing, on her part, to respect the fiction of Chinese suzerainty, and guarantee the frontier from attack by brigands. The arrangement was satisfactory to both sides, but, strange to say, it was completely frustrated by a series of unfortunate misunderstandings which led to a renewal of hostilities. No date had been fixed in the convention for the evacuation of the Chinese garrisons, and Fournier endeavoured to supplement this by a memorandum to Li Hung-Chang, at the same time announcing the fact to his Government. In pursuance of this arrangement the French troops proceeded to occupy Langson on the date fixed (21st June 1884). The Chinese commandant refused to evacuate, alleging, in a despatch which no one in the French camp was competent to translate, that he had received no orders, and begged for a short delay to enable him to communicate with his superiors. The French commandant ordered an attack, which was repulsed with severe loss. Mutual recriminations ensued, the French declaring the resistance an act of treachery, and the Chinese declaring that the French had broken faith by advancing before the date fixed. The whole question turned on the unfortunate memorandum of Captain Fournier. The Chinese alleged that in deference to Li Hung-Chang's representation, Captain Fournier had agreed to postpone the date of evacuation, and himself erased the original figures and inserted others, attesting the alteration by putting his initials in the margin; and they produced the original document so altered. Captain Fournier affirmed, on his honour, that he had made no alteration, and declared the whole thing an impudent forgery. On whichever side the truth lay, the result was greatly to embitter the feeling on both sides. From Paris there came a demand for a huge indemnity as reparation for the insult. The Peking Government offered to carry out the convention, and to pay a small indemnity for the lives lost through the misunderstanding. This was refused, and hostilities recommenced, or, as the French preferred to call them, reprisals, for the fiction was still kept up that the two countries were not at war. Under cover of this fiction the French fleet peaceably entered the harbour of Foochow, having passed the forts at the entrance to the river without hindrance. Once inside, they attacked and destroyed the much inferior Chinese fleet which was then quietly at anchor, destroying at the same time a large part of the arsenal which adjoins the anchorage (23rd Aug. 1884). Retracing its steps, the French fleet attacked and destroyed with impunity the forts which were built to guard the entrance to the Min river, and could offer no resistance to a force coming from the rear. After this exploit the French fleet left the mainland and continued its reprisals on the coast of Formosa. Keelung, a treaty port, was bombarded and taken, Oct. 4th. A similar attempt, however, on the neighbouring port of Tamsuy was unsuccessful, the landing party having been driven back to their ships with severe loss. The attempt was not renewed, and the fleet thereafter confined itself to a semi-blockade of the island, which was prolonged into 1885 but led to no practical results. Desultory operations were continued in the neighbourhood of Shanghai and Ningpo, two old vessels were taken and burnt, but the two or three really powerful boats which the Chinese then possessed took refuge behind the guns of Port Arthur, whither the French admiral did not care to follow them. By way of bringing pressure on the Chinese Government, the French at this time declared rice contraband of war, in order to stop the supplies going forward to the capital by sea. Even this, though raising an interesting point in international law, had no practical effect. Meanwhile the Chinese had been greatly emboldened by the successful defence of Tamsuy, and the failure of the French to push home such successes as they had gained. Preparations on a great scale were made to continue the war, and a rising tone was noticed, not only in the acts of the Government, but throughout the country. The new-born native press assiduously encouraged this feeling, and from this time forward began to count as a factor in the situation. Troops were massed on the frontier of Tongking, and the French forces which had pushed their way as far as the border were compelled by overwhelming masses of the enemy to fall back on their base in the delta of the river. Negotiations for peace, however, which had been for some time in progress through the mediation of Sir Robert Hart, were at this juncture happily concluded (April 1885), and the French cabinet was thereby relieved from a very embarrassing situation. The terms were practically those of the Fournier convention of the year before, the demand for an indemnity having been quietly dropped.

China, on the whole, came out of the struggle with greatly increased prestige. She had tried conclusions with a first-class European Power and had held her own. In material resources she had not been weakened. The provincial fleet at Foochow had indeed been destroyed, but it was of no serious value as a fighting force. On the other hand she had saved her three armoured cruisers, the value of the new fortress of Port Arthur as a naval base had been proved, and, most satisfactory of all, she was not crippled by the exaction of an indemnity. Morally she might claim a victory. Reasonings such as these, however, omitted to take note of the fact that France was never more than half-hearted over the war. No effective support was given to the French admiral from home, the number of troops sent to Tongking was inadequate to the task they were called on to perform, and no opportunity was afforded to see how Chinese soldiers would stand up against regular European troops. Incorrect conclusions as to the military strength of China were consequently drawn, not merely by the Chinese themselves—which was excusable—but by European and even British authorities, who ought to have been better informed. China was lulled into a false security which proved disastrous when the day of trial came. For the time, however, the lessons of the war were so far learned that the necessity for a strong fleet became generally recognized, and means were at once adopted to that end. War vessels were ordered both from England and Germany, and Admiral Lang, who had withdrawn his services while the war was going on, was re-engaged together with a number of British officers and instructors. The completion of the works at Port Arthur was taken in hand, and a beginning was made in the construction of forts at Wei-hai-wei as a second naval base. A new department was created for the control of naval affairs, at the head of which was placed Prince Chun, father of the Emperor, who since the downfall of Prince Kung in 1884 had been taking a more and more prominent part in public affairs. A tour made by Prince Chun in the spring of 1886, in the course of which he visited Port Arthur and Chefoo escorted by the fleet, attracted much attention, as being the first time that a prince so near the throne had emerged from palace seclusion and exchanged friendly visits with foreign admirals and other representatives.

**1885-1894.**

From 1885 to 1894 the political history of China does not call for extended notice. Two incidents, however, must be recorded, the first being the conclusion of a convention between Great Britain and China, in which the latter undertook to recognize British sovereignty in Burma, to delimit the frontier, and to promote overland trade intercourse between the two countries. Great Britain, on the other hand, consented to the continuance of the customary decennial tribute mission to be despatched by the "highest authority in Burma," the members, however, to be Burmese, and she also consented not to press a mission which the Indian Government were proposing to send to Tibet and to which China had agreed. The recognition of Chinese suzerainty implied in the sending a tribute mission was sharply criticized, but in point of fact it has never been acted on and is now forgotten. The other incident was the temporary occupation of Port Hamilton by the British fleet (May 1885). Rumours of Russian intrigues in Korea, coupled with recent proceedings in Afghanistan, made it appear desirable that Great Britain should have a naval base farther north than Hong-

kong. For this purpose a small group of islands at the southern point of the peninsula of Korea, forming the harbour known as Port Hamilton, were occupied. Objections, however, were raised by the Chinese Government to their continued occupation, and Great Britain expressed her willingness to withdraw on receiving sufficient guarantees against their cession to any other Power. A trilateral agreement was thereupon come to, by which Russia bound [illegible] to respect the integrity of Korean territory, and Great Britain thereupon agreed to evacuate Port Hamilton, which was carried out in February 1887. In 1890 occurred an event which, though seemingly insignificant in itself, marks a turning-point in Chinese history, viz., the resignation of Admiral Lang from the command of the Chinese fleet. One of the lessons which the Chinese Government seemed to have learned from the French war was the recognition of the value of a strong fleet. Money was not spared, and a really efficient squadron had been got together and put under the joint command of Admiral Ting and his British colleague Admiral Lang. By tact and judgment the latter had so far avoided directly raising the question of who was really chief. Order and discipline were well maintained, and both men and officers were steadily improving in the knowledge of their profession. During a temporary absence of Admiral Ting, however, the Chinese second in command claimed the right to take charge,—a claim which Admiral Lang naturally resented. The question was referred to Li Hung-Chang, who decided against Admiral Lang, whereupon the latter, feeling that his authority to maintain discipline was gone, threw up his commission. His resignation was accepted, and he left, never to return. From this point the fleet on which so much depended began to deteriorate. Superior officers again began to steal the men's pay, the ships were starved, shells filled with charcoal instead of powder were supplied, accounts were cooked, and all the corruption and malfeasance that were rampant in the army crept back into the navy. It is needless to point the moral. Chinese superciliousness, jealousy of foreigners, and contempt of foreign instruction, once more proved her ruin. What the dismissal of Admiral Lang cost her was soon to be proved in the fatal battle of the Yaloo. Meanwhile things had not been going well in other respects. Excessive taxation and misgovernment produced a general feeling of unrest which continued throughout 1889-90-91. Rumours of risings and rebellions were prevalent, promoted, it was said, by secret societies, chief of which was the "Ko lao hwei," or Old Brotherhood Society. Numerous arrests and executions took place, especially in the Yangtse valley. In 1891 there was a series of violent anti-foreign outbreaks in the same region. At Wusieh, two Englishmen were murdered, and at Wuhu, Ichang, and Kiukiang, attacks were made on the foreign settlements and serious damage was done. Many missionary establishments in the interior were destroyed. The origin of these outbreaks was the same old story. Placards were circulated accusing foreigners of kidnapping children and of murdering them in order to boil down their eyes, brains, etc., for medicine. Missionaries were charged with the grossest immorality, and with using religion as a cloak to the vilest offences. It was found that a society in Hunan, at the head of which was a notorious ex-official named Chou Han, had been flooding the country with incendiary literature of this class. Repeated efforts were made to secure the punishment of these instigators, but with indifferent success; the Chinese Government, though not exactly screening the offenders, took no energetic measures to put a stop to the calumnies. The anti-foreign agitation, however, gradually died out and things reverted to the normal condition. There appeared even a prospect of considerable railway development—the leading officials having at last come round to the opinion that railways might be beneficial at least for strategic purposes.

***War with Japan.***

We pass on to 1894, a year which was fraught with momentous consequences to China, inasmuch as it witnessed the outbreak of the Japanese war. It opened auspiciously, for in November was to be celebrated the 60th anniversary of the birth of the empress-dowager. It was resolved that it should be marked with unusual magnificence, and loyal contributions poured in from all parts. In the spring, however, the state of Korea began to attract attention. A series of chronic rebellions had baffled the authorities, and help from China was asked for. China responded and sent 2000 men under General Yeh, notifying Japan of the fact, as she was bound to do under the convention of 1885. Japan replied by sending troops also, nominally to guard her legation, which she had a right to do under the same convention. The rebellion was stamped out, and then China proposed that both sides should withdraw. Japan made a counter proposal that both should join in imposing such reforms on Korea as would prevent a recurrence of these internal dissensions. This, in turn, China refused, alleging once more that she was not wont to interfere with the domestic affairs of her vassals. Again Japan retorted, denying the alleged suzerainty, and intimating that whether China joined or not she proposed to prosecute her schemes of reform, and would keep her troops there until the necessary guarantees had been obtained for the security of her trade. At the same time categorical schemes of civil and military reform were laid before the Korean Government, and the Japanese force in Seoul was largely increased. By the beginning of July she had over 10,000 men there. The Chinese Government thereupon proceeded to send more troops to reinforce General Yeh, who was stationed at Asan, a short distance south of Seoul. Among other transports a British steamer, the *Kowshing*, was chartered and despatched with some 1200 troops. On the way, and when nearing the coast of Korea, the *Kowshing* met a Chinese man-of-war steaming back full speed to China with evident signs of disorder. As subsequently became known, this vessel, the *Chi-yuen*, had exchanged hostile shots a few hours previously with a Japanese man-of-war and got the worst of it. The *Kowshing* was presently accosted by a Japanese war vessel, the *Naniwa*, and was called upon to surrender. This the Chinese soldiery refused to permit, and the British officer in charge then proposed to take the troops back to China. This in turn the Japanese refused to allow, and after a warning the *Naniwa* opened fire on the doomed vessel. A scene of indescribable confusion followed. The vessel sank with her living freight, a few escaped by swimming to a neighbouring island, three of the British officers were picked up by Japanese boats, and all the rest perished. Formal declarations of war soon followed. The first battle was fought at Asan on the 27th July. The Japanese attack was repulsed, but the Chinese evacuated their position during the night and retreated northwards. A series of desultory skirmishes followed, but the only real stand the Chinese made was at Pingyang. The division under General Tso—the only capable and honest general in the Chinese army—offered a stubborn resistance till their leader was killed, when they turned and fled. The defeat became a rout, and left the road to China open to the victorious Japanese. Two days afterwards, on the 17th September, the naval engagement of Yaloo was fought. The Chinese fleet possessed two ironclads heavier than anything in the Japanese navy, but it was hopelessly out-manœuvred by the Japanese and lost heavily. Five vessels were sunk, burnt, or driven ashore. Night coming on, the Japanese drew off, and the remainder of the Chinese squadron was allowed to seek shelter in Port Arthur. They did not venture to put to sea again, and in the end were captured or destroyed in the harbour of Wei-hai-wei in February of the following year. On land the Japanese continued their progress, crossed the Yaloo river, and entered Chinese territory on 24th October. City after city fell into their hands, and Newchwang, a treaty port, was occupied on the 4th March. Meanwhile a second Japanese army had landed on the Liaotung peninsula, and captured the naval stronghold of Port Arthur on 22nd November. A third expedition was launched against Wei-hai-wei, where the Chinese fleet had now sought refuge. In spite of the inclemency of the winter, operations were vigorously pursued by land and sea, and on 12th February 1895 the fortress and fleet were surrendered. Admiral Ting and the general commanding committed suicide. Further resistance was hopeless, and negotiations were opened for peace. After two abortive missions, which the Japanese refused as being unprovided with sufficient powers, Li Hung-Chang was sent as plenipotentiary, and on 17th April 1895 the treaty of Shimonoseki was signed. The terms included the cession of Liaotung peninsula, then in actual occupation by the Japanese troops, the cession of the island of Formosa, an indemnity of H. taels 200,000,000 (about £30,000,000), and various commercial privileges.

***European intervention.***

The signature of this treaty brought the European Powers on the scene. It had been for some time the avowed ambition of Russia to obtain an ice-free port as an outlet to her Siberian possessions—an ambition which was considered by British statesmen as not unreasonable. It did not, therefore, at all suit her purposes to see the rising power of Japan seated along the Gulf of Liaotung, and by implication commanding the whole of the coast-line of Korea. Even before proceeding to Shimonoseki, Li Hung-Chang is believed to have received assurances from Russia that she would not allow any cession of territory in that region to become operative. At any rate, in the interval between the signature and the ratification of the treaty, invitations were addressed by Russia to the Great Powers to intervene with a view to its modification on the ground of the disturbance of the balance of power, and the menace to China which the occupation of Port Arthur by the Japanese would involve. France and Germany accepted the invitation, Great Britain declined. In the end the three Powers brought such pressure to bear on Japan that she gave up the whole of her continental acquisitions, retaining only the island of Formosa. The indemnity was on the other hand increased by H. taels 30,000,000. For the time the integrity of China seemed to be preserved, and Russia, France, and Germany could pose as her friends. Great Britain, who had taken no hand in the retrocession, was looked on with coldness, and China

even bore her a grudge because she had not at an early period stepped in and put a stop to the war. Li Hung-Chang, who had had his honours restored, was personally grateful to Russia for having extricated him from a very awkward position, and cherished the general grudge against England in an unusual degree, a state of mind of which Russia is believed to have taken full advantage during that statesman's sojourn at the Russian court as special representative of the Chinese emperor at the Tsar's coronation. Ample evidence was indeed soon forthcoming that Russia and France had not been quite disinterested in rescuing Chinese territory from the Japanese grasp, for each began to claim a reward as evidence of the imperial gratitude. Russia obtained the right to carry the Siberian railway, which, for the past four or five years, she had been pressing on with eagerness, across Chinese territory from Stretensk to Vladivostock, thus avoiding a long détour, besides giving a grasp on northern Manchuria. France obtained, by a convention dated 20th June 1895, a rectification of frontier in the Mekong valley and certain railway and mining rights in Kiangsi and Yunnan. Both Powers obtained concessions of land at Hankow for the purposes of a settlement. Russia was also said to have negotiated a secret treaty, frequently described as the "Cassini Convention," but more probably signed by Li Hung-Chang at Moscow, giving her the right in certain contingencies to Port Arthur, which was to be refortified with Russian assistance. And by way of further securing her hold, Russia guaranteed a 4 per cent. loan of £15,000,000 issued in Paris to enable China to pay off the first instalment of the Japanese indemnity.

***Mekong valley dispute.***

The convention between France and China of 20th June 1895 brought China into sharp conflict with Great Britain, and gave rise to important negotiations which must be briefly noticed. China, having by the Burma convention of 1886 agreed to recognize British sovereignty over Burma, her quondam feudatory, also agreed to a delimitation of boundaries at the proper time. Effect was given to this last stipulation by a subsequent convention concluded in London (1st March 1894), which traced the boundary line from the Shan states on the west as far as the Mekong river on the east. In the Mekong valley there were two semi-independent native territories over which suzerainty had been claimed in times gone by both by the kings of Ava and by the Chinese emperors. These territories were named Meng Lun and Kiang Hung—the latter lying partly on one side and partly on the other of the Mekong river, south of the point where it issues from Chinese territory. The boundary line was so drawn as to leave both these territories to China, but in consideration of the fact that Great Britain was surrendering to China territory over which she might claim sovereignty as successor to the kings of Ava, and in respect of which sovereign rights had in point of fact been recently exercised, it was stipulated that China should not alienate any portion of these territories to any other Power without the previous consent of Great Britain. The Power contemplated, though not named, was France, who by a treaty with Siam, concluded in 1893, had pushed the boundary of her Annamese possessions up to the left bank of the Mekong, and it was desired to interpose this particular territory as a sort of buffer, so as to avoid any conflict of French and British interests in this remote and difficult region. This object was frustrated by the convention between France and China of 1895. Yielding to French pressure, and regardless of the undertaking she had entered into with Great Britain, China so drew the boundary line as to cede to France that portion of the territory of Kiang Hung which lay on the left bank of the Mekong. Compensation was demanded from China for this breach of faith, and at the same time negotiations were entered into with France for the better determining of the interests of the two countries in Siam and the territories lying between Siam and the Chinese frontier. These resulted in a joint declaration by the Governments of France and Great Britain, dated 15th January 1896, by which it was agreed as regards boundary that the Mekong from the point of its confluence with the Nam Huok northwards as far as the Chinese frontier should be the dividing line between the possessions or spheres of influence of the two Powers. It was also agreed that any commercial privileges obtained by either Power in Yunnan or Szechuen should be open to the subjects of the other. The negotiations with China resulted in a further agreement, dated 4th February 1897, whereby considerable modifications in favour of Great Britain were made in the Burma boundary drawn by the 1894 convention. The net result of these various conventions is, that from the Gulf of Tongking westwards, as far as the Mekong, the French Annamese possessions are coterminous with the southern frontier of China, and from the Mekong as far as the confines of Assam the British Burmese possessions are coterminous with the south-western frontier. In the middle where the possessions meet, the Mekong, from the frontier of China down to the northern boundary of Siam, is the dividing line.

While Russia and France were profiting by what they were pleased to call the generosity of China, Germany alone had so far received no reward for her share in compelling the retrocession of Liaotung; but, in November 1897, she proceeded to help herself by seizing the Bay of Kiaochow in the province of Shantung. The act was done ostensibly in order to compel satisfaction for the murder of two German missionaries, which had been perpetrated a few weeks before, but it soon was found that she was determined to hold the place in any event. A cession was ultimately made by way of a lease for a term of ninety-nine years—Germany to have full territorial jurisdiction during the continuance of the lease, with liberty to erect fortifications, build docks, and exercise all the rights of sovereignty. In December the Russian fleet was sent to winter in Port Arthur, and though this was at first described as a temporary measure, its object was speedily disclosed by a request made, in January 1898, by the Russian ambassador in London that two British cruisers, then also anchored at Port Arthur, should be withdrawn "in order to avoid friction in the Russian sphere of influence." They left shortly afterwards, and their departure in the circumstances was regarded as a blow to Great Britain's prestige in the Far East. In March the Russian Government peremptorily demanded a lease of Port Arthur and the adjoining anchorage of Talienwan—a demand which China could not resist without foreign support. After an acrimonious correspondence with the Russian Government Great Britain acquiesced in the *fait accompli*. The Russian occupation of Port Arthur was immediately followed by a concession to build a line of railway from that point northwards to connect with the Siberian trunk line in north Manchuria. As a counterpoise to the growth of Russian influence in the north, Great Britain obtained a lease of Wei-hai-wei, and formally took possession of it on its evacuation by the Japanese troops in May 1898.

***Kiaochow, Port Arthur, Wei-hai-wei.***

After much hesitation the Chinese Government had at last resolved to permit the construction of railways with foreign capital. An influential official named Sheng Hsuan-hwai was appointed director-general of railways, and empowered to enter into negotiations with foreign capitalists for that purpose. A keen competition thereupon ensued between syndicates of different nationalities, and their claims being espoused by their various Governments an equally keen international rivalry was set up. Germany had insisted upon obtaining as part of the Kiaochow settlement certain preferential railway and mining rights in the province of Shantung. France had previously obtained a similar recognition for the southern provinces of Kwangsi and Yunnan, and Russia indicated clearly that she considered Manchuria as her particular field of exploitation. Great Britain, though intimating her preference for the "open door," policy, meaning equal opportunity for all, yet found herself compelled to fall in with the general movement towards what became known as the "spheres of influence" policy, and claimed the Yangtse valley as her particular sphere. This she did by the somewhat negative method of obtaining from the Chinese Government a declaration that no part of the Yangtse valley should be alienated to any foreign Power. A more formal recognition of the claim, as far as railway enterprise was concerned, was embodied in an agreement (28th April 1899) between Great Britain and Russia, and communicated to the Chinese Government, whereby the Russian Government agreed not to seek for any concessions within the Yangtse valley, including all the provinces bordering on the great river, together with Chekiang and Honan, the British Government entering into a similar undertaking in regard to the Chinese dominions north of the Great Wall. (A supplementary exchange of notes of the same date excepted from the scope of this agreement the Shan-hai-kwan-Newchwang extension which had already been conceded to the Hongkong and Shanghai Bank.) A similar promise of non-alienation in respect of the province of Fuhkien was made to the Japanese Government (April 1898), which thus earmarked that province as the Japanese sphere. As a general partition seemed thus to be in progress the Italian Government stepped in and applied for a lease of a coaling station at Sanmun, on the coast of Chekiang, together with a grant of railway and mining rights in that province. The manner in which the request was put forward gave offence to the Yamen, and a blunt refusal was returned. The incident gave rise to much feeling both in Peking and Rome. The Italian minister was recalled, but his successor fared no better. China, apprehending a repetition of the Kiaochow incident, sent orders to the local troops to resist a landing if such should be attempted on the part of the Italian men-of-war. No landing, however, was attempted, and though negotiations were continued the demand has not been further pressed.

***"Open door," and "spheres of influence."***

In 1899 Talienwan and Kiaochow were respectively thrown open by Russia and Germany to foreign trade, and, encouraged by these measures, the United States Government initiated in September of the same year a correspondence with the great

European Powers and Japan, with a view to securing their definite adhesion to the "open-door" policy. The British Government gave an unqualified approval to the American proposal, and the replies of the other Powers, though more guarded, were accepted at Washington as satisfactory. A further and more definite step towards securing the maintenance of the "open door" in China was the agreement concluded in October 1900 between the British and German Governments. The signatories, by the first two articles, agreed to endeavour to keep the ports on the rivers and littoral free and open to international trade and economic activity, and to uphold this rule for all Chinese territory as far as (*wo* in the German counterpart) they could exercise influence; not to use the existing complications to obtain territorial advantages in Chinese dominions, and to seek to maintain undiminished the territorial condition of the Chinese empire. By a third article they reserved their right to come to a preliminary understanding for the protection of their interests in China, should any other Power use those complications to obtain such territorial advantages under any form whatever. On the submission of the agreement under the fourth and last article to the Powers interested, Austria, France, Italy, and Japan accepted its principles without express reservation—Japan first requesting and obtaining assurances that she signed on the same footing as an original signatory. The United States accepted the first two articles, but expressed no opinion on the third. Russia construed the first as limited to ports actually open in regions where the two signatories exercise "their" influence, and favourably entertained it in that sense, ignoring the reference to other forms of economic activity. She fully accepted the second, and observed that in the contingency contemplated by the third, she would modify her attitude according to circumstances.

Meanwhile, negotiations carried on by the British minister at Peking during 1898 resulted in the grant of very important privileges to foreign commerce. The payment of the second instalment of the Japanese indemnity was becoming due, and it was much discussed how and on what terms China would be able to raise the amount. The Russian Government, as has been stated, had made China a loan of the sum required for the first portion of the indemnity, viz., £15,000,000, taking a charge on the customs revenue as security. The British Government was urged to make a like loan of £16,000,000 both as a matter of friendship to China and as a counterpoise to the Russian influence. An arrangement was come to accordingly, on very favourable terms financially to the Chinese, but at the last moment they drew back, being overawed, as they said, by the threatening attitude of Russia. Taking advantage of the position which this refusal gave him, the British minister obtained from the Tsung-Li-Yamen, besides the declaration as to the non-alienation of the Yangtse valley above mentioned, an undertaking to throw the whole of the inland waterways open to steam traffic. The Chinese Government at the same time undertook that the post of inspector-general of customs should always be held by an Englishman so long as the trade of Great Britain was greater than that of any other nation. Minor concessions were also made, such as the opening of new ports, but the opening of the waterways is by far the greatest advance that has been made since 1860. The privilege is hampered as yet by the obstruction of the likin service, but as the Chinese have applied for a general revision of the treaty tariffs it may be presumed that the occasion will be used to put the inland revenue tariff on a more satisfactory footing.

Of still greater importance are the railway and mining concessions granted during the same year (1898), a list of which has already been given above. The Chinese Government had been generally disposed to railway construction since the conclusion of the Japanese war, but hoped to be able to retain the control in their own hands. The masterful methods of Russia and Germany had obliged them to surrender this control so far as concerned Manchuria and Shantung, the lines in which were left to be financed and worked by the Powers interested. In the Yangtse valley, Sheng, the director-general of railways, had been negotiating with several competing syndicates, playing one off against the other to force better terms. One of these was a Franco-Belgian syndicate, which was endeavouring to obtain the trunk line from Hankow to Peking. A British company was tendering for the same work, and as the line lay mainly within the British sphere it was considered not unreasonable to expect it should be given to the latter. At a critical moment, however, the French and Russian ministers intervened, and practically forced the Yamen to grant a contract in favour of the Franco-Belgian company. The Yamen had only a few days before explicitly promised the British minister that the contract should not be ratified without his having an opportunity of seeing it. As a penalty for this breach of faith, and as a set-off to the Franco-Belgian line, the British minister required the immediate grant of all the railway concessions for which British syndicates were then negotiating, and on terms not inferior to those granted to the Belgian line. In this way all the lines in the lower Yangtse, as also the Shansi Mining Companies' lines, were secured. A contract for a trunk line from Canton to Hankow was negotiated in the latter part of the same year (1898) by an American company, which completed the list for the time being. It would have been more satisfactory if these various concessions, instead of being wrung out of the weakness of China by the rivalry of foreign Powers, had been freely granted in the confidence of strength.

***The reform movement.***

There can indeed be little doubt that the Powers, engrossed in the diplomatic conflicts of which Peking was the centre, had entirely underrated the reactionary forces gradually mustering for a final struggle against the aggressive spirit of Western civilization. The lamentable consequences of administrative corruption and incompetence, and the superiority of foreign methods which had been amply illustrated by the Japanese war, had at first produced a considerable impression, not only upon the more enlightened commercial classes, but even upon many of the younger members of the official classes in China. The dowager-empress, who, in spite of the emperor Kwang Su having nominally attained his majority, had retained practical control of the supreme power until the conflict with Japan, had been held, not unjustly, to blame for the disasters of the war, and even before its conclusion the young emperor was adjured by some of the most responsible among his own subjects to shake himself free from the baneful restraint of "petticoat government," and himself take the helm. In the following years a Reform Movement, undoubtedly genuine, though opinions differ as to the value of the popular support which it claimed, spread throughout the central and southern provinces of the empire. One of the most significant symptoms was the relatively large demand which suddenly arose for the translations of foreign works and similar publications in the Chinese language which philanthropic societies, such as that "for the Diffusion of Christian and General Knowledge amongst the Chinese," had been trying for some time past to popularize, though hitherto with scant success. Chinese newspapers published in the treaty ports spread the ferment of new ideas far into the interior. Fifteen hundred young men of good family applied to enter the foreign university at Peking, and in some of the provincial towns the Chinese themselves subscribed towards the opening of foreign schools. Reform societies, which not infrequently enjoyed official countenance, sprang up in many of the large towns, and found numerous adherents amongst the younger *literati*. Early in 1898 the emperor, who had gradually emancipated himself from the dowager-empress's control, summoned several of the reform leaders to Peking, and requested their advice with regard to the progressive measures which should be introduced into the government of the empire. Chief amongst these reformers was Kang Yu-wei, a Cantonese, whose scholarly attainments, combined with novel teachings, earned for him from his followers the title of the "Modern Sage." Of his more or less active sympathizers who had subsequently to suffer with him in the cause of reform, the most prominent were Chang Yin-huan, a member of the Grand Council and of the Tsung-Li-Yamen, who had represented his sovereign at Queen Victoria's jubilee in 1897; Chen Pao-chen, governor of Hu-nan; Liang Chi-chao, the editor of the reformers' organ, *Chinese Progress*; Su Chi-ching, a reader of the Hanlin College, the educational stronghold of Chinese conservatism; and his son Su In-chi, also a Hanlin man and provincial chancellor of public instruction in Hu-nan.

***The reform edicts.***

It soon became evident that there was no more enthusiastic advocate of the new ideas than the emperor himself. Within a few months the vermilion pencil gave the imperial sanction to a succession of edicts which, had they been carried into effect, would have amounted to a revolution as far-reaching as that which had transformed Japan thirty years previously. The fossilized system of examinations for the public service was to be altogether superseded by a new schedule based on foreign learning, for the better promotion of which a number of temples were to be converted into schools for Western education; a state department was to be created for the translation and dissemination of the standard works of Western literature and science; even the scions of the ruling Manchu race were to be compelled to study foreign languages and travel abroad; and last, but not least, all useless offices both in Peking and in the provinces were to be abolished. A further edict was even reported to be in contemplation, doing away with the *queue* or pigtail, which, originally imposed upon the Chinese by their Manchu conquerors as a badge of subjection, had gradually become the most characteristic and most cherished feature of the national dress. Had China possessed a governing class imbued with similar enlightened patriotism to that which induced the Japanese daimios in 1869 to sacrifice their feudal rights in the interests of national regeneration, even the crude series of imperial edicts drawn up by Kang Yu-wei might have proved the starting-point of a new era. But the bureaucracy of China, which had battened for centuries on corruption and ignorance, had no taste for self-sacrifice.

Other vested interests felt themselves equally threatened. The priests, whose temples were to be alienated; the military mandarins, who were led to believe that the army was going to be handed over to foreign instructors; and, above all, the imperial clansmen and bannermen, the eunuchs, and other hangers-on of the palace, whose existence was bound up with all the worst traditions of Oriental misgovernment, were all equally alarmed, and behind them stood the whole latent force of popular superstition and unreasoning conservatism.

***The coup d'état.***

The dowager-empress saw her opportunity. The Summer Palace, to which she had retired, had been for some time the centre of resistance to the new movement, and in the middle of September 1898 a report became current that, in order to put an end to the obstruction which hampered his reform policy, the emperor intended to seize the person of the dowager-empress and have her deported into the interior. Some colour was given to this report by an official announcement that the emperor would hold a review of the foreign-drilled troops at Tientsin, and had summoned Yuan Shih-kai, their general, to Peking in order to confer with him on the necessary arrangements. But the reformers had neglected to secure the goodwill of the army, which was still entirely in the hands of the reactionaries. During the night of the 20th of September the palace of the emperor was occupied by the soldiers, and on the following day Kwang Su, who was henceforth virtually a prisoner in the hands of the empress, was made to issue an edict restoring her regency. Kang Yu-wei, warned at the last moment by an urgent message from the emperor, succeeded in escaping, but many of the most prominent reformers were arrested, and six of them were promptly executed. The *Peking Gazette* announced a few days later that the emperor himself was dangerously ill, and his life might well have been despaired of had not the British minister represented in very emphatic terms the serious consequences which might ensue if anything happened to him. Drastic measures were, however, adopted to stamp out the reform movement in the provinces as well as in the capital. The reform edicts were cancelled, the reformers' associations were dissolved, their newspapers suppressed, and those who did not care to save themselves by a hasty recantation of their errors were imprisoned, proscribed, or exiled. In October the reaction had already been accompanied by such a recrudescence of anti-foreign feeling that the foreign ministers at Peking had to bring up guards from the fleet for the protection of the legations, and to demand the removal from the capital of the disorderly Kansu soldiery which subsequently played so sinister a part in the troubles of June 1900. But the unpleasant impression produced by these incidents was in a great measure removed by the demonstrative reception which the empress Tsu Tsi gave on 15th October to the wives of the foreign representatives—an international act of courtesy unprecedented in the annals of the Chinese court.

***Manchu ascendancy.***

One of the most significant features of the *coup d'état* of 1898 was the decisive part played in it by the Manchus, whose ascendancy in the councils of the dowager-empress became more and more marked. Manchus were substituted for Chinamen in many of the higher offices of the state, and even Li Hung-Chang's position was shaken. Though he was the only prominent Chinese statesman who had actively supported the empress, he was temporarily removed from the capital, under pretext of a special mission to inspect the course of the Yellow river in Shantung. The reactionary tide continued to rise throughout the year 1899, but it did not appear materially to affect the foreign relations of China, the dilatoriness and ill-will exhibited by the Tsung-Li-Yamen with respect to the punishment of the murderers of Mr Fleming and to other anti-foreign outrages amounting to little more than the usual practice of the Chinese Government in such matters. On 24th January 1900 the *Peking Gazette* published an imperial edict appointing as heir-presumptive to the throne Pu Chün, a son of Prince Tuan (himself son to Prince Tun and grandson to the emperor Tao-kwang), which was generally regarded in China as a preliminary step to the formal deposition of the emperor Kwang Su. Influential memorials from Chinese officials deprecating any such measure would seem to have deterred the empress from following up her original intention, but the choice of two rabid anti-foreign officials as tutors to Pu Chün, together with the prestige conferred upon Prince Tuan, one of the most reactionary of the Manchu princes, afforded a startling indication of the spirit which already prevailed in court circles.

***The Boxer movement.***

A few weeks earlier the brutal murder of Mr Brooks, an English missionary, in Shantung, had compelled attention to a popular movement which had been spreading rapidly throughout that province and the adjoining one of Chih-li with the connivance of certain high officials, if not under their direct patronage. The origin of the "Boxer" movement is obscure. Its name is derived from a literal translation of the Chinese designation, "The fist of righteous harmony." Like the kindred "Big Sword" Society, it appears to have been in the first instance a secret association of malcontents chiefly drawn from the lower classes. Popular disaffection in China generally assumes some such shape, and there can be little doubt that with the waning prestige of the dynasty, undermined by the Japanese war and foreign encroachments, not less than by the family feud between the emperor and the dowager-empress, a dangerous spirit of unrest was abroad amongst all classes. The Tsing dynasty was reaching what would seem to be the allotted span of Chinese dynasties, its tenure of power having already lasted longer than that of any of the last twenty dynasties, excepting its immediate predecessors, the Mings, and neither omens nor predictions were wanting to foreshadow its downfall. Whether the empress Tsu Tsi and her Manchu advisers had deliberately set themselves from the beginning to avert the danger by deflecting what might have been a revolutionary movement into anti-foreign channels, or whether with Oriental heedlessness they had allowed it to grow until they were powerless to control it, they had unquestionably resolved to take it under their protection before the foreign representatives at Peking had realised its gravity. Yü Hsien, one of its earliest patrons, had indeed been recalled on their representations from Shantung, where he had given open support to the Boxer organization, but only to be loaded with honours by the empress and transferred to the province of Shansi. The outrages upon native Christians and the threats against foreigners generally went on increasing. The Boxers openly displayed on their banners the device: "Exterminate the foreigners and save the dynasty," yet the representatives of the Powers were unable to obtain any effective measures against the so-called "rebels," or even a definite condemnation of their methods.

***Diplomacy at bay.***

Four months (January-April 1900) were spent in futile interviews with the Tsung-Li-Yamen, who, encouraged, no doubt, by the fact that the Russian minister for a long time held conspicuously aloof from the protests of his colleagues, treated the remonstrances of the Powers with growing contempt. In May a number of Christian villages were destroyed and native converts massacred in the neighbourhood of the capital, and Mgr. Favier, the venerable head of the Roman Catholic missions in China, described the situation as the gravest within his long memory. On the 2nd June two English missionaries, Mr Robinson and Mr Norman, were murdered at Yung Ching, 40 miles from Peking. The whole country was overrun with bands of Boxers, who tore up the railway and set fire to the stations at different points on the Peking-Tientsin line. Fortunately a mixed body of marines and bluejackets of various nationalities, numbering 18 officers and 389 men, had reached Peking on 1st June for the protection of the legations. The whole city was in a state of turmoil. Murder and pillage were of daily occurrence. Prince Tuan and the Manchus generally, together with the Kansu soldiery under the notorious Tung-fu-hsiang, openly sided with the Boxers. The European residents and a large number of native converts took refuge in the British legation, the largest and most central compound in the foreign quarter, where preparations were hastily made on all sides in view of a threatened attack. On the 11th the chancellor of the Japanese legation was murdered by Chinese soldiers. On the night of the 13th most of the foreign buildings, churches, and mission houses in the eastern part of the Tartar city were pillaged and burnt, and hundreds of native Christians massacred. The work of destruction continued for days unchecked by any Chinese authority, and on 20th June the German minister, Baron von Ketteler, was murdered whilst on his way to the Tsung-Li-Yamen, and there is little doubt that the same fate had been prepared for all the other foreign representatives, who were expected to visit the Yamen, as negotiations were proceeding with regard to a summons sent to them on the previous day to leave Peking within twenty-four hours. At 4 P.M. on the afternoon of the 20th the Chinese troops opened fire upon the legations, and the eight weeks' siege began which will remain memorable in history as one of the most splendid instances of what the heroism and intelligence of a handful of Europeans can achieve against Asiatic hordes.

***Action of the Powers.***

Meanwhile Peking had been completely cut off since the 14th from all communication with the outside world, and in view of the gravity of the situation, naval and military forces were being hurried up by all the Powers to the gulf of Pe Chili. On 10th June Admiral Seymour had already left Tientsin with a mixed force of 2000 British, Russian, French, Germans, Austrians, Italians, Americans, and Japanese, to repair the railway and restore communication with Peking. But his expedition met with unexpectedly severe resistance, the line was torn up in its rear, and, unprovided with transport or supplies, it had great difficulty in making good its retreat after suffering heavy losses. Great anxiety prevailed for some days as to its fate, and no definite tidings of its whereabouts were received until it had fought its way back to within a day's march of Tientsin. When it reached Tientsin again on 26th

June, the British contingent of 915 men had alone lost 124 killed and wounded out of a total casualty list of 62 killed and 218 wounded. The Chinese had in the meantime made a determined attack upon the foreign settlements at Tientsin, and communication between the city and the sea being also threatened, the allied admirals had demanded on the 16th the surrender of the Taku forts at the mouth of the Pei-ho. The Chinese replied to the ultimatum by opening fire with great vigour during the following night, whereupon a flotilla of British, French, German, Japanese, and Russian gunboats bombarded the forts, which were captured by landing parties early on the 17th. The situation at Tientsin, nevertheless, continued precarious, and it was not till the arrival of considerable reinforcements that the troops of the allied Powers were able to assume the offensive, taking the native city by storm on 14th July, at a cost, however, of over 700 killed and wounded. Even in this emergency international jealousy had grievously delayed the necessary concentration of forces. Three British brigades were ordered up from India, a few French colonial regiments were sent on from Saigon, the Americans detached a body of troops from the Philippines, the Russians despatched a brigade from Port Arthur, though their military resources were severely taxed by the simultaneous outbreak of hostilities in Manchuria, and preparations were made in Germany, France, and Italy, to send out fresh contingents, the German force alone numbering over 20,000 men. But the situation required immediate action. No power was so favourably situated to take such action as Japan, and the British Government, who had strongly urged her to act speedily and energetically, undertook at her request to sound the other Powers with regard to her intervention. No definite objection was raised, but the replies of Germany and Russia barely disguised their ill-humour. Great Britain herself went so far as to offer Japan the assistance of the British treasury, in case financial difficulties stood in the way, but on the same day on which this proposal was telegraphed to Tokio (6th July), the Japanese Government had decided to embark forthwith the two divisions which it had already mobilized. By the beginning of August one of the Indian brigades had also reached Tientsin, together with smaller reinforcements sent by the other Powers, and thanks chiefly to the energetic counsels of the British commander, General Sir Alfred Gaselee, a relief column, numbering 20,000 men, at last set out for Peking on 4th August, a British naval brigade having started up river the previous afternoon. It met with only half-hearted resistance, and after a series of small engagements and very trying marches it arrived within striking distance of Peking on the evening of the 13th. The Russians tried to steal a march upon the allies during the night, but were checked at the walls and suffered heavy losses. The Japanese attacked another point of the walls the next morning, but met with fierce opposition, whilst the Americans were delayed by getting entangled in the Russian line of advance. The British contingent was more fortunate, and skilfully guided to an unguarded water-gate, General Gaselee and a party of Sikhs were the first to force their way with trifling loss through to the British legation. About 2 P.M. on the afternoon of 14th August, the long siege was raised.

***The siege of the legations.***

For nearly six weeks after the first interruption of communications, no news reached the outside world from Peking except a few belated messages, smuggled through the Chinese lines by native runners, urging the imperative necessity of prompt relief. During the greater part of that period the foreign quarter was subjected to heavy rifle and artillery fire, and the continuous fighting at close quarters with the hordes of Chinese regulars, as well as Boxers, decimated the scanty ranks of the defenders. The supply of both ammunition and food was slender. But the heroism displayed by civilians and professional combatants alike was inexhaustible. Some of the legations were totally or partially destroyed. In their anxiety to burn out the British legation, the Chinese did not hesitate to set fire to the adjoining buildings of the Hanlin, the ancient seat of Chinese classical learning, and the storehouse of priceless literary treasures and state archives. The *Fu*, or palace, of Prince Su, separated only by a canal from the British legation, formed the centre of the international position, and was held with indomitable valour by a small Japanese force under Colonel Sheba, assisted by a few Italian marines and volunteers of other nationalities and a number of Christian Chinese. The French legation on the extreme right, and the section of the city wall held chiefly by Germans and Americans, were also points of vital importance which had to bear the brunt of the Chinese attack. Little is known as to what passed in the councils of the Chinese court during the siege. But there is reason to believe that throughout that period grave divergences of opinion existed amongst the highest officials. The attack upon the legations appears to have received the sanction of the dowager-empress, acting upon the advice of Prince Tuan and the extreme Manchu party, at a grand council held during the night of 18th-19th June, upon receipt of the news of the capture of the Taku forts by the international forces. The emperor himself, as well as Prince Ching and a few other influential mandarins, strongly protested against the empress's decision, but it was acclaimed by the vast majority of those present. The moderate party was probably not in a position to do more than act as a drag upon the more violent faction. Three members of the Tsung-Li-Yamen were publicly executed for attempting to modify the terms of an imperial edict ordering the massacre of all foreigners throughout the provinces, and most of the Manchu nobles and high officials, and the eunuchs of the palace, who have played an important part in Chinese politics throughout the dowager-empress's tenure of power, were heart and soul with the Boxers. But it was noted by the defenders of the legations that Prince Ching's troops seldom took part, or only in a half-hearted way, in the fighting, which was chiefly conducted by Tung-fu-hsiang's soldiery and the Boxer levies. The modern artillery which the Chinese possessed was only spasmodically brought into play. Nor did any of the attacking parties ever show the fearlessness and determination which the Chinese had somewhat unexpectedly displayed on several occasions during the fighting at and around Tientsin. Nevertheless, the position of the defenders at the end of the first four weeks of the siege had grown well-nigh desperate. Mining and incendiarism proved far greater dangers than shot and shell. The Japanese had been forced back to their third and last line of defence in the *Fu*, and two-thirds of the French legation had been destroyed or wrested from its heroic defenders. The British legation was being hard pressed from the Mongol market as well as from the Imperial Carriage Park, and the firing on the city walls was severe and unceasing. The casualty list, amongst the officers especially, was heavy, and the need of constant watchfulness along the whole line of defences was a great strain upon the physical endurance of the attenuated garrison. Suddenly, just when things were looking blackest, on the 17th of July the Chinese ceased firing, and a sort of informal armistice secured a period of respite for the beleaguered Europeans. The capture of the native city of Tientsin by the allied forces had shaken the self-confidence of the Chinese authorities, who had hitherto not only countenanced, but themselves directed the hostilities. By a curious coincidence it was just at the time when the besiegers were relaxing their efforts that the intense anxiety of the civilized world with regard to the fate of the besieged reached its culminating point. Circumstantial accounts of the fall of the legations and the massacre of their inmates were circulated in Shanghai and telegraphed to Europe, and coupled with the despairing tone of the few messages which had been smuggled out of Peking in June—more especially Sir Robert Hart's message of 24th June—and with the admissions made by Chinese provincial officials, these reports found general credence. Mr Brodrick, under-secretary of state for Foreign Affairs, officially stated in the House of Commons on 17th July, that though the British Government had no direct confirmation of these painful rumours, they had, unfortunately, little reason to regard them as otherwise than substantially correct. It was not till the following week that an authentic message received through the Chinese legation at Washington from the American minister proved these fears to be premature. Similar telegrams followed from Sir Claude Macdonald and other foreign representatives, and various communications from the Chinese Government, though the pacific assurances they contained were largely mendacious, showed that they were at any rate growing alarmed at the consequences of their outrageous action. Desultory fighting, nevertheless, continued, and grave fears were entertained that the approach of the relief column would prove the signal for a desperate attempt to rush the legations before effectual assistance could reach them. The attempt was made, but failed. The relief, however, came not a day too soon. Of the small band of defenders which, including civilian volunteers, had never mustered 500, 65 had been killed and 131 wounded. Ammunition and provisions were almost at an end. Even more desperate was the situation at the Pei-tang, the Roman Catholic northern cathedral and mission house, where with the help of a small body of French and Italian marines, Mgr. Favier had organized an independent centre of resistance for his community of over 3000 souls. Their rations were absolutely exhausted, when on 15th August a relief party was despatched to their assistance from the legations.

***The condition of Peking.***

The ruin wrought in Peking during the two months' fighting was appalling. Apart from the wholesale destruction of foreign property in the Tartar city—mission houses, churches, hospitals, native stores where foreign goods had been sold, native houses suspected of any connexion or sympathy with foreigners—and of Chinese as well as European buildings in the vicinity of the legations, the wealthiest part of the Chinese city had been laid in ashes. The flames from a foreign drug store fired by the Boxers had spread to the adjoining buildings, and finally consumed the whole of the business quarter with all its invaluable stores of silks, curiosities, furs, &c. The retribution which overtook

Peking after its capture by the international forces was scarcely less terrible. Looting was for some days almost universal. But it would have been well, for the credit of Western civilization and Christianity, had the reprisals exercised by some of the foreign contingents been confined to looting. The whole city was divided up into separate areas of occupation between the contingents of different nationalities, and in the Russian and French quarters unbridled license prevailed for some time. It should be added that the French force at that period consisted chiefly of colonial troops from Tongking and Annam. Order was, however, gradually restored, first in the Japanese and then in the British and American quarters, though several months elapsed before there was any real revival of native confidence.

*The flight of the Chinese court.*

So unexpected had been the rapid and victorious advance of the allies, that the dowager-empress with the emperor and the rest of the court did not actually leave Peking until the day after the legations had been relieved. But the northern and western portions of the Tartar city had not yet been occupied, and the fugitives made good their escape on the afternoon of the 15th in the direction of the Western Hills. When the allies some days later marched through the Forbidden City, they only found a few eunuchs and subordinate officials in charge of the imperial apartments. At the end of September, Field-Marshal Count von Waldersee, with a German expeditionary force of over 20,000 men, arrived to assume the supreme command conferred upon him with the more or less willing assent of the other Powers. As a matter of fact, his authority was never practically recognized by either the French or the American commanders, and was only effectively exercised over the British and the small Italian and Austrian contingents. A large portion of the Japanese troops was shipped back to Japan soon after the relief of the legations, and the bulk of the Russian forces was withdrawn into Manchuria. There were indeed no longer any important military operations to be carried out. After a few punitive expeditions had been sent to Paoting-fu and other districts in the neighbourhood of Peking, where exceptionally brutal outrages had been committed during the summer, the duties of the foreign troops were henceforth chiefly in the nature of police work. The Germans, however, having arrived too late to take any part in the relief of Peking, often showed a mischievous anxiety to extend the sphere of operations. Their discipline, especially in their treatment of the defenceless Chinese population, fell lamentably short of the high standard expected from a great military nation, and their predatory raids in search of Boxers resulted only in increasing the confusion and misery which prevailed in the zone of foreign occupation. The removal by the Germans of the ancient astronomical instruments from Peking was condemned even in the German press as an act of unjustifiable vandalism. Towards the end of February 1900 preparations were made at the German headquarters for an extensive forward movement in the direction of Si-nghan-fu, but it was ultimately abandoned, owing to the refusal of the other Powers, and more especially of Great Britain and Japan, to countenance such an adventurous enterprise. Strangely enough, the German contingent, which saw less actual fighting than any other foreign force, suffered the two most conspicuous losses during the whole campaign. Count York, a staff officer of the greatest promise, died of asphyxia in a Chinese inn during a winter march, and General von Schwarzhoff, chief of the staff to Count von Waldersee, lost his life in the fire which destroyed the apartments in the Winter Palace occupied by the German headquarters (17th April).

*The political situation.*

The political task which confronted the Powers after the occupation of Peking was far more arduous than the military one. The action of the Russians in Manchuria, even in a treaty port like New-chwang, the seizure of the railway line not only to the north of the Great Wall, but also from Shan-hai-kwan to Peking, by the Russian military authorities, and the appropriation of an extensive line of river frontage at Tientsin as a Russian "settlement," were difficult to reconcile with the pacific assurances of disinterestedness which Russia, like the rest of the Powers, had officially given. Great anxiety prevailed as to the effect of the flight of the Chinese court in other parts of the empire. The anti-foreign movement had not spread much beyond the northern provinces, in which it had had the open support of the throne and of the highest provincial officials. But amongst British and Americans alone, over 200 defenceless foreigners, men, women, and children, chiefly missionaries, had fallen victims to the treachery of high-placed mandarins like Yü Hsien, and hundreds of others had had to fly for their lives, many of them owing their escape to the courageous protection of petty officials and of the local gentry and peasantry. The Roman Catholic missionaries and communities throughout the north had met, or been threatened, with the same fate, and sporadic outbreaks such as that which had occurred at Su-chan, south of the Yangtse, showed that there were explosive materials scattered all over the empire. In the Yangtse valley order had been maintained by the energy of the viceroys of Nanking and Wu-chang, who had acted throughout the critical period in loyal co-operation with the British consuls and naval commanders, and had courageously disregarded the imperial edicts issued during the ascendancy of the Boxers. After some hesitation, an Indian brigade, followed by French, German, and Japanese contingents, had been landed at Shanghai for the protection of the settlements, and though the viceroy, Liu Kun-yi, had welcomed British support, and even invited the joint occupation of the Yangtse forts by British and Chinese troops, the appearance of other European forces in the Yangtse valley was viewed with great suspicion. In the south there were serious symptoms of unrest, especially after Li Hung-Chang had left Canton for the north, in obedience, as he alleged at the time, to an imperial edict which, there is reason to believe, he invented for the occasion. The Chinese court, after one or two intermediate halts, had retired to Si-nghan-fu, one of the ancient capitals of the empire, situated in the inaccessible province of Shen-si, over 600 miles south-west of Peking. The influence of the ultra-reactionaries, headed by Prince Tuan and General Tung-fu-hsiang, still dominated its councils, although edicts, illusory if genuine, were from time to time stated to have been issued for the punishment of some of the leading officials concerned in the anti-foreign outrages, and credentials were sent to Prince Ching and to Li Hung-Chang, who, after waiting for some weeks upon events at Shanghai, had proceeded to Peking, authorizing them to treat with the Powers for the re-establishment of friendly relations.

*The Anglo-German agreement.*

On 16th October the Anglo-German agreement, to which reference has already been made, was signed in London, and its publication immediately upon signature created some excitement at the time. The negotiations which had led up to it had been conducted with great celerity and secrecy, and it would appear, from a despatch which was subsequently published from Lord Salisbury to the British representative in St Petersburg, that the British negotiator was in no small degree influenced by the aggressive features of Russia's action at the time in northern China. Germany, on the other hand, would seem to have been chiefly actuated by the desire to forestall any isolated action on the part of Great Britain in the Yangtse valley. The agreement certainly had no immediate effect upon the political situation. It did not modify Germany's attitude with regard to Russia, for Count von Waldersee continued to lend his support as far as possible to the Russian military authorities in northern China whenever differences of opinion arose between them and the British, and the German Government a few months later openly denied that the agreement applied to Manchuria, in spite of the contrary opinion entertained by the British Government. But it has given Germany a claim to a footing in the Yangtse valley which it is difficult to reconcile with the policy propounded by British ministers when they published the Yangtse "assurance," obtained in 1898 from the Tsung-Li-Yamen. In one of his statements to the Reichstag, the imperial chancellor referred to the Anglo-German agreement as "the Yangtse agreement," and that designation has ever since been universally adopted in Germany.

*The negotiations.*

The harmony of the Powers, which had been maintained with some difficulty up to the relief of the legations, was subjected to a severe strain as soon as the basis of negotiations with the Chinese Government came to be discussed. The eleven Powers having diplomatic representatives in Peking, including, therefore, such minor Powers as Spain, Holland, and Belgium, claimed to have an equal voice in these discussions, and the conferences held between the foreign ministers in the Chinese capital had constantly to be supplemented by references to their governments and by prolonged correspondence between the different cabinets. While for various reasons Russia, Japan, and the United States were inclined to treat China with great indulgence, Germany insisted upon the signal punishment of the guilty officials as a *conditio sine quâ non*, and in this she had the support not only of the other members of the Triple Alliance, whose interests in China were only of secondary importance, but also of Great Britain, and to some extent even of France, who, as protector of the Roman Catholic Church in Eastern countries, could not allow the authors of the atrocities committed upon its followers to escape effectual punishment. It was not until after months of laborious negotiations that an agreement was finally arrived at with regard to the general tenour of the demands to be formally made upon the Chinese Government. They were embodied in a joint note signed by all the foreign ministers on 20th and 21st December 1900. The preamble recited the chief crimes committed by the Chinese, denounced the treachery of the Chinese Government in declaring, through its representatives abroad, that it was protecting the legations while it was actually besieging them, and announced that the allied Powers consented to accede to China's petition for peace on "irrevocable conditions" therein stated. These were substantially as follows :—Honourable reparation for

the murder of Baron von Ketteler and of M. Sugiyama was to be made in a specified form, and expiatory monuments were to be erected in cemeteries where foreign tombs had been desecrated. "The most severe punishment befitting their crimes" was to be inflicted on the personages designated by the decree of 21st September, and also upon others to be designated later by the foreign ministers, and the official examinations were to be suspended in the cities where foreigners had been murdered or ill-treated. An equitable indemnity, guaranteed by financial measures acceptable to the Powers, was to be paid to states, societies, and individuals, including Chinese who had suffered because of their employment by foreigners, but not including Chinese Christians who had suffered only on account of their faith. The importation or manufacture of arms or *matériel* was to be forbidden; permanent legation guards were to be maintained at Peking, and the diplomatic quarter was to be fortified, while communication with the sea was to be secured by a foreign military occupation of the strategic points and by the demolition of the Chinese forts, including the Taku forts, between the capital and the coast. Proclamations were to be posted throughout China for two years, threatening death to the members of anti-foreign societies, and recording the punishment of the ringleaders in the late outrages; and the viceroys, governors, and provincial officials were to be declared by imperial edict responsible, on pain of immediate dismissal and perpetual disability to hold office, for anti-foreign outbreaks or violations of treaty within their jurisdictions. China was to facilitate commercial relations by negotiating a revision of the commercial treaties. The Tsung-Li-Yamen was to be reformed, and the ceremonial for the reception of foreign ministers modified as the Powers should demand. Compliance with these terms was declared to be a condition precedent to the arrangement of a time limit to the occupation of Peking and of the provinces by foreign troops.

Under instructions from the court, the Chinese plenipotentiaries affixed their signatures on 14th January 1901 to a protocol, by which China pledged herself to accept these terms in principle, and the conference of ministers then proceeded to discuss the definite form in which compliance with them was to be exacted. This further stage of the negotiations proved even more laborious and protracted than the preliminary proceedings. No attempt was made to raise the question of the dowager-empress's responsibility for the anti-foreign movement, as Russia had from the first set her face against the introduction of what she euphemistically termed "the dynastic question." But even with regard to the punishment of officials whose guilt was beyond dispute, grave divergences arose between the Powers. The death penalty was ultimately waived in the case even of such conspicuous offenders as Prince Tuan and Tung-fu-hsiang, but the notorious Yü Hsien and two others were decapitated by the Chinese, and three other metropolitan officials were ordered to commit suicide, whilst upon others sentences of banishment, imprisonment, and degradation were passed, in accordance with a list drawn up by the foreign representatives. The question of the punishment of provincial officials, responsible for the massacre of scores of defenceless men, women, and children, was unfortunately reserved for separate treatment, and, when it came up for discussion, it became impossible to preserve even the semblance of unanimity, the Russian minister at once taking issue with his colleagues, although he had originally pledged himself as formally as the others to the principle. Count Lamsdorff frankly told the British ambassador at St Petersburg that Russia took no interest in missionaries, and as the foreigners massacred in the provinces belonged mostly to that class, she declined to join in the action of the other Powers. Fortunately the rest of the Powers, including even Japan, who, as a non-Christian state, might have been excused for adopting the same attitude as Russia, preserved a united front, and though the satisfaction ultimately obtained was not altogether adequate, the list of punishments proposed by the British minister, Sir Ernest Satow, was presented to the Chinese plenipotentiaries with the signatures of all the foreign representatives except the Russian.

***The Manchurian convention.***

The real explanation of Russia's cynical secession from the concert of Powers on this important issue must be sought in her anxiety to conciliate the Chinese in view of the separate negotiations in which she was at the same time engaged with China in respect of Manchuria. When the Boxer movement was at its height at the end of June 1900, the Chinese authorities in Manchuria had wantonly "declared war" against Russia, and for a moment a great wave of panic seems to have swept over the Russian administration, civil and military, in the adjoining provinces. The reprisals exercised by the Russians were proportionately fierce. The massacre at Blagovestchensk, where 5000 Chinese—men, women, and children—were flung into the Amur by the Cossacks, was only one incident in the reign of terror by which the Russians sought to restore their power and their prestige. The resistance of the Chinese troops was soon overcome, and Russian forces overran the whole province, occupying even the treaty port of New-chwang. The Russian Government officially repudiated all responsibility for the proclamations issued by General Gribsky and others, foreshadowing, if not actually proclaiming, the annexation of Chinese territory to the Russian empire. But Russia was clearly bent on seizing the opportunity for securing a permanent hold upon Manchuria. In December 1900 a preliminary agreement was made between M. Korostovetz, the Russian administrator-general, and Tseng, the Tartar general at Mukden, by which the civil and military administration of the whole province was virtually placed under Russian control. In February 1901 negotiations were opened between the Russian Government and the Chinese minister at St Petersburg for the conclusion of a formal convention of a still more comprehensive character. The Russian Government refused to disclose its terms, but the draft prepared by the Russian Foreign Office was informally communicated through Chinese channels to the British and other friendly governments. In return for the restoration to China of a certain measure of civil authority in Manchuria, Russia was to be confirmed in the possession of exclusive military, civil, and commercial rights, constituting in all but name a protectorate, and she was also to acquire preferential rights over all the outlying provinces of the Chinese empire bordering on the Russian dominions in Asia. The clauses relating to Chinese Turkestan, Kashgar, Yarkand, Khotan, and Mongolia were subsequently stated to have been dropped, but the convention nevertheless provoked considerable opposition both in foreign countries and amongst the Chinese themselves. Most of the Powers, including Germany, who, however, denied that the Anglo-German agreement of 16th October 1900 applied to Manchuria, advised the Chinese Government not to pursue separate negotiations with one Power whilst collective negotiations were in progress at Peking, and both Japan and Great Britain pressed for definite information at St Petersburg with regard to the precise tenour of the proposed convention. At the same time the two viceroys of the lower Yangtse memorialized the Throne in the strongest terms against the convention, and these protests were endorsed not only by the great majority of Chinese officials of high rank throughout the provinces, but by popular meetings and influential guilds and associations. Ultimately the two viceroys, Chang Chih-tung and Liu Kun-yi, took the extreme step of warning the Throne that they would be unable to recognize the convention, even if it were ratified, and notwithstanding the pressure exercised in favour of Russia by Li Hung-Chang, the court finally instructed the Chinese minister at St Petersburg to decline his signature. The attitude of Japan, where public feeling ran high, was equally significant, and on 3rd April the Russian Government issued a circular note to the Powers, stating that, as the generous intentions of Russia had been misconstrued, she withdrew the proposed convention.

***The peace protocol.***

The work of the conference at Peking, which had been temporarily disturbed by these complications, was then resumed, and soon reached a stage which brought the possibility of an early evacuation within the range of discussion. It was generally felt that the prolonged occupation and the inaction to which the majority of the foreign troops were necessarily condemned were detrimental to the maintenance of discipline, and the friction which led to such unpleasant incidents as those which occurred in March and April at Tientsin, where conflicts between British troops and French, Germans, and Russians were with difficulty averted, gave additional cause for anxiety. The Anglo-Russian dispute over the construction of certain roads and railway sidings at Tientsin also showed that, although the Russians had been induced to hand over the Peking-Shan-hai-kwan railway (18th January) to the German military authorities, who in their turn surrendered it (21st February) to the British, an international occupation was still fraught with manifold dangers. Early in April Count von Waldersee invited all the foreign commanders to meet him and discuss the feasibility of a partial withdrawal of troops. The discussion led to no immediate results, but it helped to stimulate the proceedings of the diplomatists. The question of indemnities, however, gave rise to renewed friction. Each Power drew up its own claim, and whilst Great Britain, the United States, and Japan displayed great moderation, other Powers, especially Germany and Italy, put in claims which were strangely out of proportion to the services rendered by their military and naval forces. Not only the amount of the indemnity, but the mode of payment and the ear-marking of revenues out of which China was to meet it, gave rise to great differences of opinion. Germany proposed an immediate 10 per cent. increase of the Chinese customs tariff on foreign imports, but this proposal met with determined opposition from other commercial Powers, and especially from Great Britain, whose trade would have to bear the chief part of the burden. It was at last settled that China should pay altogether an indemnity of 450 million taels, to be secured (1) on the unhypothecated balance of the customs revenue administered by the imperial maritime customs, the import duties

being raised forthwith to an effective 5 per cent. basis; (2) on the revenues of the "native" customs in the treaty ports; (3) on the total revenues of the salt gabelle. Finally, after more than sixty plenary conferences and innumerable meetings of sub-committees had been held by the diplomatists in Peking, the peace protocol was drawn up in a form which satisfied all the Powers as well as the Chinese court. The formal signature was, however, delayed at the last moment by a fresh difficulty concerning Prince Chun's penitential mission to Berlin. The prince, an amiable and enlightened youth, half-brother to the emperor, had reached Basel towards the end of August on his way to Germany, when he was suddenly informed that he and his suite would be expected to perform *kotow* before the German emperor. The prince resented this unexpected demand, and referred home for instructions. The Chinese court appear to have remained obdurate, and the German Government perceived the mistake that had been made in exacting from the Chinese prince a form of homage which Western diplomacy had for more than a century refused to yield to the Son of Heaven, on the ground that it was barbarous and degrading. The point was waived, and Prince Chun was received in solemn audience by the Emperor William at Potsdam on 4th September. Three days later, on 7th September, the peace protocol was signed at Peking by the two Chinese plenipotentiaries and the representatives of Great Britain, Germany, France, Russia, the United States, Japan, Austria-Hungary, Italy, the Netherlands, Belgium, and Spain.

Article 1 recorded the satisfaction to be given to Germany for the murder of Baron von Ketteler.

Article 2 recited the punishments inflicted on the guilty officials and the posthumous honours rendered to the three mandarins who had been executed during the siege for their endeavours to stem the anti-foreign movement. It also placed on record the suspension of official examinations in all cities where anti-foreign outrages of an aggravated character had been perpetrated.

Article 3 recorded the satisfaction to be given to Japan for the murder of M. Sugiyama.

Article 4 provided for the erection by the Chinese of expiatory monuments.

Article 5 dealt with the prohibition of the importation of arms and warlike material.

Article 6 set forth the amount and mode of payment of the indemnity.

Articles 7, 8, and 9 defined the area of the new legation quarter at Peking, and dealt with its protection and with that of the railway and the whole line of communication between Peking and the sea.

Article 10 recorded the measures taken by the Chinese Government to prevent the recurrence of anti-foreign agitation or troubles.

Article 11 provided for the amendment of existing treaties of commerce and navigation, and for river conservancy measures at Tientsin and Shanghai.

Article 12 dealt with the reorganization of the Chinese Ministry of Foreign Affairs, and modifications of court ceremonial as regards the reception of foreign representatives.

The British Government at once appointed a Special Commission, with Sir J. Mackay, member of the Council of India, as chief commissioner, to proceed to Shanghai to carry on the commercial negotiations, provided for in article 11, with the commissioners appointed by China. These negotiations were also to deal with the removal of existing obstacles to foreign trade, such as *likin*, &c., and with regulations for facilitating steamer navigation on inland waters.

In accordance with the terms of the protocol, all the foreign troops, with the exception of the legation guards, were withdrawn from Peking on 17th September, and from the rest of Chih-li, with the exception of the garrisons at the different points specified along the line of communications, by 22nd September. On 7th October it was announced that the Chinese court had left Si-nghan-fu on its way back to the northern capital. A month later (7th November) the death of Li Hung-Chang at Peking removed, if not the greatest of Chinese statesmen, at any rate the one who had enjoyed a larger share of the empress-dowager's confidence and figured in the eyes of the outside world more prominently than any other during that long chapter of wasted opportunities which had opened for the Chinese empire after the suppression of the great Taiping rebellion, and was brought to a close by the Boxer movement, the international occupation of Peking, and the peace protocol of 1901.

With this settlement a new era opens. What it will produce none can venture to foretell. On the one hand, the Powers have been induced to display great leniency with regard to the punishment of the court and the high officials implicated in the anti-foreign outrages of 1900; and on the other, the pecuniary compensation they have exacted is calculated to weigh heavily on the Chinese people, and on the innocent not less than on the guilty. In the north of China the excesses committed by some of the foreign contingents unquestionably lowered the reputation of all Western powers collectively, notwithstanding the high standard of discipline maintained by the British, American, and Japanese forces, and by the later French contingent sent out direct from France. It must be noted also that amongst progressive Chinese officials a widespread feeling of disappointment prevailed that the Powers should have failed to avail themselves of the opportunity to insist upon the introduction of administrative reforms into China. The necessity of such reforms had been more widely realized by the Chinese themselves during the recent crisis than at any previous moment in the modern history of China, and several high officials like the Yangtse viceroys, the viceroy of Canton, and the governor of Shantung, Yuen Shih-kai, one of the ablest of the young Chinese mandarins, repeatedly memorialized the Throne in this sense. Imperial edicts were from time to time issued from Si-nghan-fu announcing important reforms, especially in the system of education and qualifications for the public service, but their value remained speculative so long as most of the appointments made by the court continued to be bestowed on members of the old reactionary party.

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**China-Japan War of 1894-95.**—The causes of the war between China and Japan arose out of the rival claims of the two Powers to assert influence in Korea. It was an old tradition in Japan, dating back to the legendary achievements of the Emperor Jingu, that Korea occupied a position of quasi-vassalage to the empire. At the end of the 16th century an expedition sent by the Emperor Hideyoshi occupied Seoul and Phyong-yang. The Koreans invoked the aid of China, and after a prolonged war the Japanese forces were withdrawn shortly before the death of Hideyoshi. Inadequate sea power, rendering the supply of the Japanese troops precarious, seems to have been the cause of the ultimate failure, although the Chinese were frequently defeated in the field. In 1627, and again in 1637, Korea was invaded from the north by the Manchus, who soon afterwards established their dynasty at Peking. According a purely nominal allegiance to China, the Koreans subsequently maintained their isolation for more than two centuries. After the revolution which ended in 1868—when Japan, adopting Western reforms, started upon a wonderful career of progress—it was natural that her ambitions in regard to Korea should receive a fresh impulse. In 1875 a Japanese force landed on Kang-hwa Island, and after a naval demonstration at Chemulpo a treaty was obtained opening Fusan to Japanese trade. From this time Japan began to play an active part in Korean affairs, and under her influence a progressive party arose in Seoul, which soon found itself in conflict

with the ways of the mass of the people. In July 1882 the legations were burned by a mob and some Japanese officers were massacred. The minister who succeeded in reaching the sea and escaping was sent back with a military escort, and an indemnity was demanded and obtained. The Chinese at the same time sent a small force to Korea. In December 1884 a fresh outbreak occurred at Seoul. A plot to seize the king and establish a progressive government failed, and the Japanese were again driven out of the capital by the Koreans, assisted by Chinese. Japan sent troops and enforced the payment of a second indemnity. In April 1885 a convention was signed at Tientsin by Count Ito and Li Hung-Chang, by which both Powers undertook to withdraw their military forces from Korea, each being pledged to inform the other of any decision to despatch troops in the event of future disturbances. This convention secured comparative tranquillity in Korea for nine years. The murder at Shanghai, on 28th March 1894, of Kim-ok-kim, one of the leaders of the abortive revolution of 1884, created much excitement in Seoul, where the Tong-Hak rebellion was beginning to cause alarm. At the end of May the Tong-Haks defeated the Korean forces, and early in June the Government appealed to China for military assistance. A small Chinese force was at once sent to Asan; and the Japan Government being informed, according to the terms of the convention of Tientsin, promptly ordered its minister, Otori, who was on leave, to return to Seoul. Warships were sent to Chemulpo, and Otori with an escort of marines reached Seoul on 10th June. The Japanese rapidly followed up this step by the despatch of about 5000 troops under Major-General Oshima, who relieved the marines by the middle of June. A complicated situation thus arose. Chinese troops were present in Korea by the request of the Government with a view to put down an armed rebellion. The Japanese controlled the capital, and were determined to carry out reforms by force if necessary. An interesting diplomatic correspondence led only to a deadlock. Japan absolutely declined to recognize Korea "as a tributary state of China," to limit her military forces in the peninsula, or to place any restrictions upon their movements; but she proposed that the two Powers should "unite their efforts for the speedy suppression of the disturbance," and should subsequently send commissioners to inaugurate jointly certain specified measures of reform. The Tsung-Li-Yamen considered that "the idea may be excellent, but the measures of reform must be left to Korea herself. Even China herself would not interfere with the internal administration of Korea, and Japan having from the very first recognized the independence of Korea, cannot have the right to interfere." The Japanese foreign minister replied that "the Imperial Government, much to their regret, cannot share the hopeful views" thus expressed, and considered that the government of Korea "is lacking in some of the elements which are essential to responsible independence." Ultimately—on 16th July—the Tsung-Li-Yamen was informed that as the Chinese Government appeared "disposed to precipitate complications," Japan was "relieved of all responsibility for any eventuality that may in future arise." War was now inevitable unless the Peking Government was willing to abdicate all claims over Korea. The claims were valueless; but Chinese troops were already in the country by invitation, and in these circumstances it was not to be expected that the shadowy suzerainty would be abandoned.

At Seoul the issue was forced by the Japanese minister, who delivered an ultimatum to the Korean Government on 20th July. On the 23rd the palace was forcibly occupied; and the pro-Chinese party being removed from power, the control of the Government passed into the hands of the Japanese. Meanwhile China had made efforts to reinforce the detachment at Asan, and had despatched about 8000 troops to the Yalu river. The outbreak of war thus found the Japanese in military possession of Seoul and ready to send large forces to Korea, while the Chinese occupied Asan (about 40 miles southward of the capital), and had a considerable body of troops in Manchuria in addition to those despatched to the Yalu river. To Japan the command of the sea was essential for the secure transport and supply of her troops. Without it the experience of the war of the 16th century would be repeated. China, on the other hand, could utilize overland routes to Korea; but difficulties and delays would necessarily be entailed. To both Powers the naval question was thus all-important.

War was not finally declared till 1st August, by which time collisions had occurred on sea and land. On 25th July Major-General Oshima, with about 2500 men, started for Asan and found the Chinese entrenched at Sung-hwan. The position was successfully attacked on the 29th, with a loss of about 90 killed and wounded; but Yeh, the Chinese commander, escaped with the greater part of his force, and reached Phyong-yang by a wide detour. Meanwhile the Japanese squadron was proceeding to Chemulpo, the cruisers *Akitsushima*, *Yoshino*, and *Naniwa* being sent on in advance. On the morning of 25th July these vessels met the *Tsi-yuen* and the *Kuang-yi* near Phung Island. An engagement occurred, in which the *Kuang-yi* was disabled and run ashore, the *Tsi-yuen* escaping to Wei-hai-wei, chased by the *Yoshino*. The Chinese vessels, hopelessly overmatched, seem to have been well fought. At this juncture the wooden despatch boat *Tsao-kiang* approached from the south-east, and was captured by the *Akitsushima*, while the British steamer *Kowshing*, carrying 1200 Chinese troops from Taku to Asan, also arrived, and was ordered by the *Naniwa* to bring-to and anchor.

**Kowshing incident.**

The *Kowshing* having been directed to follow the *Naniwa*, the Chinese threatened to kill the officers if they complied or attempted to leave the ship. The *Naniwa* then opened fire and sank the *Kowshing* in less than half an hour. More than 1000 of the Chinese troops were drowned. The destruction of the *Kowshing* undoubtedly contributed to the Japanese success at Sung-hwan, and the intention of the Chinese to crush their enemies at Seoul between forces moving from the north and south was frustrated. Henceforth the Japanese had to deal only with the forces north of the capital.

It was now of vital importance to the Chinese to prevent the transport of Japanese troops to Chemulpo, which was carried on with the greatest energy. The Chinese fleet, however, remained in port, and the Japanese made no attempt to obtain and keep touch with it. During August and September the Japanese were busied in landing troops and stores at Chemulpo and Gensan, while the Chinese forces in Manchuria moved slowly to the Yalu river. On 8th August the Japanese began to move northwards. By 12th September about 14,000 men had converged upon Phyong-yang in three columns from Gensan, Sak-riong, and Chung-hua, and the main body under Lieutenant-General Nodzu from Huang-ju. A general attack was made on 15th September, and the strongly entrenched position was captured, with a loss of about 650 killed and wounded. The Chinese, numbering about 12,000, suffered heavily, and retreated northwards over the river Yalu. Korea being thus cleared, the war entered upon another phase.

**Yalu battle.**

Two days after the capture of Phyong-yang the hostile fleets came in contact. Admiral Ito seems to have taken no direct measures to prevent the landing of troops in the Yalu, and five Chinese transports left Taku on 14th September with a cruiser escort, picking up the Pei-yang squadron, under Admiral Ting, *en route*. About 4000 men were disembarked on the 16th, and the Chinese warships weighed early on the 17th for the return voyage. They were sighted at about half-past eleven in the forenoon by the Japanese squadron, which was reconnoitring in the neighbourhood of the island of Hai-yang.

The tables on the following page give a detail of the fleets, which were not unevenly matched, the Japanese having the advantages of more modern ships, quick-firing guns, speed, and homogeneity, while the Chinese fleet contained two second-class battleships, the *Ting-Yuen* and the *Chen-Yuen*.

Admiral Ting attempted to form his force in quarter-line abreast, but the evolution was not accomplished, and the Chinese fleet bore down in a somewhat irregular line, the two battleships being in the centre and the weakest vessels—the *Chao-Yung* and the *Yang-Wei*—on the wings. Admiral Ito divided his squadron into two parts, which were separately handled throughout the action, moving always in single column line ahead. The flying squadron, consisting of the fast vessels *Yoshino*, *Naniwa*, *Takachiho*, and *Akitsushima*, was ordered to pass round the Chinese right wing and attack the rear. In place of turning to starboard as intended, the squadron bore away to attack two detached Chinese vessels, which with some torpedo boats appeared to be

*Chinese Squadron.*

| Classification. | Ships' Names | Date of Launch. | Displacement. | Armour (in inches). On Belt. | Armour (in inches). On Turret, Barbette, or Battery. | Speed. | Guns. | Torpedo Discharges. |
|---|---|---|---|---|---|---|---|---|
| Battleships—2nd class | Ting-Yuen<br>Chen-Yuen | 1881<br>1882 | 7430 | 14 | 12 | 14·5 | Four 12-in., two 6-in., two 4-in. (Four 6-pdr., two 3-pdr.) Q.F., 8 M. | 3 |
| Armoured cruisers | Lai-Yuen<br>King-Yuen | 1887 | 2850 | 9½ | 8 | 15 | Two 8¼-in., two 6-in., 8 M. | 4 |
| Cruisers—3rd class, protected | Tsi-Yuen | 1883 | 2355 | 0 | 6 | 15 | Two 8·4-in., one 6-in., 10 M. | 4 |
| | Chi-Yuen<br>Ching-Yuen | 1886 | 2300 | 0 | 0 | 18 | Three 8·4-in., two 6-in., 16 M. | 4 |
| Do. do. unprotected | Chao-Yung<br>Yang-Wei | 1881 | 1350 | 0 | 0 | 16 | Two 10-in., four 40-pdr., 7 M. | 0 |
| | Kwan-Chia | 1887 | 1300 | 0 | 0 | 16·5 | Three 4·7-in. Q.F., three 6-pdr. Q.F., 4 M. | 0 |
| Armoured cruiser | [1]Ping-Yuen | 1888 | 2850 | 8 | 5 | 12 | One 12-in., two 6-in., 8 M. | 4 |
| Torpedo vessel | [1]Kwang-Ping | 1889 | 1030 | 0 | Hull partly of wood | 16·5 | Three 4·7-in. Q.F., two 6-pdr. Q.F., 4-M. | 4 |
| Gunboats | [1]Epsilon<br>[1]Kappa | 1879<br>1881 | 440 | 0 | 0 | 10 | One 11-in. M.L., 2 L., 4 M. | 0 |
| Torpedo boats—1st class | [1]Foo-Lung | 1886 | 120 | 0 | 0 | 24 | Two 3-pdr. Q.F. | 2 |
| | [1]Tyo-Jih | 1887 | 90 | 0 | 0 | 23 | Two 3-pdr. Q.F. | 3 |

1 Ships that took little or no part in the action.

*Japanese Squadron.*

| Classification. | Ships' Names. | Date of Launch. | Displacement. | Armour (in inches). On Belt. | Armour (in inches). On Turret, Barbette, or Battery. | Speed. | Guns. | Torpedo Discharges. |
|---|---|---|---|---|---|---|---|---|
| Cruisers—2nd class, protected | Matsushima<br>Itsukushima<br>Hasidate | 1890<br>1889<br>1891 | 5277 | 0 | 12 | 17·5 | [2]One 13-in.; twelve 5-in. Q.F., fifteen 3-pdr. and 2½-pdr. Q.F. | 4 |
| Armoured cruiser | Chiyoda | 1890 | 2450 | 4½ | 0 | 19 | Ten 5-in. Q.F., fourteen 3-pdr. Q.F., and 3 M. | 3 |
| Cruisers—2nd class, protected | Yoshino | 1892 | 4150 | 0 | 0 | 23 | Four 6-in., eight 5-in., twenty-two 3-pdr., all Q.F. | 5 |
| | Naniwa<br>Takachiho | 1885 | 3650 | 0 | 0 | 18·7 | Two 10-in., six 6-in.; two 6-pdr. Q.F., and 12 M. | 4 |
| | Akitsushima | 1892 | 3150 | 0 | 0 | 19 | Four 6-in., six 5-in., six 3-pdr., all Q.F. | 4 |
| Battleship—3rd class | Fuso | 1877 | 3718 | 7 | 9 | 13 | Four 9½-in., two 7-in., 8 M. | 0 |
| Armoured cruiser | Hi-Yei | 1878 | 2200 | 4½ | Hull composite. | 13 | Three 7-in., six 6-in., 8 M. | 0 |
| Gun-vessel | Akagi | 1889 | 615 | 0 | 0 | 12 | One 9½-in., one 6-in.; six 3-pdr. Q.F. | 0 |
| Armoured transport | Sakio-Maru | 1888 | 2913 | 0 | 0 | 14 | Four Q.F., probably 6-pdrs. | 0 |

2 Aft in *Matsushima;* forward in her two sister-ships.

attempting to join the fleet. Meanwhile the main squadron, led by the flagship *Matsushima*, followed, and circling round the Chinese line passed its left wing. The flying squadron, recalled by signal, again engaged the right wing. The courses became somewhat complicated; but, broadly speaking, the two Japanese squadrons continued to steam independently round the Chinese vessels, concentrating their fire upon individual groups. On the other hand, the Chinese almost from the first lost all order and attempted no manœuvring; but the two battleships *Ting-Yuen* and *Chen-Yuen* supported each other, and their armour proved a match for the Japanese ordnance, which was unable to disable them. Before sunset the *Yang-Wei*, *Chao-Yung*, *King-Yuen*, and *Chi-Yuen* had been sunk by shells, and the *Matsushima* and *Hi-Yei* were much damaged. The crews of both fleets were much exhausted. The Japanese pursuit seems to have been half-hearted, and contact was lost during the night. The total Japanese loss amounted to 115 killed and 103 wounded, of which nearly half occurred on board the *Matsushima*. The Chinese lost about 600 men in the sunken ships, in addition to about 100 killed and between 200 and 300 wounded. The action was decided solely by gun fire, although the Chinese discharged two torpedoes against the armed transport *Sakio-Maru* without effect. The result of the action was to confer upon the Japanese the full command of the sea, and to enable them to prosecute the land campaign without hindrance. The surviving Chinese ships, with the exception of one which went aground near Ta-lien-wan and was destroyed, reached Port Arthur, and subsequently steamed to Wei-hai-wei.

The Japanese now determined to invade Manchuria with the army under Marshal Yamagata, and to embark a second army, consisting of the 1st division and a brigade of the 6th division with siege artillery, under Marshal Oyama, for the capture of Port Arthur, and subsequently to move up the Liao-Tung peninsula and join hands with the northern force. The Japanese crossed the Yalu on 24th and 25th of October, meeting little resistance, and successfully occupied Antung, Chin-lien-cheng, and Feng-huang. Thence on the 9th November General Tachimi, with the 5th division, advanced along the road to Mukden, and reconnoitred the Mo-tien-ling Pass on the 12th, while the 3rd division under General Oseko, operating to the south, occupied Ta-tung-kau on the 5th. By a combined attack of General Oseko's force and a battalion of infantry under Colonel Mihara moving from Fung-huang, Hsin-yen, on the route to Hai-cheng, was taken on the 18th. Leaving a garrison at Hsin-yen, General Oseko's main force returned to Ta-ku-shan. A pause in the general advance of the first army now occurred, and holding their advanced positions, the Japanese explored the country by means of reconnoitring parties.

**Port Arthur.**

The detached brigade of the second army disembarked on 24th October about 38 miles to the north-east of Ta-lien-wan, and its advanced guard occupied Pi-tzu-wo on the following day. The landing of the whole force, with its horses and stores, required twelve days. On 6th November the important town of Chin-chau was attacked and taken, and on the 7th Ta-lien-wan, with its three modern coast forts, was occupied without resistance, the fleet arriving in the bay on the same day. The Japanese were now in possession of a good harbour, where their siege train could be landed, 10 miles from Port

Arthur. Here the Chinese possessed a strongly fortified position held by about 9000 men. The attack was delivered on 21st November after a bombardment of the forts by 36 siege and 60 field and mountain guns. The resistance was contemptible, and Port Arthur was captured with a loss of only 270 killed and wounded.

Meanwhile in Manchuria the Chinese assumed the offensive. On 25th November the Japanese outpost at Tsao-ho-kau, 5 miles from the Mo-tien-ling Pass, was attacked in force. The attack was repulsed, and a flying column under Colonel Tachimi, leaving Fung-huang on the following day, reached Tsao-ho-kau by a mountain road, defeating a Chinese force in the neighbourhood. The difficulties of supplying an advanced party, which was now confronted by superior forces, caused the Japanese to withdraw from Tsao-ho-kau, and to concentrate nearer Fung-huang, towards which the Chinese moved in three columns. On 14th December the Chinese were defeated. Meanwhile on 10th December the 3rd division began its advance from Hsin-yen upon Hai-cheng, which was taken on the 13th. The Japanese now occupied a somewhat exposed position, threatened by considerable Chinese forces at Ying-kau and Liao-Yang. General Sung, advancing from the former with about 9000 men, was attacked and defeated on 19th December; but the Japanese, who had about 4500 men present, lost nearly 400, the Chinese offering a comparatively stubborn resistance. On 17th January the Liao-Yang force, estimated at 14,000 strong, appeared in front of Hai-cheng and opened an ineffective long-range fire, dispersing in disorder when the Japanese advanced against them. A similarly futile attack was made on 22nd January, the Japanese loss being trifling.

The advance of the second army northward was long delayed by difficulties of transport, aggravated by the rigours of the climate. At length, on 1st January, a brigade of infantry and a regiment of cavalry, with three batteries of artillery, started from Chin-chau under General Nogi and attacked a Chinese force strongly posted at Kai-ping on the 10th. The position was carried after three hours' fighting, with a loss of more than 300 killed and wounded, the Chinese showing some steadiness. Communication with the force occupying Hai-cheng was at once established.

The situation in Manchuria being thus secured, the Japanese proceeded to attack Wei-hai-wei, where lay the surviving vessels of the Pei-yang squadron. On 18th January a naval demonstration was made at Teng-chau, 70 miles west of Wei-hai-wei, and on the 19th the Japanese began their disembarkation at Yung-cheng Bay, about 12 miles from Wei-hai-wei. The force employed consisted of the 2nd division, newly mobilized, and a brigade from the second army, under Marshal Oyama. The Chinese made no attempt to oppose the landing, and on the 26th the troops advanced. The eastern forts were captured on the 30th, the only effective opposition being that offered by the Chinese ships, which, steaming near to the land, inflicted some loss upon the Japanese. The guns in the western defences were disabled by a landing party on 1st February, and these defences were occupied by the Japanese on the following day. On the night of 4th February the Chinese squadron in harbour was attacked by ten torpedo boats. Two boats were lost, but the armour-clad *Ting-Yuen* was sunk. On the following night a second attack was made by four boats, and the *Wei-Yuen*, *Lai-Yuen*, and a gunboat were sunk. On 9th February the *Ching-Yuen* was sunk by the guns in one of the eastern forts manned by Japanese sailors. It was now seen that the remaining vessels were at the mercy of the Japanese, and on the 12th Admiral Ting wrote to Admiral Ito offering to surrender, and then took poison, other officers following his example. On the 16th the Japanese occupied Lien-kung island, and the remnant of the Chinese squadron passed into their hands.

***Wei-hai-wei.***

While the Wei-hai-wei campaign was in progress the Chinese despatched a great peace mission to Japan, which arrived at Hiroshima on 31st January with credentials which were pronounced by Count Ito to be "fatally defective." The original draft made by the United States minister at Peking had been replaced by another of Chinese composition, and the idea of the Tsung-Li-Yamen seems to have been to ascertain the views of the Japanese Government without themselves being committed. The Japanese declined to treat in these circumstances, and the mission returned to China.

In February the Chinese made two feeble attacks on Hai-cheng which were easily repulsed, and the Japanese at Kai-ping having been reinforced, advanced along the coast road, and after occupying Tai-ping-shan dislodged a considerable Chinese force under General Sung from an entrenched position. The Chinese were now concentrated in three groups at Ying-kau, New-chwang, and Liao-Yang; and General Katsura at Hai-cheng having been reinforced, advanced on 28th February with the 3rd division, and captured New-chwang on 4th March. The Chinese suffered heavy loss. Two days later, Marshal Yamagi with the western column moved towards Ying-kau, which was occupied on 7th March, General Sung retreating across the Liao river. The Japanese forces at Ying-kau and New-chwang now combined in attacking Tien-chwang-tai, which was taken on 9th March.

The Chinese forces in Manchuria being thoroughly broken and dispersed, there was nothing to prevent the Japanese from proceeding to the occupation of Peking, since the melting of the ice which forms along the northern shores of the Gulf of Pe-chi-li would permit them to land and supply large forces at Shan-hai-kwan, within 170 miles of the capital. Negotiations were therefore opened, and Li Hung-Chang proceeded to Shimonoseki, where a treaty was signed on 17th April. The terms included the "full and complete independence and autonomy of Korea," and the cession of the southern portion of the province of Shin-king (with a frontier extending from the Yalu river to Ying-kau), of Formosa and adjacent islands, and of the Pescadores group. Article IV. fixed an indemnity of 200 millions of taels. By Article VI. four additional cities and ports were opened to Japanese trade, and rights of navigation on Chinese rivers were extended. Wei-hai-wei was to be occupied as a guarantee of performance. The cession of territory in the province of Shin-king was subsequently cancelled by the joint action of Russia, France, and Germany.

The China-Japan war presents little interest from the military point of view. The proved excellence of the Japanese organization was, however, a revelation. The operations were carried through to complete success in a most difficult country during all the severity of a northern winter. The Japanese commanders were not only able to move and supply their troops, but they showed exact knowledge of the liberties which could be taken in face of Chinese forces. No European army could have accomplished so much in so short a time. In all that relates to the despatch of troops over-sea the Japanese organization fulfilled every requirement. Their navy showed itself to be a formidable weapon of war, well capable of holding its own among the fleets of the world. Politically the main results of the war were two: 1st, the raising of Japan to the position of a great naval and military power; and, 2nd, the hastening by some years of the accomplishment of the plans of Russia for the absorption of Manchuria and the Liao-Tung peninsula. (G. S. C.)

**Chinandega,** or CHINENDEGA, capital of a department of the same name in the republic of Nicaragua, Central America, situated on the Managua railway, 18 miles N.W. of Leon and 12 E. of Corinto. It has considerable trade in cotton and sugar, and is surrounded by banana plantations. In 1849 it was the temporary capital of the three united republics of Nicaragua, Honduras, and Salvador. Population, about 12,000.

**Chindwin.**—This river, like the Irrawaddy, of which it is the largest tributary, has its entire course in Burmese territory. It is called Ningthi by the Manipuris. The Chindwin is formed by the junction of the Tanai, the Tawan, and the Tarôn or Turông, but it is still uncertain which is the main stream. The Tanai has hitherto been looked on as the chief source. It rises in about 25° 30′ N. lat. and 97° E. long., on the Shwedaung-gyi peak of the Kumôn range, 12 miles N. of Mogaung, and flows due north for the first part of its course until it reaches the Hukawng valley, when it turns to the west and flows through the middle of the plain to the end of the valley proper. There it curves round to the south, passes through the Tarôn or Turông valley, takes the name of the Chindwin, and maintains a general southerly course until it enters the Irrawaddy, after flowing through the entire length of the Upper and Lower Chindwin districts, in about 21° 30′ N. lat. and 95° 15′ E. long. Its extreme outlets are 22 miles apart, the interval forming a succession of long, low, partially populated islands. The most southerly mouth of the Chindwin is, according to tradition, an artificial channel, cut by one of the kings of Pagān. It was choked up for many centuries until in 1824 it was opened out by an exceptional flood. The Tanai (it is frequently called Tanaikha, but *kha* is merely the Kachin

word for river), as long as it retains that name, is a swift, clear river, from 50 to 300 yards wide and from 3 to 15 feet deep. In the Hukawng valley it has steep banks, fringed to a depth of a mile or more inland with wild plantain-trees. The river is navigated by native boats in the Hukawng valley, but launches cannot come up from the Chindwin proper because of the reefs below Taro. The earlier tributaries are on the right bank; they are the Tabye, the Tawan, and the Turông or Tarôn. The Tawan, at its junction with the Tanai, close to the Mashi ferry, measures about 400 yards from bank to bank, and the breadth of the actual stream in the dry weather is 150 yards. It probably flows from the range which forms the south-west boundary of Hkamti Lông, whose peaks are snow-covered during the dry season. The Tarôn, Turông, or Towang river seems to be the real main source of the Chindwin. It flows into the Hukawng valley from the north, and has a swift current with a succession of rapids. At Ningpyen it is 300 to 400 yards wide, and has well-defined banks. Its sources are in the hills to the south of Sadiya, rising from 10,000 to 11,000 feet above sea-level. For the first portion of its course the river flows through a deep valley, with a general east and west direction, as far as its junction with the Loglai. It then turns south, and after draining an intricate system of hills, breaks into the Hukawng valley a few miles to the north of Saraw, and joins or receives the Tanai about 10 miles above Kintaw village. Except the Tanai, the chief branches of the Upper Chindwin rise in mountains that are covered at least with winter snows. Below the Hukawng valley the Chindwin is interrupted at several places by falls or transverse reefs. At the village of Haksa there is a fall, which necessitates transhipment from the large boats which ply below to canoes. Not far below this the Uyu river comes in on the left bank at Homalin, and from this point downwards the steamers of the Irrawaddy Flotilla Company ply for the greater part of the year. The Uyu flows through a fertile and well-cultivated valley, and during the rainy season it is navigable for a distance of 150 miles from its mouth by steamers of light draught. Ordinarily regular steam communication with Homalin ceases in the dry weather, but from Kindat, nearly 150 miles below it, there are regular weekly steamers all the year round. Below Kindat the only considerable affluent of the Chindwin is the Myit-tha, which receives the Chin hills drainage. As far as Mingin the general course of the Chindwin is south-westerly; below that town it curves eastwards towards the Irrawaddy. The Chindwin rises very considerably during the rains, but in March and April it is here and there so shallow as to make navigation difficult even for small steam launches. Whirlpools and narrows and shifting sandbanks also give some trouble, but much has been done to improve navigation since the British annexation. (J. G. Sc.)

**Chindwin,** Upper and Lower, two districts in the Sagaing division of Upper Burma. Upper Chindwin has an area of 19,062 square miles, and a population, according to the census of 1891, of 111,533, living in 980 villages, and paying in 1898-99 a revenue of Rs.3,22,057. Lower Chindwin has an area of 3481 square miles, and a population of 233,316 living in 893 villages, and paying in 1898-99 a revenue of Rs.5,53,982. Upper Chindwin lies to the north of the lower district, and is bounded on the N. by the Chin Naga and Kachin hills; on the E. they are bounded by the Myit Kyina, Katha, and Shwebo districts; Lower Chindwin is bounded on the S. by the Pakôkku and Sagaing districts; and both districts are bounded on the W. by the Chin hills, and by Pakôkku on the southern stretch. The chief flat country is along the banks of the Chindwin river, which runs through the centre of both districts, and the plain to the east of the river in Lower Chindwin is very extensive and fertile. The western portion of both districts is hilly, and the greater part of Upper Chindwin is of the same character. In Upper Chindwin, out of 12,199,680 acres, only 112,388 were cultivated in 1899; in Lower Chindwin 296,326 acres out of a total of 2,227,584. In Upper Chindwin 1,640,823 acres more were available, and 541,085 acres in the lower district. Both have valuable teak forests. The area of forest land in Lower Chindwin is 301,440 acres, and in the upper district 1,085,120 acres. The area of reserved forest is yearly being extended. In 1898 there were 471 square miles of reserved tracts in Lower Chindwin. The total rainfall in 1898-99 was in Lower Chindwin 27·96 inches, and in Upper Chindwin 60·94. Both registered a highest temperature in May of 106° F., and the lowest reading in December was 54° at Mônywa, and 52° at Kinday in Upper Chindwin. In Lower Chindwin the population was made up of 232,158 Buddhists and Jains, 426 Mahommedans, 374 Hindus, 320 Chins and other hill races, and 38 Christians. In Upper Chindwin there were 108,816 Buddhists and Jains, 1112 Hindus, 1048 Chins and other hill races, 481 Mahommedans, and 76 Christians. Coal exists in extensive fields, but these are not very accessible. Rice forms the great crop, but a certain amount of til-seed and of indigo is also cultivated. Kinday, with a population of 2423, is the headquarters of the upper district, and Mônywa, with a population of 6316, of the lower. Both are on the Chindwin river, and are served by the steamers of the Irrawaddy Flotilla Company. Alôn, close to Mônywa, and formerly the headquarters, is the terminus of the railway from Sagaing westwards, which was opened in 1900. (J. G. Sc.)

**Chingleput,** or Chengalpat, a town and district of British India, in the Madras Presidency. The town, situated 36 miles by rail from Madras, had a population in 1881 of 5617; in 1891 of 9763. It has two high schools. The district of Chingleput surrounds the city of Madras, stretching along the coast for about 115 miles. The administrative headquarters are at Saidapet. It contains an area of 2842 square miles and a population in 1891 of 1,136,928, being 400 persons per square mile. In 1901 the population was 1,312,722, showing an increase of 9 per cent. The land revenue and rates were Rs.20,07,908, the incidence of assessment being Rs.2:2:6 per acre; the number of police was 735. In 1897-98, out of a total cultivated area of 659,898 acres, 419,298 were irrigated. Salt is extensively manufactured all along the coast. Cotton-weaving is also largely carried on. There are 574 indigo vats, with an out-turn valued at Rs.2,00,000; 83 tanneries, with an out-turn valued at Rs.29,00,000; and an English cigar factory. In 1896-97 the number of schools was 1047, attended by 29,291 pupils.

**Chinkiang,** or Chin-Keang-fu, a treaty port in China, situated on the river Yangtse above Shanghai, from which it is distant 160 miles. It is a place of considerable importance as a distributing centre, but has no direct trade with foreign countries. It lies at the point where the Grand Canal running north and south intersects the Yangtse, which runs east and west, and thus is peculiarly well situated to be a commercial entrepôt. Its trade, however, lies mainly with the north bank, where the Grand Canal is navigable for vessels drawing 8 to 10 feet of water. On the south bank the canal has been allowed to silt up so as to be impassable during the winter months. Railway communication with Shanghai on the one hand and with Nanking on the other will no doubt improve its prospects. Chinkiang is also the proposed terminus of the

Anglo-German railway to be built from Tientsin southwards through Shantung. The total value of exports and imports for 1899 was H. taels 25,691,000 (£3,854,000). In 1880 the total was H. taels 14,297,000 (£3,932,000). Chinkiang was the seat of a serious riot on the 5th February 1898, when the British consulate and several foreign houses were burned down by a native mob. The population is estimated at 240,000. The number of foreign residents is very small, the trade being almost entirely in the hands of natives.

**Chippenham,** a municipal borough and market town in the Chippenham parliamentary division (since 1885) of Wiltshire, England, on the Avon, 13 miles N.E. of Bath by rail. Works for milk-condensing, bacon-curing, and making railway signals, guns, and carriages have been established. Area, 359 acres; population (1881), 4495; (1901), 5074.

**Chippewa Falls,** capital of Chippewa county, Wisconsin, U.S.A., situated in 44° 45′ N. lat. and 91° 23′ W. long., in the north-western part of the state, on the Chippewa river, at an altitude of 831 feet. It is at the intersection of three railways, and possesses a fine water-power, which has given rise to extensive manufactures, largely of lumber. Population (1880), 3982; (1890), 8670; (1900), 8094, of whom 2357 were foreign-born.

**Chishima,** the Japanese term (literally "a thousand islands") for the Kuriles (*q.v.*).

**Chitral.**—The state of Chitral (see also HINDU KUSH) is somewhat larger than Wales, and supports a population of between 70,000 and 80,000 rough, hardy hillmen. Both the state and its capital are called Chitral, the latter being situated about 47 miles from the main watershed of the range of the Hindu Kush, which divides the waters flowing down to India from those which take their way into the Oxus and on to Turkestan and Central Asia. Chitral is an important state because of its situation at the extremity of the country over which the Government of India exerts its influence, and for some years before 1895 it had been the object of the policy of the Government of India to control the external affairs of Chitral in a direction friendly to British interests, to secure an effective guardianship over its northern passes, and to keep watch over what goes on beyond these passes. This policy resulted in a British agency being established at Gilgit (Kashmir territory), with a subordinate agency in Chitral, the latter being usually stationed at Mastang (65 miles nearer to Gilgit than the Chitral capital), and occasional visits being paid to the capital.

In December 1894 Surgeon-Major Robertson, C.S.I. (India Medical Service)—afterwards Sir George Robertson, K.C.S.I.—the British agent, was at Gilgit; and his assistant, Lieutenant Gurdon, with ten men of his escort, was staying on a visit to the Chitral capital, the remainder of his escort of 100 men remaining at Mastang. On the 1st January 1895 the Mihtar (or Ruler) of Chitral was treacherously murdered at the secret instigation of Sher Afzul, who himself was an ex-Mihtar, and had been dethroned by a stronger party in the state and forced to fly for refuge to Cabul. His chief ally was Umra Khan, chieftain of Jhandol, whose restless ambition, not satisfied with numerous small conquests and increases of territory, had long been set on the Mihtarship of Chitral. For the time being, however, he posed as an ally of Sher Afzul; but without waiting for the latter's arrival from Cabul, he himself, on hearing of the Mihtar's murder, hastened with his forces to seize Chitral. He met with some success, capturing Killa Dresh, 25 miles to the south of Chitral Fort; but here he was opposed and beaten by the Chitralis themselves. At this juncture he was joined by Sher Afzul, who quickly won over the Chitralis; and the two forces amalgamated and made common cause against the British, whose presence at Chitral was considered likely to interfere with the return of Sher Afzul to the throne. The combined force at once marched to attack Chitral Fort.

On hearing of the Mihtar's assassination, Lieutenant Gurdon at Chitral immediately informed Dr Robertson at Gilgit, and with great discretion avoided all collision with the new Mihtar (the assassin Amir-ul-Mulk). Gurdon was soon reinforced by 50 men from his headquarters at Mastang, and on the 1st February Dr Robertson himself arrived from Gilgit and assumed political charge. The situation remained unchanged until Umra Khan, marching on Chitral, captured Killa Dresh; and on Sher Afzul joining him, a joint letter was sent to Dr Robertson, ordering his immediate withdrawal to Mastang. The demand was ignored, and in their turn the Government of India ordered Umra Khan to withdraw to his own territory. As he refused, the Government of India prepared for war; and, abandoning the route through Gilgit and over the snow-bound passes as impracticable, they decided on an advance from Nowshera (British India), less than 200 miles from Chitral, through Swat and Jhandol (Umra Khan's state). Major-General Sir R. Low was selected to command this relieving force, and on the 1st April an army of some 15,000 men was concentrated beyond Nowshera at Hoti-Mardan on the frontier. On 3rd April Sir R. Low stormed the Malakand Pass, and won a decisive victory over the Swatis, who had been induced by Umra Khan to oppose the British. The position was considered impregnable by the enemy, but was carried with great gallantry. After this victory the force pushed on into Swat, and a few days later crossed the Swat river in the teeth of a stubborn resistance and continued the forward march.

Dr Robertson, on arrival at Chitral, determined to try to open up communication with Gilgit and Mastang. Accordingly, he despatched Lieutenants Fowler and Edwardes with a small party for this purpose. After two marches they were attacked by the enemy, but managed to send word on to Mastang. A Mastang party under Captain Ross advanced to relieve them, but was in its turn attacked by overwhelming numbers, and eventually had to cut its way back, losing Captain Ross and 54 men killed. Fowler and Edwardes held out for a week with magnificent bravery, but eventually were, through treachery, overwhelmed and captured. Mastang itself was now besieged, and Chitral completely cut off. The garrison of the former place made a gallant defence, and were able to hold out until relieved by Colonel Kelly, whose march will be presently described

Sir R. Low's force had pushed forward to the Paingkua river, and on the 13th April Lieutenant Edwardes was released by Umra Khan and sent into the British camp. The same day a third successful battle was fought, and on the 16th the force crossed the river, finally defeated the enemy, and pushed on towards Chitral. A few days later Lieutenant Fowler also was sent in by Umra Khan, who had brought these officers down with him from Chitral, and hoped by releasing them to prevent the invasion of his country. But this was not General Low's view of the matter, and on the 18th inst. his force occupied Umra Khan's deserted stronghold in Jhandol, the latter fleeing with his family and treasure towards Cabul. He was not overtaken, and remained at Cabul a refugee.

Meantime the siege of Chitral had begun, and was being prosecuted with the utmost vigour by Sher Afzul, Umra Khan having proceeded south to oppose Sir R. Low. The defence of Chitral will always be counted among the finest exhibitions of British pluck. The garrison numbered only 543, of whom 137 were non-combatants. On the first day of the siege a reconnaissance by the garrison was repulsed with heavy loss, Captain Baird and 24 men being killed. This engagement was the hardest fought during the whole war. The military command was in the hands of Captain Townshend, to whose skill, energy, and valour the successful resistance of the garrison was practically due; Dr Robertson, though ranking himself as a non-combatant, assisting most gallantly in the perilous duties of the defence, in the performance of which he was severely wounded. The siege lasted 46 days. One of its most brilliant features was a sortie by Lieutenant Harley to destroy the besiegers' mines on the 17th April.

The relief of Chitral was at last accomplished by Colonel Kelly. This officer, with his regiment, the 32nd Pioneers, was at this time employed at road-making in the Gilgit district. On the 22nd March (the siege of Chitral having begun on the 4th) Colonel Kelly was ordered by the Government of India to assume military command of all the troops under the Gilgit agency. He was made acquainted with what had taken place at Chitral, and was given practically a free hand to make such dispositions and movements of the troops under his command as he considered necessary. He immediately decided to march over the snow passes on a relief expedition, in spite of the fact that this route had been considered impracticable by the Government of India and the road through Swat, Jhandol, and Dir decided on. The troops at Colonel Kelly's disposal were entirely native troops, consisting of 400 men of the 32nd Pioneers, with 2 mountain guns, 40 sappers and miners, and some 150 ragged and undisciplined levies from the wilds of surrounding native states. With this small force he had to march through 220 miles of hostile country yielding scarcely any supplies; and above all, he had to cross the terrible Shandur Pass, 12,230 feet high, at this time covered with deep snow. In the face of all

these difficulties Colonel Kelly set out on the 23rd March, the day after receiving his orders. Marching rapidly, the little force successfully crossed the Shandur Pass on the 28th March. On the 9th April Colonel Kelly fought and defeated the Chitralis, and on the same day relieved the garrison of Mastang. On the 13th April Colonel Kelly again fought a successful action at Nisa Gol. The enemy having now been dispersed, the road to Chitral was left clear, and on the 20th April the gallant little force relieved Chitral Fort without opposition from Sher Afzul and his followers, who had fled during the previous night. General Low's army was then at Umra Khan's stronghold, and no news arriving of the relief by Colonel Kelly, one lightly-equipped brigade under General Gatacre was pushed on towards Chitral. On 1st May they crossed the Lewarai Pass (10,000 feet high) over deep snow. Here they halted, as all opposition was over. Colonel Kelly's force soon returned to Gilgit, but Sir Robert Low's troops held the line from Nowshera to Chitral for six months while the future policy was being arranged. At one time during the occupation the force had actually received orders to evacuate the whole country; but before this was commenced a change of Government occurred in England, and the new Cabinet immediately reversed the orders of their predecessors. Eventually the force was withdrawn during September and October 1895, a brigade being left at Killa Dresh. This was to be relieved every two years. The Khan of Dir (to whom were returned the lands seized by Umra Khan) and the Khan of Nawayai were subsidized to keep the road in repair and to ensure the safety of the biennial reliefs to and from Killa Dresh. Umra Khan was not permitted to return to his country. Sher Afzul, finding resistance hopeless, surrendered with his force. He and twenty of his chief men, with the assassin Amir-ul-Mulk, were sent to India to remain perpetually domiciled at Dharmsala, a hill-station in the Himalayas. (C. J. B.)

**Chittagong,** a seaport of British India, giving its name to a district and a division of Bengal. It is situated on the right bank of the Karnaphuli river, about 12 miles from its mouth. It is the terminus of the Assam-Bengal railway. The municipal area covers about 9 square miles; population (1881), 20,969; (1891), 24,069. Chittagong is the second seaport of Bengal. In 1897-98 the sea-borne exports were valued at Rs.1,12,63,036, of which more than half was jute, other items being tea, raw cotton, rice, and hides. There is also a large trade by country boats, which brought imports in 1897-98 valued at Rs.33,87,915, chiefly cotton, rice, spices, sugar, and tobacco. There is one rice-husking mill, employing 65 persons, with an out-turn valued at Rs.1,50,000. There are a Government college, a law class, a high school, and two Roman Catholic convent schools. Two of the five printing-presses issue vernacular newspapers.

The district of CHITTAGONG is situated at the north-east corner of Bengal, occupying a strip of coast and hills between the sea and the mountains of Burma. Its area (excluding the Chittagong Hill Tracts) is 2563 square miles. The population in 1891 was 1,290,167, giving an average density of 503 persons per square mile. Classified according to religion, Hindus numbered 302,333; Mahommedans, 924,849; Buddhists (from Arakan), 61,615; Christians, 1191, of whom 256 were Europeans; "others," 179. In 1901 the population was 1,352,722, showing an increase of 5 per cent. The land revenue and rates are Rs.10,16,834; the number of police is 497; the death-rate in 1897 was 49·46. This high mortality was partly due to the destructive cyclone of October. In 1896-97 the number of boys at school was 56,593, being 62 per cent. of the male population of school-going age. The northern portion of the district is traversed by the Assam-Bengal railway. Tea cultivation is moderately successful. In 1897-98 there were 23 gardens, with 4025 acres under tea, employing permanently 3556 persons and producing more than two million lb. The Chittagong forests yielded in 1897-98 a gross revenue of Rs.77,406.

The CHITTAGONG HILL TRACTS, formerly an independent district, have been reduced to the status of a subdivision. They occupy the ranges between Chittagong proper and the south Lushai hills. The area covers 5419 square miles. In 1891 the population was 107,286, giving an average density of 20 persons per square mile. In 1901 the population was 124,851, showing an increase of 16 per cent. The inhabitants, who are either Arakanese or aboriginal tribes, are almost all Buddhists. The headquarters are at Rangamati (population, 2336), which was entirely wrecked by the cyclone of October 1897. There is one tea garden with 100 acres under tea, employing 120 persons and producing 27,000 lb.

The division of CHITTAGONG lies at the north-east corner of the Bay of Bengal, extending northward along the left bank of the Meghna. It consists of the three districts of Chittagong (including the Hill Tracts), Noakhali, and Tipperah. Its area covers 12,118 square miles; the population in 1891 was 4,190,081, giving an average density of 345 persons per square mile.

**Chittore,** a town of British India, in the North Arcot district of Madras, situated in 13° 13′ N. lat. and 79° 8′ E. long.; station on the South Indian railway. Population (1881), 5809; (1891), 9965. Formerly a military cantonment, it is now only the civil headquarters of the district. It has an English church, mission chapel, and Roman Catholic chapel, a high school, two printing-presses, and several literary institutes.

**Chitty, Sir Joseph William** (1828-1899), English judge, was born in London in 1828. He was the second son of Mr Thomas Chitty (himself son and brother of well-known lawyers), a celebrated special pleader and writer of legal text-books, in whose pupil-room Earl Cairns, Lord O'Hagan, Chief Justice Whiteside, Mr Justice Willes, Mr Justice Quain, Sir James Hannen, and many other distinguished lawyers began their legal education. Joseph Chitty was educated at Eton and Balliol, Oxford, gaining a first-class in 1851, in the old honour school of *Literæ Humaniores*, and being afterwards elected to a fellowship at Exeter College. His principal distinctions during his school and college career had been earned in athletics, and he came to London as a man who had stroked the Oxford boat and captained the Oxford cricket eleven, besides bearing a well-known legal name and being possessed of first-class abilities. In these circumstances he had little difficulty in making his mark. He became a member of Lincoln's Inn in 1851, was called to the bar in 1856, and made a queen's counsel in 1874, electing to practise as such in the court in which Sir George Jessel, Master of the Rolls, presided. Chitty was highly successful in his method of dealing with a very masterful if exceedingly able judge, and soon gained the reputation of having the ear of the court to such an extent that his practice became very large, his fees being stated to have amounted at one time to £13,000 a year, a large sum for one not a law officer of the Crown. In 1880 he entered the House of Commons, being returned as Liberal member for Oxford (city) at the general election of that year. His parliamentary career was short, for in 1881 the Judicature Act required that the Master of the Rolls should cease to sit regularly as a judge of first instance, and Chitty was selected to fill the vacancy thus created in the Chancery division. It was remarked that two other judges during the century, Lord Hatherley and Sir William Erle, had represented Oxford in Parliament. Sir Joseph Chitty was for sixteen years a popular judge, in the best meaning of the phrase, being noted for his courtesy, geniality, patience, and scrupulous fairness, as well as for his legal attainments, and being much respected and liked by those practising before him, in spite of a habit of interrupting counsel, possibly acquired through the example of Sir George Jessel—a habit which in the case of Mr Justice Chitty did not accelerate the despatch of business as it did with his predecessor, but which no doubt was inspired, as a rule, by his desire to appreciate every detail of the case before him. His ready ejaculation "*Fiat justitia ruat cœlum,*" when a piece of the ceiling of his court fell while he was on the bench, is deserving of record. He remained a puisne judge until 1897, when, on the retirement of Sir Edward Kay, L.J., he was promoted to the Court of Appeal. There he more than sustained—in fact, he appreciably increased—his reputation as a lawyer and a judge, proving himself to possess considerable knowledge of the common law as well as of equity, during the short time which elapsed before

his death. He died in London on 15th February 1899, after a very short illness, originating in an attack of the prevailing epidemic of influenza.

Many legal contemporaries of Sir Joseph Chitty had been distinguished athletes while young. Lord Esher, M.R., Lord Justice A. L. Smith, Mr Justice Denman, and Lord Macnaghten may be mentioned as instances of university oars who were on the bench while he was a judge, while Sir Richard Webster (afterwards Lord Alverstone, L.C.J.) and Sir R. T. Reid, both law officers of the Crown, had been "blues" for running and cricket respectively. During four seasons Chitty kept wicket for the Eton eleven, of which he was captain in 1847 (he was afterwards held to be the best amateur wicket-keeper in England), and in those four years Eton won seven matches out of the eight played against Harrow and Winchester. At Oxford he played at cricket against Cambridge in 1848 and 1849, and won still greater fame on the river. He rowed 2 in the Oxford eight in the inter-university boat-race of March 1849, and 4 in the second of the two races rowed in that year. No inter-university race as such took place in 1850 or 1851, but in the latter year Oxford with Chitty stroke won the Grand Challenge Cup at Henley, Cambridge being a competitor; and in 1852 the inter-university race was again held, and Chitty stroked a strong Oxford crew to victory. In after life he acted as umpire in the inter-university boat-race for twenty-four years, ceasing to do so in 1881, and he was an active member of the Inns of Court Rifle Volunteers (the Devil's Own), holding a major's commission from 1869 to 1877, having been one of those who organized it in 1860, and having then been given a commission as a captain. In a profession largely filled by university men such a record was not likely to be forgotten. Sir Joseph Chitty married in 1858 Clara Jessie, daughter of Chief Baron Pollock, and left children who can thus claim descent from two of the best-known legal families of the 19th century.

AUTHORITIES.—*The Times*, 16th February 1899.—*Law Journal*, 18th February 1899.—*Law Times*, 18th February 1899.—*Law Quarterly*, vol. xv. p. 128.—*Law Magazine*, vol. xxv. p. 257. (E. A. AR.)

**Choisy-le-Roi,** a town in the arrondissement of Sceaux, department of Seine, France, 4 miles in direct line S.E. of Paris, on the left bank of the Seine and on the railway to Orleans. A monument was erected in 1882 to Rouget de l'Isle, author of the "Marseillaise," who died here 1836. It has manufactures of cloth, felt, gloves, earthenware, porcelain, and glass, and considerable river trade. Population (1881), 6700; (1901), 11,287.

**Cholera.**—Much light has been thrown upon Asiatic cholera since 1880. Western experience has been enlarged by several epidemic outbreaks in different countries, and by one pandemic visitation of great violence; and the study of the disease by modern methods has resulted in important additions to our previous knowledge of its nature, causation, mode of dissemination, and prevention.

*Causation.*

The cause is a micro-organism identified by Koch in 1883. An account of it will be found under PATHOLOGY (*Parasitic Diseases*). For some years it was called the "comma bacillus," from its supposed resemblance in shape to a comma, but it was subsequently found to be a vibrio or spirillum, not a bacillus. The discovery was received with much scepticism in some quarters, and the claim of Koch's vibrio to be the true cause of cholera was long disputed, but is now universally acknowledged. Few micro-organisms have been more elaborately investigated, but very little is known of its natural history, and its epidemiological behaviour is still surrounded by obscurity. At an important discussion on the subject, held at the International Hygienic Congress in 1894, Professor Gruber of Vienna declared that the deeper investigators went the more difficult the problem became, while M. Metschnikoff of the Pasteur Institute made a similar admission. The difficulty lies chiefly in the variable characters assumed by the organism and the variable effects produced by it. The type reached by cultivation through a few generations may differ so widely from the original in appearance and behaviour as to be hardly recognizable, while, on the other hand, of two organisms apparently indistinguishable one may be innocuous and the other give rise to the most violent cholera. This variability offers a possible explanation of the frequent failure to trace the origin of epidemic outbreaks in isolated places. It is commonly assumed that the micro-organism is of a specific character, and always introduced from without, when cholera appears in countries or places where it is not endemic. In some cases such introduction can be proved, and in others it can be inferred with a high degree of probability, but sometimes it is impossible to trace the origin to any possible channel of communication. A remarkable case of this kind occurred at the Nietleben Lunatic Asylum near Halle, in 1893, in the shape of a sudden, explosive, and isolated outbreak of true Asiatic cholera. It was entirely confined to the institution, and the peculiar circumstances enabled a very exact investigation to be made. The facts led Professor Arndt, of Greifswald, to propound a novel and interesting theory. No cholera existed in the surrounding district and no introduction could be traced, but for several months in the previous autumn diarrhœa had prevailed in the asylum. The sewage from the establishment was disposed of on a farm, and the effluent passed into the river Saale above the intake of the water-supply for the asylum. Thus a circulation of morbid material through the persons of the inmates was established. Dr Arndt's theory was that by virtue of this circulation cholera was gradually developed from previously existing intestinal disease of an allied but milder type. The outbreak occurred in winter, and coincided with the freezing of the filter-beds at the water-works. The theory is worth notice, because a similar relation between the drainage and the water-supply frequently exists in places severely attacked by cholera, and it has repeatedly been observed that the latter is preceded by the prevalence of a milder form of intestinal disease. The inference is not that cholera can be developed *de novo*, but that the type is unstable, and that a virulent form may be evolved under favourable conditions from another so mild as to be unrecognized, and consequently undetected in its origin or introduction. This is quite in keeping with the observed variability of the micro-organism, and with the trend of modern research with regard to the relations between other pathogenic germs and the multifarious gradations of type assumed by other zymotic diseases. The same thing has been suggested of diphtheria.

*Epidemicity.*

Cholera is endemic in the East over a wide area, ranging from Bombay to Southern China, but its chief home is British India. It principally affects the alluvial soil near the mouths of the great rivers, and more particularly the delta of the Ganges. Lower Bengal is pre-eminently the standing focus and centre of diffusion. In some years it is quiescent, though never absent; in others it becomes diffused, for reasons of which nothing is known, and its diffusive activity varies greatly from equally inscrutable causes. At irregular intervals this property becomes so heightened that the disease passes its natural boundaries and is carried east, north, and west, it may be to Europe or beyond to the American continent. We must assume

that the micro-organism, like those of other epidemic diseases, acquires greater vitality and toxic energy, or greater power of reproduction at some times than at others, but the conditions that govern this behaviour are quite unknown, though no problem has a more important bearing on public health. Bacteriology, as already intimated, has thrown no light upon it, nor has meteorology. Some results of modern research, indeed, tend to assign increasing importance to the relations between surface soil and certain micro-organisms, and suggest that changes in the level of the subsoil water, to which Pettenkofer long ago drew attention, may be a dominant factor in determining the latency or activity of pathogenic germs. But this is largely a matter of conjecture, and, so far as cholera is concerned, the conditions which turn an endemic into an epidemic diease must be admitted to be still unknown.

On the other hand, the mode of dissemination is now well understood. Diffusion takes place along the lines of human intercourse. The poison is carried chiefly by infected persons moving from place to place; but soiled clothes, rags, and other articles that have come into contact with persons suffering from the disease may be the means of conveyance to a distance. There is no reason to suppose that it is air-borne, or that atmospheric influences have anything to do with its spread, except in so far as meteorological conditions may be favourable to the growth and activity of the micro-organisms. Beyond all doubt, the great manufactory of the poison is the human body, and the discharges from it are the great source of contagion. They may infect the ground, the water, or the immediate surroundings of the patient, and so pass from hand to hand, the poison finding entrance into the bodies of the healthy by means of food and drink which have become contaminated in various ways. Flies which feed upon excreta and other foul matters may be carriers of contagion. Of all the means of local dissemination, contaminated water is by far the most important, because it affects the greatest number of people, and this is particularly the case in places which have a public water-supply. A single contaminated source may expose the entire population to danger. All severe outbreaks of an explosive character are due to this cause. It is also possible that the cholera poison multiplies rapidly in water under favourable conditions, and that a reservoir, for instance, may form a sort of forcing-bed. But it would be a mistake to regard cholera as purely a water-borne disease, even locally. It may infect the soil in localities which have a perfectly pure water-supply, but have defective drainage or no drainage at all, and then it will be found more difficult to get rid of, though less formidable in its effects, than when the water alone is the source of mischief. In all these respects it has a great affinity to enteric fever. With regard to locality, no situation can be said to be free from attack if the disease is introduced and the sanitary conditions are bad; but, speaking generally, low-lying places on alluvial soil near rivers are more liable than those standing high or on a rocky foundation. Of meteorological conditions it can only be said with certainty that a high temperature favours the development of cholera, though a low one does not prevent it. In temperate climates the summer months, and particularly August and September, are the season of its greatest activity.

***Western diffusion.***

Cholera spreads westwards from India by two routes—(1) by sea to the shores of the Red Sea, Egypt, and the Mediterranean; and (2) by land to Northern India and Afghanistan, thence to Persia and Central Asia, and so to Russia. In the great invasions of Europe during the 19th century it sometimes followed one route and sometimes the other. Four such invasions are mentioned in the article in the ninth edition of the *Encyclopædia*—those of 1830-39, 1847-49, 1853-54, and 1865-67—but by some writers the epidemic of 1853 is regarded as a recrudescence of that of 1847. The earlier ones followed the land route by way of Afghanistan and Persia, and took several years to reach Europe. That of 1865 travelled more rapidly, being carried from Bombay by sea to Mecca, from there to Suez and Alexandria, and then on to various Mediterranean ports. Within the year it had not only spread extensively in Europe, but had reached the West Indies. In 1866 it invaded England and the United States, but during the following year it died down in the West. The subsequent history of cholera in Europe may be stated chronologically.

1869-74.—This invasion was traced to the great gathering of pilgrims at Hardwar on the Upper Ganges in the month of April 1867. From there the returning pilgrims carried it to the Punjab, Cashmere, and Afghanistan, whence it spread to Persia and the Caspian, but it did not reach Russia until 1869. During the next four years a number of outbreaks occurred in Central Europe, and notably one at Munich in the winter of 1873. The irregular character of these epidemics suggests that they were rather survivals from the pandemic wave of 1867 than fresh importations, but there is no doubt that cholera was carried overland into Russia in the manner described.

1883-87.—This visitation, again, came by the Mediterranean. In 1883 a severe outbreak occurred in Egypt, causing a mortality of above 25,000. Its origin remained unknown. During this epidemic Koch discovered the comma bacillus. The following year cholera appeared at Toulon. It was said to have been brought in a troopship from Saigon in Cochin China, but it may have been connected with the Egyptian epidemic. A severe outbreak followed and reached Italy, nearly 8000 persons dying in Naples alone. In 1885 the south of France, Italy, Sicily, and Spain all suffered, especially the last, where nearly 120,000 deaths occurred. Portugal escaped, and the authorities there attributed their good fortune to the institution of a military cordon, in which they have had implicit confidence ever since. In 1886 the same countries suffered again, and also Austria-Hungary. From Italy the disease was carried to South America, and even travelled as far as Chile, where it had previously been unknown. In 1887 it still lingered in the Mediterranean, causing great mortality in Messina especially. According to Dr Wall, this epidemic cost 250,000 lives in Europe and at least 50,000 in America. A particular interest attaches to it in the fact that a localized revival of the disease was caused in Spain in 1890 by the disturbance of the graves of some of the victims who had died of cholera four years previously.

1892-95.—This great invasion reverted again to the old overland route, but the march of the disease was of unprecedented rapidity. Within less than five months it travelled from the North-West Provinces of India to St Petersburg, and probably to Hamburg, and thence in a few days to England and the United States. This speed, in such striking contrast to the slow advance of former occasions, was attributed, and no doubt rightly, to improved steam transit, and particularly the Transcaspian railway. The progress of the disease was traced from place to place, and almost from day to day, with great precision, showing how it moves along the chief highways and is obviously carried by man. The main facts are as follows:—Cholera was extensively and severely prevalent in India in 1891, causing 601,603 deaths, the highest mortality since 1877. In March 1892 it broke out at the Hardwar fair, a day or two before the pilgrims dispersed; on 19th April it was at Kabul, on 1st May at Herat, and 26th May at Meshed. From Meshed it moved in

three directions—due west to Tehran in Persia, north-east by the Transcaspian railway to Samarkand in Central Asia, and north-west, by the same line in the opposite direction, to Uzun-ada on the Caspian Sea. It reached Uzun-ada on 6th June; crossed to Baku, 18th June; Astrakhan, 24th June; then up the Volga to Nijni Novgorod, arriving at Moscow and St Petersburg early in August. The part played by steam transit is clear from the fact that the disease took no longer to travel all the way from Meshed to St Petersburg by rail and steamboat than to traverse the short distance from Meshed to Tehran by road. On 16th August cases began to occur in Hamburg; on 19th August a fireman was taken ill at Grangemouth in Scotland, where he had arrived the day before from Hamburg; and on 31st August a vessel reached New York from the same port with cholera on board. On 8th September the disease appeared in Galicia, having moved somewhat slowly westwards across Russia into Poland, and on 26th September it was in Budapest. Holland and Servia were also attacked, while isolated cases were carried to Norway, Denmark, and Italy. Meanwhile two entirely separate epidemics were in progress elsewhere. The first was confined to Arabia and the Somali coast of Africa, and was connected with the remains of an outbreak in Syria and Arabia in 1890-91. The second arose mysteriously in France about the time when the overland invasion started from India. The first known case occurred in the prison at Nanterre, near Paris, on 31st March. Paris was affected in April, and Havre in July. The origin of this outbreak, which was of a much less violent character than that which came simultaneously by way of Russia, was never ascertained. Its activity was confined to France, particularly in the neighbourhood of Paris, together with Belgium and Holland, which was placed between two fires, but escaped with but little mortality. The number of persons killed by cholera in 1892, outside of India, was reckoned at 378,449, and the vast majority of those died within six months. The countries which suffered most severely were as follows:—European Russia, 151,626; Caucasus, 69,423; Central Asian Russia, 31,804; Siberia, 15,037—total for Russian empire, 267,890; Persia, 63,982; Somaliland, 10,000; Afghanistan, 7000; Germany, 9563; France, 4550; Hungary, 1255; Belgium, 961. Curiously enough, the south of Europe, which had been the scene of the previous epidemic visitation, escaped. The disease was of the most virulent character. In European Russia the mortality was 45·8 per cent. of the cases, the highest rate ever known in that country; in Germany it was 51·3 per cent.; and in Austria-Hungary, 57·5 per cent. Of all the localities attacked, the case of Hamburg was the most remarkable. The presence of cholera was first suspected on 16th August, when two cases occurred, but it was not officially declared until 23rd August. By that time the daily number of victims had already risen to some hundreds, while the experts and authorities were making up their minds whether they had cholera to deal with or not. Their decision eventually came too late and was superfluous, for by 27th August the people were being stricken down at the rate of 1000 a day. This rate was maintained for four days, after which the vehemence of the pestilence began to abate. It gradually declined, and ceased on 14th November. During those three months 16,956 persons were attacked and 8605 died, the majority within the space of a few weeks. The town, ordinarily one of the gayest places of business and pleasure on the Continent, became a city of the dead. Thousands of persons fled, carrying the disease into all parts of Germany; the rest shut themselves indoors; the shops were closed, the trams ceased to run, the hotels and restaurants were deserted, and few vehicles or pedestrians were seen in the streets. At the cemetery, which lies about 10 miles from the town, some hundreds of men were engaged day and night digging long trenches to hold double rows of coffins, while the funerals formed an almost continuous procession along the roads; even so the victims could not be buried fast enough, and their bodies lay for days in sheds hastily run up as mortuaries. Hamburg had been attacked by cholera on fourteen previous occasions beginning with 1831, but the mortality had never approached that of 1892; in the worst year, which was 1832, there were only 3687 cases and 1765 deaths. The disease was believed to have been introduced by Jewish emigrants passing through on their way from Russia, but the importation could not be traced. The Jews were segregated and kept under careful supervision from the middle of July onwards, and no recognized case occurred among them. The total number of places in Germany in which cholera appeared in 1892 was 269, but it took no serious hold anywhere save in Hamburg. The distribution was chiefly by the waterways, which seem to affect a larger number of places than the railways as carriers of cholera. In Paris 907 persons died, and in Havre 498. Between 18th August and 21st October 38 cases were imported into England and Scotland through eleven different ports, but the disease nowhere obtained a footing. Seven vessels brought 72 cases to the United States, and 16 others occurred on shore, but there was no further dissemination.

During the winter of 1892-93 cholera died down, but never wholly ceased in Russia, Germany, Austria-Hungary, and France. With the return of warm weather it showed renewed activity, and prevailed extensively throughout Europe. The recorded mortality for the principal countries was as follows:—Russia (chiefly western provinces), 41,047; Austria-Hungary, 4669; France, 4000; Italy, 3036; Turkey, 1500; Germany, 298; Holland, 376; Belgium, 372; England, 139. Hardly any country escaped altogether; but Europe suffered less than Arabia, Mesopotamia, and Persia. Cholera broke out at Mecca in June, and owing to the presence of an exceptionally large number of pilgrims caused an appalling mortality. The chief shereef estimated the mortality at 50,000. The pilgrims carried the disease to Asia Minor and Constantinople. In Persia also a recrudescence took place and proved enormously destructive. Dr Barry estimated the mortality at 70,000. At Hamburg, where new waterworks had been installed with sand filtration, only a few sporadic cases occurred until the autumn, when a sudden but limited rush took place, which was traced to a defect in the masonry permitting unfiltered Elbe water to pass into the mains. In England cholera obtained a footing on the Humber at Grimsby, and to a lesser extent at Hull, and isolated attacks occurred in some 50 different localities. Excluding a few ship-borne cases, the registered number of attacks was 287, with 135 deaths, of which 9 took place in London. It is interesting to compare the mortality from cholera in England and Wales, and in London, for each year in which it has prevailed since registration began:—

| Year. | England and Wales. | | London. | |
|---|---|---|---|---|
| | Deaths. | Deaths per 10,000 living. | Deaths. | Deaths per 10,000 living. |
| 1848 | 1,908 | 1·1 | 652 | 2·9 |
| 1849 | 53,293 | 30·3 | 14,137 | 61·8 |
| 1853 | 4,419 | 2·4 | 883 | 3·5 |
| 1854 | 20,097 | 10·9 | 10,738 | 42·8 |
| 1865 | 1,297 | 0·6 | 196 | 0·6 |
| 1866 | 14,378 | 6·8 | 5,596 | 18·4 |
| 1893 | 135 | 0·05 | 9 | 0·002 |
| 1894 | nil | nil | nil | nil |

In 1894 no deaths from cholera were recorded in England, but on the Continent it still prevailed over a wide area. In Russia over 30,000 persons died of it, in Germany about 500, but the most violent outbreak was in Galicia, where upwards of 8000 deaths were registered. In 1895 it still lingered, chiefly in Russia and Galicia, but with greatly diminished activity. In that year Egypt, Morocco, and Japan were attacked, the last severely. Since then cholera has been in abeyance until the severe epidemic in India in 1900.

**Prevention.**

The great invasion just described was fruitful in lessons for the prevention of cholera. It proved that the one real and sufficient protection lies in a standing condition of good sanitation backed by an efficient and vigilant sanitary administration. The experience of Great Britain was a remarkable piece of evidence, but that of Berlin was perhaps even more striking, for Berlin lay in the centre of four fires, in direct and frequent communication with Hamburg, Russia, France, and Austria, and without the advantage of a sea frontier. Cholera was repeatedly brought into Berlin, but never obtained a footing, and its successful repression was accomplished without any irksome interference with traffic or the ordinary business of life. The general success of Great Britain and Germany in keeping cholera in check by ordinary sanitary means completed the conversion of all enlightened nations to the policy laid down so far back as 1865 by Sir John Simon, and advocated by Great Britain at a series of international congresses—the policy of abandoning quarantine, which Great Britain did in 1873, and trusting to sanitary measures with medical inspection of persons arriving from infected places. This principle was formally adopted at the international conference held at Dresden in 1893, at which a convention was signed by the delegates of Germany, Austria, Belgium, France, Great Britain, Italy, Russia, Switzerland, Luxemburg, Montenegro, and the Netherlands. Under this instrument the practice is broadly as follows, though the procedure varies a good deal in different countries:—Ships arriving from infected ports are inspected, and if healthy are not detained, but bilge-water and drinking-water are evacuated, and persons landing may be placed under medical supervision without detention; infected ships are detained only for purposes of disinfection; persons suffering from cholera are removed to hospital; other persons landing from an infected ship are placed under medical observation, which may mean detention for five days from the last case, or, as in Great Britain, supervision in their own homes, for which purpose they give their names and places of destination before landing. All goods are freed from restrictions, except rags and articles believed to be contaminated by cholera matters. By land, passengers from infected places are similarly inspected at the frontiers and their luggage "disinfected"—in all cases a pious ceremony of no practical value, involving a short but often vexatious delay; only those found suffering from cholera can be detained. Each nation is pledged to notify the others of the existence within its own borders of a "foyer" of cholera, by which is meant a focus or centre of infection. The precise interpretation of the term is left to each Government, and is treated in a rather elastic fashion by some, but it is generally understood to imply the occurrence of non-imported cases in such a manner as to point to the local presence of infection. The question of guarding Europe generally from the danger of diffusion by pilgrims through the Red Sea was settled at another conference held in Paris in 1894. The provisions agreed on included the inspection of pilgrims at ports of departure, detention of infected or suspected persons, and supervision of pilgrim ships and of pilgrims proceeding overland to Mecca.

The substitution of the procedure above described for the old measures of quarantine, and other still more drastic interferences with traffic, presupposes the existence of a sanitary service and fairly good sanitary conditions if cholera is to be effectually prevented. No doubt if sanitation were perfect in any place or country, cholera, along with many other diseases, might there be ignored, but sanitation is not perfect anywhere, and therefore it requires to be supplemented by a system of notification with prompt segregation of the sick and destruction of infective material. These things imply a regular organization, and it is to the public health service of Great Britain that the complete mastery of cholera has mainly been due in recent years, and particularly in 1893. Of sanitary conditions the most important is unquestionably the water-supply. So many irrefragable proofs of this fact were given during 1892-93 that it is no longer necessary to refer to the time-honoured case of the Broad Street pump. At Samarkand three regiments were encamped side by side on a level plain close to a stream of water. The colonel of one regiment took extraordinary precautions, placing a guard over the river, and compelling his men to use boiled water even for washing. Not a single case of cholera occurred in that regiment, while the others, in which only ordinary precautions were taken, lost over 100 men. At Ashkabad the cholera had almost disappeared, when a banquet was given by the governor in honour of the Czar's name-day. Of the guests one-half died within twenty-four hours; a military band, which was present, lost 40 men out of 50; and one regiment lost half its men and 9 officers. Within forty-eight hours 1300 persons died out of a total population of about 13,000. The water-supply came from a small stream, and just before the banquet a heavy rain-storm had occurred, which swept into the stream all surface refuse from an infected village higher up and some distance from the banks. But the classical example was Hamburg. The water-supply is obtained from the Elbe, which became infected by some means not ascertained. The drainage from the town also runs into the river, and the movement of the tide was sufficient to carry the sewage matter up above the water-intake. The water itself, which is no cleaner than that of the Thames at London Bridge, underwent no purification whatever before distribution. It passed through a couple of ponds, supposed to act as settling tanks, but owing to the growth of the town and increased demand for water, it was pumped through too rapidly to permit of any subsidence. Eels and other fish constantly found their way into the houses, while the mains were lined with vegetation and crustacea. The water-pipes of Hamburg had a peculiar and abundant fauna and flora of their own, and the water they delivered was commonly called *Fleischbrühe*, from its resemblance to thick soup. On the other hand, at Altona, which is continuous with Hamburg, the water was filtered through sand. In all other respects the conditions were identical, yet in Altona only 328 persons died, against 8605 in Hamburg. In some streets one side lies in Hamburg, the other in Altona, and cholera stopped at the dividing line, the Hamburg side being full of cases and the Altona side untouched. In the following year, when Hamburg had the new filtered supply, it enjoyed equal immunity, save for a short period when, as we have said, raw Elbe water accidentally entered the mains.

But water, though the most important condition, is not the only one affecting the incidence of cholera. The case of Grimsby furnished a striking lesson to the contrary. Here the disease obtained a decided hold, in spite of a pure water-supply, through the fouling of the soil by cesspits and defective drainage. At Havre also its prevalence was due to a similar cause. Further, it was

conclusively proved at Grimsby that cholera can be spread by sewage-fed shell-fish. Several of the local outbreaks in England were traced to the ingestion of oysters obtained from the Grimsby beds. In short, it may be said that all insanitary conditions favour the prevalence of cholera in some degree. Preventive inoculation with an attenuated virus was introduced by M. Haffkine, and has been extensively used in India, with considerable appearance of success so far as the statistical evidence goes.

As already remarked, the latest manifestations of cholera show that it has lost none of its former virulence and fatality. The symptoms, about which nothing need be said, are now regarded as the effects of the toxic action of the poison formed by the micro-organisms upon the tissues and especially upon the nervous system. But this theory has not led to any effective treatment. Drugs in great variety were tried in the Continental hospitals in 1892, but without any distinct success. The old controversy between the aperient and the astringent treatment reappeared. In Russia the former, which aims at evacuating the poison, was more generally adopted; in Germany the latter, which tries to conserve strength by stopping the flux, found more favour. Two methods of treatment were invariably found to give great relief, if not to prolong life and promote recovery—the hot bath and the injection of salted water into the veins or the subcutaneous tissue. These two should always be tried in the cold and collapsed stages of cholera.

*Treatment.*

*Cholera Nostras.*—The word *nostras*, which is good Latin, and used by Cicero, means "belonging to our country." It is applied to the original form of cholera, known from time immemorial, in order to distinguish it from the Asiatic variety, which was unknown until the 19th century. The relations between the two are very obscure. Clinically they may exactly resemble each other, and bacteriology has not been able to draw an absolute line between them. The real difference is epidemiological. Cholera—that is, cholera nostras—was described by Sydenham two centuries ago as sometimes epidemic, but only the Asiatic variety has been known to behave as a destructive pestilence; by cholera nostras is generally meant a disease which may be violent in individual cases, but possesses no epidemic significance.

See *Local Government Board Reports*, 1892-93-94-95.—CLEMOW. *The Cholera Epidemic of 1892 in the Russian Empire.*—WALL. "Asiatic Cholera."—NOTTER. *Epidemiological Society's Transactions*, vol. xvii. (A. SL.)

**Chorley,** municipal borough, parish, and market town, England, in the Chorley division of Lancashire, 22 miles N.W. from Manchester by rail. Recent public buildings include St George's church institute and a cottage hospital and public dispensary. There is a public free library. Cotton-spinning and the manufacture of cotton and muslin are extensively carried on, and there are also iron and brass foundries and boiler factories. Area of municipal borough, 3614 acres. Population (1881), 19,478; (1891), 23,087; (1901), 26,850.

**Chórum,** ancient *Euchaita*, altitude 2300 feet, a town of Asia Minor, in the Yuzgat sanjak of the Angora vilâyet, situated at the edge of a wide plain. Euchaita was attacked by the Huns A.D. 508, and became a centre of religious enthusiasm. Population, 12,500, including a few Christians.

**Chota** (or CHUTIA) **Nagpur,** a division of British India in Bengal, consisting of five British districts and nine tributary states. It is a hilly, forest-clad plateau, inhabited mostly by aboriginal races, between the basins of the Sone, the Ganges, and the Mahanadi. The five British districts are Hazaribagh, Lohardaga, Palamau, Manbhum, and Singhbhum. The total area is 26,966 square miles, and in 1891 the population was 4,628,792, giving an average density of 172 persons per square mile, compared with 471 for Bengal generally. Christian missions have been specially active in this tract. In 1891 the number of native converts was 88,897, mostly in Lohardaga, being more than half the total for all Bengal. In 1896-97 five missions maintained 203 schools, attended by 5063 boys and 1208 girls. The nine tributary states of Chota Nagpur are Sirguja, Gangpur, Udaipur, Jashpur, Bonai, Korea, Changbhakar, Kharsawan, and Seraikella. The two last are tiny areas within the British district of Singhbhum, on the line of the Bengal-Nagpur railway. The others stretch over a large tract of hills separating Bengal from the Central Provinces. The total area comprises 16,054 square miles. The population in 1891 was 883,359, giving an average density of 55 persons per square mile, ranging from 238 in Kharsawan to 20 in Changbhakar. In 1901 the total population was 982,439, showing an increase of 11 per cent. The total gross revenue of the chiefs is estimated at Rs.2,40,000; the number of schools is 79, with 1626 pupils. The Bengal-Nagpur railway touches on Udaipur, and runs through a considerable part of Gangpur. In this last state there were serious disturbances in 1896, but the administration is improving under closer British supervision.

**Christadelphians** (Χριστοῦ ἄδελφοι), a community founded by John Thomas (1848), who studied medicine in London and then migrated to America. There he at first joined the "Campbellites," but afterwards struck out independently, preaching largely upon the application of Hebrew prophecy and of the language of the Apocalypse to current and future political events. In America and in Great Britain he gathered a number of adherents, and formed a community which is said to have extended to most English-speaking countries. It consists of exclusive "Ecclesias," with neither ministry nor organization. The members meet on Sundays to "break bread" and discuss the Bible. Their theology is strongly millenarian, centring in the hope of a world-wide theocracy, with its seat at Jerusalem. They believe that they alone have the true exegesis of Scripture, and that the "faith of Christendom" is "compounded of the fables predicted by Paul." No statistics are published.

See ROBERTS. *Dr Thomas: His Life and Work*, and *A Declaration of the Truth*, &c. Birmingham.

**Christchurch,** town in Selwyn county, New Zealand, next to Dunedin the most populous town in South Island. Its manufactures are of importance, though its position is still due mainly to the large agricultural district round it. Its cathedral church, museum, public library, public gardens, agricultural show-ground, and chief cricket-grounds are the best of their kind in the colony. Three hundred students attend lectures at Canterbury College. Steam tramways connect the town with the sea-side, and though flat, it is well drained and healthy. Its fine public park has been well planted and improved. Its suburbs are noted for the number and taste of their private gardens. Mean temperature for the year, 52°; average yearly rainfall, 26 inches. Population (1901), 17,537; including suburbs, 57,041.

**Christian IX.,** KING OF DENMARK (1818-——), fourth son of Duke Wilhelm of Schleswig-Holstein-Sonderburg Glücksburg, was born 8th April 1818, and succeeded to the throne on the death of King Frederick VII., 15th November 1863, in accordance with the provisions of the

Treaty of London of 8th May 1852, and the Danish law of succession of 31st July 1853. On 26th August 1842 he married Louise, daughter of Landgrave Wilhelm of Hesse-Cassel. In 1846, when the whole house of Schleswig-Holstein signed the famous "Protest," Christian held back, and he was the only prince of that house who remained in the military service of Denmark from 1848-50. He was therefore clearly indicated as the proper person to fill the vacant place of heir to the Danish throne, to which he had a claim in right of his wife, the cousin and heiress of Frederick VII., and he was so recognized by the Treaty of Warsaw of 5th January 1851. Upon coming to the throne his first act was to ratify the Eider Danish constitution, by which the Duchy of Schleswig was incorporated with Denmark. This led to a war with Prussia and Austria, which ended with the Peace of Vienna, 30th October 1864, Christian ceding Schleswig-Holstein and Lauenburg to Germany. The king's pronounced conservatism has led to serious collision in the Danish Parliament, which from 1873-95 regularly refused to vote the budgets presented by his majesty's ministers. On 29th September 1898 the king lost his consort Louise, who died at the age of eighty-one. Their numerous children made brilliant marriages: (1) Frederick, born 3rd June 1843; married, 26th April 1898, to Princess Alexandra of Mecklenburg; (2) Alexandra, born 1st December 1844; married, 10th March 1863, to the Prince of Wales, now King Edward VII.; (3) Wilhelm, born 24th December 1845, elected King of the Hellenes, under the title of Georgios, by the Greek National Assembly, 31st March 1863; married, 27th October 1867, to Olga Constantinowna, grand duchess of Russia; (4) Marie Dagmar, born 26th November 1847; married, 9th November 1866, to Alexander III., Czar of Russia; (5) Thyra, born 29th September 1853; married, 21st December 1878, to Prince Ernest Augustus, duke of Cumberland; (6) Waldemar, born 27th October 1858; married, 22nd October 1885, to Princess Marie d'Orléans.

# CHRISTIAN CHURCH, THE.

THE present article does not deal with the state, condition, or progress of any particular or national church. The recent history of various Christian communions will be found under their special and appropriate titles; but, in addition to those articles which treat of the present position and prospects of particular churches, it has been thought well to devote some space to a wider purpose, and to endeavour to measure the progress of what may for convenience' sake be called the Christian Church at large. The object, therefore, of this article is to deal with the advance of the Church of Christ generally; it aims at putting before its readers the present position of Christendom in relation to the moving forces and influences of the world; in brief, it is an attempt to answer the question, How far has the Christian idea advanced among men? Naturally and necessarily the question suggests a wide range of inquiry, and, to be fully answered, would require a treatise rather than a brief article; but while it will be needful, from time to time, to take a backward glance at other and earlier ages, we shall, as far as is possible, restrict ourselves to the movements of recent years, and the period which we wish to keep specially in mind will be the last generation. Roughly speaking, our sketch will be mainly occupied with the period covered by the latter half of the 19th century. We shall endeavour to measure the progress of Christianity in various ways, by reference to statistical facts, to influences in matters not reducible to statistics, and, lastly, by reference to certain changes in the direction of Christian energy and methods observable in recent years.

## I. The Measurement of the Progress of Christianity as expressed by Statistics.

Statistics are proverbially misleading; but while we may well use them with caution, and exercise careful self-restraint in making hasty inferences from them, they are valuable within their measure and scope. The individual items must not be unduly pressed; we must even bear in mind that the apparent significance of their details may be readily misunderstood; but they furnish the basis of judging the general direction of a given movement; they enable us to discriminate between the inrush of the wave and the incoming of the tide. Thus we note in the history of Christianity certain periods of reaction; the rapid progress in one age is checked in another. There were times when the very life of Christianity seemed to be threatened; there are places where flourishing Christian churches existed, and from which they have vanished. To take an example of a period of reaction, it seems well established that towards the close of the 2nd century the Christian population in the Roman empire declined. Persecution diminished the numbers of the Church. In the 18th century Voltaire felt justified in predicting that Christianity was about to disappear from among men. He spoke more from his wishes than his judgment, perhaps; but he was too shrewd an observer of his times to have committed himself to prophecy without some real or apparent justification. He saw that to a large extent the intellectual classes of his countrymen had been alienated or seduced from their faith. He did not perceive the religious forces which were even then at work preparing for the rejuvenation of Christian energy. As there have been epochs of arrested progress in Christian history, so there have been places where Christianity has made progress, but where the promise of earlier successes has not been sustained. Readers of Christian history have asked, What became of the half-million converts in South India who owed their faith to Xavier, or of the 300,000 in Ceylon who were the fruits of Dutch missionary effort? Still more, readers will recall the story of Christianity in North Africa, and the vigorous churches in Carthage, Alexandria, and Hippo. Few facts mark more eloquently the temporary ebb of Christian influence than the decay of the churches which were once the churches of Cyprian, Augustine, and Origen.

Christianity—it is well to realize the fact—has been subject to certain human influences, or, to speak more correctly, the Christian Church numbered among its adherents multitudes who were swayed by the ordinary emotions and passions of mankind, and were open to the influences of fear or gain. There were favourable as well as unfavourable times. This was frankly recognized by the earliest Christian historian, when he noted the fact that when persecution ceased the Church was multiplied (Acts ix. 31). There were, in fact, periods which tested the stability of men's faith, and which enabled men to distinguish between the transitory wave, whose size and bulk was due to some favourable wind, and the rising tide, which owed its strength to more heavenly influence. The table which we present below reflects these fluctuating conditions, but, on the whole, witnesses to a steady and continuous advance.

(i.) The *proportion of the Christian population to the population of the world* is the subject of our first statistical inquiry. Gibbon estimated that on the most favourable estimate the Christian population of the empire before

the days of Constantine was one-twentieth of the whole (*Hist.*, Milman's edit., 1846, vol. i. p. 520). Bishop Lightfoot so far agreed with Gibbon that he regarded (*Historical Essays*, pp. 79, 80) the estimate as too favourable, but he accepted it as a sufficiently just one for purposes of comparison. He reckoned that the empire of Rome ruled over from one-seventh to one-tenth of the then population of the world; thus the Christian population in the close of the 3rd century could only claim at the most one-twentieth of one-seventh of the human race—*i.e.*, only one in every 140. Bishop Lightfoot, in conclusion, adopted $\frac{1}{150}$ as the proportion of Christians to the world population at that time. He claimed that the proportion in the present day was one in five. But there is reason to think that this is below the true proportion. The Christian Church to-day can, it is believed, claim one-third of the population of the world.

The following tables can only be accepted as rough and approximate estimates. We have very few data for determining either the population of the world or the Christian population from century to century, but on the whole the proportions set out here are probably sufficiently near the fact for general purposes of comparison.

The accompanying table exhibits at a glance the general progress of Christianity:—

| A.D. | World Population. | Christian Population. |
|---|---|---|
| 100 | .. | 5,000,000 |
| 200 | ... | 2,000,000 |
| 300 | . | 5,000,000 |
| 400 | .. | 10,000,000 |
| 800 | ... | 30,000,000 |
| 900 | ... | 40,000,000 |
| 1000 | .. | 50,000,000 |
| 1500 | ... | 100,000,000 |
| 1600 | .. | 125,000,000 |
| 1700 | ... | 155,000,000 |
| 1800 | 1,000,000,000 | 200,000,000 |
| 1875 | 1,396,842,000 | 394,000,000 |
| 1880 | ... | 410,000,000 |
| 1890 | ... | 493,000,000 |
| 1896 | 1,500,000,000 | 500,000,000 |

The diminution between A.D. 100 and A.D. 200 is accounted for by persecution; the rapid increase between A.D. 300 and A.D. 400 to the patronage of the Emperor Constantine. The Christian reader will note, however, with satisfaction that the increase within the last hundred years has been more rapid than in any similar period, and that the ratio of increase has been augmented since 1880. The Protestant reader will observe that the increase within the last three or four hundred years has been more rapid than in the period preceding the Reformation.

The increase in the 19th century is represented by the following figures. The percentage of the Christian population to the world population, which was 20 in 1800, was 28·5 in 1875 and was 33·3 in 1896; and whereas the average yearly increment between 1800 and 1875 was something over 2,500,000, it was over 5,000,000 between 1875 and 1896; or, to put the result in quarter-century periods, whereas the average gain for each of the first three quarters of the 19th century was 65,000,000, the average gain of the last quarter of the century was 106,000,000. It is worthy of note that this coincides with the period during which intercession for missions became a recognized duty on the part of the Church. Dr Dorchester speaking of the United States, says in his *Problems of Religious Progress* that whereas in the beginning of the century the proportion of communicants to the population was one in fourteen or fifteen, in 1890 it was one in four or five; or, in other words, while the population had grown 11·8-fold, the communicants had increased 38-fold.

Thus it would seem that simultaneously with the deepening of the religious spirit in the Christian churches there has been rapid progress in the spread of Christianity. We can only indicate this advance by the general figures we have cited; but it may serve to illustrate the general character of the progress in non-Christian lands if we set down here the figures which relate to India. The number of Christians in India between 1841-51 was estimated at 91,000; between 1851-61 at 138,000; and between 1861-71 at 224,000; between 1871-81 at 897,216; and between 1881-91 at 2,284,380. These figures represent a growth of 50 per cent. for each decade. Beside this we may place two very remarkable results of the missionary work in West Africa. In Sierra Leone, where missionary work can scarcely be said to have commenced till 1815, there is now a self-supporting, self-governing, self-extending church, and seven out of eight of the inhabitants are Christian.

(ii.) The measure of Christian progress may also be given by statistics indicating *world influence* or ascendancy.

***Political influence.***

(*a*) More remarkable than the growth in the number of adherents is the increase of the influence and power of the Christian nations. Thus it has been reckoned that three hundred years ago 3,480,900 square miles of the world's surface were under the government of the Christian nations, and 45,619,100 square miles were under the government of non-Christian peoples —*i.e.*, one mile out of every thirteen was under Christian governing influence. Now, however, the figures are altered: the number of square miles under Christian government is 40,317,200, that under non-Christian influence is 8,782,300—*i.e.*, the Christian nations rule between four and five square miles for every one governed by non-Christian peoples, or 82 per cent. of the governed area of the world.

(*b*) The supremacy of Christian governing power is shown in the statistics of the populations now dependent upon the Christian nations. In 1500 only 100,000,000 of people were under Christian rule, now there are 900,000,000.

(*c*) It may be interesting to note the relative ascendancy of the different forms of Christianity in this world-influence. For convenience' sake we may take the three broad divisions, viz.: the Greek, the Roman Catholic, and the Protestant nations respectively. The area of the world ruled by Christian and non-Christian people is between 49,000,000 and 50,000,000 square miles. Of these the rule is distributed as follows:—Non-Christian nations, 8,782,000; Greek (Christian), 8,752,000; Roman Catholic (Christian), 14,147,000; Protestant (Christian), 17,417,000; or in percentages, non-Christian, 18 per cent.; Greek, 18 per cent.; Roman Catholic, 28 per cent.; Protestant, 36 per cent. If we examine the populations under these governments respectively, we have the following results:—Under Christian rule, 890,000,000; distributed as follows: under Greek, 128,000,000; under Roman Catholic, 242,000,000; under Protestant, 520,000,000. The result may be exhibited by the following table, which compares the populations under these governments in 1700 and in 1900 respectively:—

| Date. | Greek. | Roman Catholic. | Protestant. | Total. |
|---|---|---|---|---|
| 1700 | 33,000,000 | 90,000,000 | 32,000,000 | 155,000,000 |
| 1900 | 128,000,000 | 242,000,000 | 520,000,000 | 890,000,000 |

(*d*) Alongside these figures we may place another fact. There has been a marked change in the diffusion of European languages during the last 100 years, and it will be readily seen that the diffusion of language is, if not a diffusion of influence, yet a measure of its diffusion. In 1800 French was spoken by 31,000,000 of people; German and Russian tongue each by 30,000,000; the Spanish by 26,000,000; and English by 20,000,000. In 1890 the figures stood thus: French, 51,000,000; German and

Russian, each 75,000,000; Spanish, 42,000,000; and English, 111,000,000. In other words, English, which was the least influential of European languages, now holds the leading place, while French has fallen from the first to the fourth place; or, to put this fact into percentages, the increase of the diffusion of these languages has been in ninety years as follows:—

| | |
|---|---|
| French . . . . . | 64·5 per cent. |
| German, Russian . . . . . | 150 ,, |
| Spanish . . . . . | 61·5 ,, |
| English . . . . . | 450 ,, |

It will be seen that the increase of the Teutonic races is far in excess of that of the Latin races; and when we keep in mind the greater birth-rate in the Teutonic races,[1] we can realize that, unless some great and unexpected change takes place, the future influence of the Christian nations will be increasingly in the hand of the Teutonic or Protestant division of Christendom.

(*e*) The importance and significance of the ascendancy of Christian nations will be best realized by placing side by side the population and area of a selected number of the Christian nations and the native or colonial populations and areas now under their rule. We draw our statistics from an interesting monograph carefully brought up to date by Lieut.-Colonel V. Murari Brá, instructor in geography in the Scuola di Guerra in Italy.

| | Mother Country. | | Dependencies. | |
|---|---|---|---|---|
| | Area. | Population. | Area. | Population. |
| Great Britain | 314,950 | 41,220,000 | 27,861,000 | 348,496,000 |
| Germany . | 540,658 | 56,000,000 | 2,605,100 | 9,230,000 |
| Holland . | 33,000 | 5,200,000 | 2,045,700 | 35,500,000 |
| Denmark . | 38,830 | 2,175,000 | 194,580 | 130,000 |
| United States | 9,450,000 | 78,500,000 | 443,060 | 9,636,000 |
| France . . | 536,408 | 38,800,000 | 8,812,710 | 50,340,000 |
| Italy . . | 286,648 | 32,000,000 | 477,300 | 600,000 |
| Spain . . | 497,244 | 18,100,000 | 709,450 | 340,000 |
| Russia . . | 22,430,000 | 135,000,000 | 310,000 | 3,000,000 |
| | 34,127,738 | 406,995,000 | 43,458,900 | 457,272,000 |

If we group the nations according to kinship, arranging them under the classes of Teutonic, Latin, and Slav races respectively, we get the following results:—

| | Mother Countries. | | Dependencies. | |
|---|---|---|---|---|
| | Area. | Population. | Area. | Population. |
| Teutonic {European only} | 927,438 | 104,595,000 | 32,706,380 | 393,356,000 |
| Latin . . . . | 1,320,300 | 88,900,000 | 9,999,460 | 51,280,000 |
| Slav . . . . | 22,430,000 | 135,000,000 | 310,000 | 3,000,000 |

Thus the governing power of the Teutonic, Latin, and Slav races in Europe may be represented by the following figures:—For every square kilometre or square mile of mother country, the Teutonic races govern 35, the Latin races govern 7·5, and the Slav 00·13 square miles; and for every inhabitant in the mother country there are in the dependencies of the Teutonic nations 3·7 inhabitants, in the Latin ·057, and in the Slav ·002. It is no flight of rhetoric to say that almost two-thirds of the world's population and four-fifths of its area are now under the government of Christian nations, and by far the largest share of this has fallen into the guardianship of the Teutonic nations, who govern not far short of 600,000,000 of people, or more than two-thirds of the whole population now under Christian rule. So far then as political and administrative influence is concerned, the ascendancy of the Christian nations is beyond all doubt.

In this influence wealth counts as an important factor, and the accumulations of that class of power which belongs to what is called wealth are chiefly in the hands of Christian lands. They make the markets of the world; they direct by far the largest portion of its commerce. And when wealth is measured as so much per head of the population, the non-Christian peoples scarcely enter into the calculation of the political economists. It is no doubt true that in countries not yet commercially organized there are no materials on which to base a calculation, but it is also true that in a sense it is only when the means of production are organized that wealth in any economic sense may be said to exist; and it is in the Christian countries that these means of power are practically concentrated. The wealth per head of the Christian nations varies from £60 in Russia to £302 in England; France stands here at the head of the Latin nations with £253 per head, as England does at the head of the Teutonic nations. The average wealth of the Teutonic nations is £226 per head, that of the Latin £140, and that of the Slav about £6.

***Economic influence.***

(iii.) As a statistical measure of Christian energy, it will be convenient to notice some *phases of Christian activity* which have marked recent years.

(*a*) There has been a very marked development of missionary enterprise (see MISSIONS). It is difficult to present a statistical estimate of the force of this development. It will be best to point out a few salient facts. We shall first confine ourselves to that which is popularly called missionary work, viz., Christian labours carried on among heathen or non-Christian peoples. The number of separate societies for that purpose has largely increased during the last century. It has been estimated that in 1790 there were in Great Britain only two societies which contemplated missionary work as within the scope of their operations, viz., the Society for the Promotion of Christian Knowledge and the Society for the Propagation of the Gospel. Neither of these societies, however, directed its work solely towards the heathen world: the former aimed at circulating Christian literature in all quarters; the latter paid, and rightly paid, special attention to the needs of Britons in the colonies and in foreign parts. A century has seen the establishment of numerous societies for direct and exclusive missionary work. It has been estimated that the number of missionary societies is little short of 300; some of these are small and comparatively poor, but others are large and important organizations, resembling great State departments, commanding and distributing large revenues, and entailing upon their committees of management wide and varied responsibility and an almost statesmanlike judgment in the handling of difficult and delicate problems.

(*b*) There are in Great Britain alone twenty-nine foreign missionary societies. Four or five of these administer each an income of over £100,000 a year. They occupy nearly 10,000 stations and sub-stations; they employ 2739 European missionaries, upwards of 1800 women workers, and more than 27,000 native helpers. In the article on MISSIONS a full survey of the condition and prospects of various missionary societies is given. Here it may be enough to notice that the United States missionary societies employ about half the number of male missionaries sent out by Great Britain, while their women missionaries nearly equal the British, being over 1700; their native agents are about 13,000; and the estimated missionary contributions (Protestant) of the

[1] The birth-rate of all European countries declined between 1875 and 1900, but the statement in the text is still substantially true, inasmuch as the birth-rate in Germany is still greatly in excess of the birth-rate in the Latin kingdoms. The decline in the birth-rate in Great Britain is serious, but it is nothing like the decline in France; though all English-speaking people should earnestly consider the population question as it affects their own race.

English-speaking world amount to nearly £3,000,000 annually.

(*c*) In this connexion may be instanced the diffusion of the Bible in the world. The British and Foreign Bible Society was founded in 1804; the American Bible Society twelve years later; in 1891 these two societies were but two out of 80 Bible societies in the world. In 1800 the translations of the Bible were 47 in number; there are now 90 complete and 230 partial versions, making a total of 320 translations more or less complete.

(*d*) Evidence of the continuous growth of aggressive Christian energy may be found in the rapid increase of missionary bishoprics which has taken place of recent years. In the first half of the 19th century 23 new bishoprics were founded; in the latter half there were 69; the rate of increase was trebled in the second period. The same feature is shown in the Protestant Episcopal Church of America. During the 19th century it has added 73 new bishoprics, and 52 of these belong to the latter half of it. The two churches added to their organization 165 new sees in the same century, and no fewer than 73 of these have come into existence since 1870.

(*e*) But apart from figures, the whole position of Christian business has undergone a change in public estimation. Missionary meetings used to be dull, and missionary literature flat and insipid. Now all this is changed. Meetings are large and enthusiastic, and missionary literature displays a culture and breadth of treatment unknown to our fathers. The journals or magazines issued by societies treat of every land from Greenland to Patagonia, from Japan to the Southern Islands, and they set forth with intelligence and learning questions of geography, philology, sociology, art and science, native manners and customs, in addition to, or in illustration of, direct missionary information. The popular sympathy which so often waits on popular knowledge has been further enlisted by what are known as missionary loan exhibitions. In these vivid illustrations of native life and missionary work are given by means of costumes, curiosities, and models. To such an exhibition in Birmingham there were as many as 100,000 visitors; and everywhere similar exhibitions have been crowded.

As a witness to the changed popular feeling towards missionary enterprise, perhaps nothing can be more striking than the fact that there are now in England and America public monuments commemorating the zeal and devotion of the missionary. In Washington Square in New York there is a church which is a memorial to Judson the missionary; in Westminster Abbey there is a monument to David Livingstone, who lies in the ancient national shrine where the greatest of Englishmen are buried.

### II. The Measure of Christian Progress in Matters not Reducible to Statistics.

(i.) *The Alleged Decline of Christian Influence.*—In estimating the present position and prospects of the Christian religion, it is necessary to refer to matters which are regarded by its friends and foes as tokens of its declining influence.

First, it is said that there are signs that Christianity has lost, or is losing, its moral influence. Ordinances and institutions which owe their sanctity to Christian influence are no longer socially observed. The Sunday, for instance, is being slowly transformed into a day of pleasure. Still more significant, it is alleged, is the lowering of moral standards: that which was once regarded as harmful is now treated as legitimate; the increase of luxury has led many to treat indulgences as though they were necessaries; the wish to live according to a liberal scale, and after an easeful fashion, has stimulated a passionate eagerness for wealth, and the determination to have it has led to a disregard of the code of honour, while the possession of the good things of life, as they are called, has produced enervation of character; restlessness, born of ease, has destroyed steadiness of habit; and impatience of toil has driven men to seek riches in doubtful rather than in diligent methods. In these ways, it is said, the claims of the Christian life are subordinated to the interests of the moment.

Against this must be set the fact that the apprehensions which here find expression have been common in all ages; they cannot be accepted as evidence of the declining influence of Christianity without some more tangible evidence. Earnestness, ambitious of greater Christian consistency, is always alive to contemporary evils. "The Lord's day is become the devil's market day" was the complaint of a bishop in 1724. Immorality at the same time was considered to be so rampant that men said, "Our light looks like the evening of the world." It is thus that men who measure public manners by the measure of their philanthrophic desires will ever speak. But for the purpose of the scientific historian, contemporary morals must be measured by a comparison of facts and statistics, and not by the despondency of the good. When, therefore, we find a steady diminution in pauperism and crime, and a marked increase of longevity owing to a more careful regard for human life and its conditions of health and happiness, we shall see that the advance of moral improvement is steady and sure, even if not rapid enough to satisfy the desires of the good. The most wholesome sign, under these circumstances, is the dissatisfaction of the good, for it is the witness that the spirit of earnestness and devotion is still a powerful factor in social life. When we quit the warm realms of zeal and enter the cold sphere of statistics, we find that the progress of moral standards advances with slow but decisive foot. The percentage of crime is strikingly lower; the paupers are proportionately fewer; greater care for the condition of the poor indicates a more tender public conscience. Social ambitions among us are becoming more unselfish. The general moral sense is higher. Intemperance is now a disgrace; slavery is illegal, and would be impossible to any enlightened Christian society. The ethical principles of Christianity have been planted deep among our social ideas, and have revolutionized manners. In our judgment, whatever undesirable features remain as blemishes on our civilization, the standards of moral life are gradually improving, and this improvement is largely due to the prevailing force of Christian ethics.

Secondly, it is said that everywhere men are increasingly reluctant to identify themselves with the Christian religion. Many discard the outward forms of Christian worship; attendance at worship is declining; and, perhaps most startling of all, the number of those who join the ranks of the Christian ministry is steadily diminishing among all Christian denominations. This last fact is the one which Christian churches should face: a searching inquiry into the causes for the decline of candidates for the ministry of the Church would be of the greatest interest. Till such inquiry has been made we can only speculate upon causes. Among these the following have been suggested:—(*a*) The unsettled condition of theological opinion, due to the progress of historical criticism. This is probably one cause, and it has given rise to the question how far the Christian churches should relax the terms of subscription required by their ministers. There can be no doubt that many of the dogmas to which subscription is required are, if not obsolete, yet expressed in terms which are at least incongruous with modern ideas.

On the other hand, the results of recent criticism are at present felt to be less destructive than the criticism of two generations ago. (*b*) The Christian ministry is a severer test of religious earnestness to-day than it was in the days of our fathers. The increase of luxury has set the scale of living higher. To maintain the position of a simple gentleman is more costly than it was. The remuneration of the Christian minister has not kept pace with the growing expenses of life, but the demands upon his time and resources have increased. (*c*) There is a widespread feeling that there are other ways open to Christian zeal besides those of the stated ministry, and the number of those who devote their lives in independent fashion to works of Christian benevolence has greatly increased of late years.

On the whole, the argument that Christianity has lost, or is losing, influence ends probably in the conclusion that certain formal aspects of Christianity have less hold upon men than formerly, but the increase of the influence of the Christian spirit is great and growing. Whether the present tendencies will end in a fatal relaxation of Christian ordinances, or in a better-proportioned estimate of their value; whether the decline of attachment to certain formal aspects of Christianity will lead to a renunciation of some of its essential principles, or will bring about a federation or union of Christian churches, are questions of deep interest, but are outside the scope of the present inquiry. It is enough for us to indicate our belief that, however much there may be to deplore in modern life, there is no real ground for believing that the social and ethical influence of Christianity has declined or is declining in the world.

(ii.) *Christianity and Morals.*—Chiefest among those signs of progress is the influence of Christian ideas upon the principles, whether of law or custom, which now govern the world. It will no doubt always be a matter of controversy how much of the humane principles now accepted among civilized nations is due to education, experience, and evolution, and how much to direct Christian influence. Results are complex, and we must seek their ancestry in more than one line, but no reasonable person who reads the story of modern civilization can doubt that the slow acceptance of the principles taught by Christ has powerfully affected its development. "The great characteristic of Christianity," says Mr Lecky, "and the proof of its divinity, is that it has been the main source of the moral development of Europe." Only by degrees, indeed, have the principles of Christianity been accepted or, indeed, understood.

For example, take the matter of slavery. The habit of enslaving prisoners of war received its first check when the sense of Christian brotherhood created a strong feeling among Christian peoples against the enslavement of their fellow-Christians when taken prisoners. The Crusades, when Christian nations fought side by side against a pagan foe, no doubt served to strengthen this feeling of repugnance against such enslavement. By degrees, however, the sense of brotherhood extended; the family of Christ were not only those who called themselves by His name, but all those who were sharers of His redemption. To enslave a brother meant to enslave any man, for every man was a brother for whom Christ died. Thus the anti-slavery movement arose out of a better appreciation of the spirit of Christ; and Christian men were all along the inspiration of the movement. This example may serve as a type of many other humane movements which have imposed a sort of unwritten law upon the conscience of civilized nations.

What is called international law, for instance, has in one sense no real existence. Nations have not yet accepted any definite written code of laws by which they are content to abide; but the broad and popular maxims, which expressed the Christianized feeling of mankind, became the basis of various erudite and influential works which may, broadly speaking, be called treatises on international law. Grotius, for example, definitely proclaimed that his book *De Jure*, &c., was an endeavour to present in orderly and codified form the customs and maxims which had grown out of the appreciation of Christian principles.

It has often been stated, and arguments have been founded on the statement, that Christianity laid down no rules respecting some of the great evils of the world—such as the status of women, slavery, and war. This is true, for Christianity is not a religion of rules, but a religion of principles; it is the introduction into human life of a new spirit, and that spirit is love. The improvements in the condition of the world, the spreading abroad of humaner principles of conduct, including humaner methods of war, are little more than the apprehension of the principles laid down by Christ and expressed by the apostolic declaration—"Love worketh no ill to his neighbour." The width of the application of the principle was made plain by Christ when He answered the question, "Who is my neighbour?" by the parable of the good Samaritan. The indications of the recognition of these principles mark stages in the history of civilization. Alcuin noted the influence of Christian principles in the treatment of slaves. Under the sceptre of Charlemagne an abhorrence of needless bloodshed gained hold upon the public mind, while in more modern times the Red Cross Society and the Geneva Convention have assuaged the horrors of the battlefield. The substitution of arbitration for war belongs to the future, but great progress has been made in the direction of peaceful solutions of international difficulties. The subject enlists Christian and humane sympathy in an increasing degree. The conference of bishops of the Anglican Church in 1897 directed attention to it, and issued a report which showed how largely both the idea and practice of arbitration had become familiar to the civilized world.

The changed conditions of modern life present, no doubt, new problems and new difficulties. There are some who despair of the application of Christian principles to the political and social questions which confront our times; but such persons overlook both the progress which has already been made, and also the fact that many of the problems which confront us to-day—*e.g.*, the industrial problems—are problems of recent growth, which owe their existence to the rapid commercial and political changes of the 19th century. Meanwhile the remarkable widening of the direction of Christian energy, of which we shall speak later on, shows that Christian public opinion is not likely to rest satisfied with a half-hearted application of the teaching of Christ, and that, whether ultimately successful or not, there is not a department of public life, nor a phase of human need or suffering, which the Christian conscience will allow to remain outside the reach of the Christian spirit.

The widened sweep of Christian energy is evidenced in the expanded conception of missionary effort. Missionary societies have almost universally enlarged the sphere of their work—the elevation of woman, ministry to the sick, the amelioration of social conditions enter into the aim of the missionary. Time and space forbid our discussing these at length, but two or three examples will make clear how closely allied the introduction of gentler or humaner customs are with the preaching of Christianity. The Christian missionary has been influential in bringing about the mitigation, if not the cessation, of cruel popular customs like suttee and infanticide.

(α) *Suttee.*—Among the changes for the better which the 19th century witnessed was the abolition of suttee or sati, *i.e.*, the self-destruction of the widow on the grave or funeral pyre of her husband. This was viewed in India as a virtuous or good act; hence its name, Sati, from a root signifying good or pure. The good or loyal wife was expected to follow her husband beyond the grave, to minister to him in the unseen. The custom prevailed almost universally in India in the beginning of the 19th century. In 1817 on an average two widows were burned daily in Bengal alone. In 1829 Lord William Bentinck declared the practice criminal. The English Government, in spite of many petitions declaring the religious character of the custom, supported Lord William Bentinck. The Christian Church led the way in this great reform. The agitation against the custom was begun by Carey, the missionary, in 1801. The extent of the benefit of the change may be judged when it is remembered that there are (1895) upwards of 22 millions of widows in India, all of whom would have been doomed by this cruel custom to a premature death, and more than 70,000 of these mere children under ten years of age.

(β) *Infanticide.*—This was, and still is, largely prevalent in China, but Christian influence has reduced the practice, and Christian philanthropy, by providing orphanages, has rescued numbers of children from an early death. One missionary tells us that at Amoy there was a pond in the town known as the babies' pond; into it babies were flung by their mothers, the little bodies were seen floating in the water, and the inhabitants looked on with indifference. Christian teaching rendered the practice less popular; the pond is now dried up, while foundling institutions provide for some 2000 children in the district. This is one illustration among many. Infanticide is practised in India. In the judgment of one writer, at the lowest estimate fully one-third of the girls born among the natives are still secretly murdered (Houghton, *Women of the Orient*, p. 71; Dennis, vol. i. p. 133). In Formosa and in the Pacific Islands the same custom prevails; in the latter not less than two-thirds of the children were put to death. Against this cruel custom the missionary exercises a restraining influence. Our churches, said an agent, are practically anti-infanticide societies.

(γ) *General Beneficence.*—But Christian energy has not confined its influence to the mitigation of great evils. It has become the minister of active benevolence. Orphanages and asylums spring up in missionary stations as well as hospitals and dispensaries, and on the staff of missionary societies are now found a certain proportion of medical missionaries. These are, if we mistake not, the product of the 19th century. It is safe to say that not a single medical missionary existed in any part of the heathen world a century ago; now there are no fewer than 217 in China alone. Evidence of the widespread humanizing influence of such agencies may be gathered from the fact that in a single year in the province of Shantung 200,000 cases were treated (*Methodist New Connexion Missionary Report*, 1900, p. 34). Much prejudice existed at first in the minds of Christian people. The undertaking of medical work appeared to them likely to interfere with the more distinctively religious aims of the missionary, but this feeling has almost entirely disappeared; and since Dr S. F. Green, a young American Presbyterian, went out (1847) to Ceylon, the value of the medical missionary has been recognized, and there are few missionary societies who have not some fully qualified doctors upon their staff. To take an example, the Church Missionary Society employs more than 50 medical missionaries, and the number of patients treated in one year (1900) was—of in-patients, 11,557; and of out-patients, 641,006.

(iii.) *The Happier Relations between Scientific and Religious Thought.*—There has been a marked change in the general feeling of the Church towards what is loosely called Science. Broadly speaking, we may say that the attitude of irreconcilable hostility on the part of the Church has almost entirely disappeared. The intelligent part of the Church has now consented to give to science the things which are science's. It is recognized that there is no part of the world of phenomena on which science has not a right to speak and to be heard. We must, however, remember that this is only a rough general estimate, and represents rather the existence of an altered feeling than an exact measurement of results. The improved feeling, it must be allowed, is due both to the larger and more scientific spirit which has pervaded Christendom, and also to the more reverent spirit which has characterized scientific inquiry. The contemptuous spirit of arrogant unbelief has passed away from scientific circles; the widening range of knowledge has left room for wonders which a narrower age of science would have scorned; there is scope for the play of activities undreamed of half a century ago. Among the best circles of scientific and Christian thought the dogmatic temper has given place to the spirit of the historical investigator. The statement must not be taken too widely. The dogmatic temper is still uppermost in some questions of the Church. The infallibility which is so dear to the religionist has fostered this dogmatic temper, and alike among the unenlightened advisers of the Vatican and in the circles of evangelical ignorance the voice of knowledge is refused and its messengers are cast out.

On the whole, however, everywhere except in such strongholds of idolized ignorance a calmer and more equable spirit possesses Christendom. It is recognized that the so-called conflict between science and religion never truly existed; the conflict was seen to be a battle between certain theological opinions and some conclusions of science. It was seen that in some cases the conclusions of science had been misunderstood, and in more cases the theological opinions were in no way parts of essential Christianity, but were rather doubtful inferences, stated in forms incidental to a particular epoch. The wide admixture of error with truth, the facility with which mistaken deductions were accepted as of equal authority with primary principles, and the diverse measures applied to language by scientific and theological thinkers were recognized; and with this recognition the most potent factors of dispute disappeared and a happier epoch alike for science and theology was inaugurated. As marks of the changes we have spoken of we may notice the totally different way in which the essays in *Lux Mundi* were received from the way in which *Essays and Reviews* were met by an earlier generation, and the significant difference between the titles of two books—one published in 1860 and the other in 1889—both dealing with the relations of science and Christianity. Mr Draper called his book the *Conflict between Science and Religion*. Dr Andrew White called his far abler and more judicious work, *The Conflict of Science and Theology*. One reason for the happier spirit which now prevails probably lies in the conviction that the battle for intellectual freedom has been finally won. No investigator now needs to veil his conclusions in a demoralizing ambiguity or to apologize for pursuing truth. Simultaneously with this secured position of the scientific inquirer there came faster to the world—and the fact is most significant—treatises on behalf of faith from the studies and laboratories of men of science.

The prevalence of this happier spirit has brought about a more wholesome and benevolent view of non-Christian beliefs. The science of comparative religion has been of service here. The faiths of the world have been investigated in a calm and impartial spirit. No thoughtful Christian man would use the language which was common fifty or sixty years ago when speaking of the creeds of other lands. The elements of truth in other creeds are now sought for; crude forms of worship are no longer looked upon as half hypocritical; Mahommed is no longer denounced as an impostor. This more temperate view of other men's creeds has naturally been followed by a great tenderness of spirit, and in some quarters the fear has been expressed that this tenderness may give rise to a kind of indifference in matters of faith. It is probable that, in their effort to do justice to heathen religions, some writers have overlooked or minimized the grave moral and social evils which are inextricably woven up with low theological ideas; but, nevertheless, on the whole it is remarkable that the generation which has learned to look with kindlier eyes upon other religions coincides with the generation which has shown the most ardent missionary

enthusiasm. The truth seems to be that the result of calm investigation has brought out into clearer relief the true significance and the moral and spiritual superiority of Christianity. Men in separating their thoughts of Christianity from the symbols of the churches, and in forming through the witness of their creeds clearer conceptions of human need, have been able to realize alike the simplicity and the marvellous fitness of Christianity to promote the elevation of human character, and thus they are able to recognize Christianity as a great evolutionary force in human history.

(iv.) *The Question of Reunion.*—The progress of Christianity has, in the view of many, been hindered by the numberless parties and organizations into which it has been divided. It is possible, however, that those who regard the divisions of Christendom with dismay may have overlooked the possible advantages of the conditions which they deplore. Apart from the energy which rivalry may stimulate, it must not be forgotten that only by the recognition of such divisions could some of the most precious of human inheritances have been preserved. Religious freedom, the shield and guardian of intellectual integrity in matters of faith, was purchased at the price of division. The endeavour to preserve union by external pressure failed, and it is now realized that the outward union of Christendom must begin with the promotion of an inward harmony. The prospects of a great external reunion of Christendom involve questions too large to be discussed here. It may, however, be well to notice that there are in recent times features, unfavourable as well as favourable, to the hopes of reunion. The stiffening of the attitude of the Roman Catholic Church which has been noticeable since the declaration of infallibility; exaggerated or mistaken ecclesiastical conceptions favoured by certain schools of thought; the tendency to treat variations of custom as transgressions of an imaginary divine law; the creation of new sins, of which denominationalism is only too fruitful: these and other features of modern Christianity are unfavourable to reunion. On the other hand, the development of a passionate yearning for reunion which has found voice all the world over; the frank recognition of the disastrous results of division, especially in the modern mission field; the growth of the practical, and the decay of the dogmatic spirit, are all favourable. Meanwhile the desire for reunion has not been confined to empty wishes. Practical steps have not been wanting. The fusion of two important bodies in Scotland—the Free Church and the United Presbyterian Church—is perhaps the most remarkable example of successful negotiation. Other negotiations are in process, and in Scotland devout men are working for a better understanding between the Church of Scotland and the Scottish Episcopal Church. Complete reunion is as yet far off, but some concordat or federation among the churches of the Reformation is a vision which many good and wise men cherish as neither unreasonable nor impossible. In the view of many the existence of common work carried on by interdenominational societies is calculated to show that some such federation may be legitimately and hopefully desired, if not expected.

The strength of the practical and individual movements in Christendom is illustrated in what follows.

### III. The Measure of Christian Progress in the Light of certain Altered Conditions.

Modern life, and what is called the modern spirit, have altered the conditions of Christendom. Men can more clearly measure the relation of Christian churches to one another; they can more clearly see their duty to the world. The scientific spirit has helped to reduce to their fitting proportion many matters which were once deemed of primary importance. Questions which former ages discussed are not left untouched; theological acrimony, if not extinct, does not cover the same field as before. The dogmatic temper has given way to a kindlier and more practical spirit, and we are able to measure the progress of Christianity by the aspirations which are now cherished, and by the change of Christian methods in practical, personal, and co-operative directions.

(i.) *The Growth of the Practical Spirit.*—There has been a marked change in ideals in recent times, and the change has mainly been in the very strong preference for work which, for distinction's sake, we may call practical. It is needful, perhaps, to explain what is meant: the energies of Christian bodies were in the main directed in former years to work which was almost exclusively ecclesiastical and controversial—*i.e.*, the members of different Christian societies or churches endeavoured to enlarge the borders of these societies by bringing in those who were careless in life or hostile in creed. There was, if we may use the phrase, a certain egotistic flavour about their work; and they were satisfied if they could maintain their own services, and bring in some aliens into their fold. Of recent years men have been desirous of wider and more practical benevolence; they have not merely wished to bring men into their church; they sought to carry the power of Christian influence and of the Christian spirit among men. They have looked at the great world, and they have been filled with the practical compassion which has prompted the inquiry, "What can we do for them?" The result has been the development of a vast amount of practical activity, more or less unrelated to the dogmatic restraints of former times. This spirit of practical Christianity has found expression in a variety of organizations—in societies, guilds, brigades, institutes, and what are known as settlements. The "settlement" means the residence in the very centre of the poorer quarters of great cities of men and women who are ready to labour—not always on distinctly or distinctively religious lines—among the needy and uncultivated classes. The aim is to bring culture, knowledge, harmless recreation, and above all, personal influence, to the very doors of the neglected. The watchword of such settlements is personal service. A young Oxford man, brilliant and devoted, Arnold Toynbee by name, has the credit of leading the way in this class of beneficent work; at all events, it was his name that was given to the Hall in Whitechapel which, under the fostering care and influence of the Rev. S. A. Barnett, was the first material embodiment of the movement. Since his time many settlements of the same or similar nature have sprung up in Great Britain and America. Young men at the universities were found to sympathize with this class of movement; and now there is in London an Oxford house, a Cambridge, an Eton, and a Harrow mission, besides many others, which act as channels for the guidance and employment of Christian or philanthropic energy. Some of these—indeed, many—are now in connexion with some one or other of the kindred bodies; but the general features of all these settlements is the recognition of any practical work calculated to minister to the cultivation and happiness of the too long neglected classes. The practical spirit shows itself also in the formation of guilds, camps, and institutes. Lads and girls, and even children are gathered together; efforts are made to organize for them not only educational and religious opportunities, but harmless recreation—holidays and excursions are arranged, games are provided, and devoted men and women identify themselves in kindly and sympathetic fashion as partners in these recreations and sharers in these games. Almost universally the influence of Christian people has been drawn into channels which an earlier generation

would have regarded as somewhat too secular to be worthy of Christian zeal. Societies like the Kyrle Society have sprung up, and endeavoured to brighten and beautify the life of the poor. The very remarkable movement known as the Salvation Army (*q.v.*) came under the influence of the practical spirit we are speaking of, and the social side of its work has been in some respects its most successful and satisfactory achievement.

The signs of this practical spirit meet us on all sides—at home in orphanages and asylums; abroad in dispensaries, medical missions (of which we have spoken), and leper settlements. Looking at these facts, observers of history have pointed out that the guiding force of Christian life has passed through the hands of various races. The Hebrew race gave it inspiration, the Greek gave it intellectual expression, the Roman gave it opportunity of world ascendancy, the Teutonic intensified its spiritual individualism, and the Anglo-Saxon race is now giving to it wide and varied practical application. However this may be, the practical work is now multitudinous and its development rapid. Toynbee Hall, the first of the settlements, was started in 1885; and there are now more than 70 such establishments in existence—35 in the United States; the resident workers in these are reckoned to be at least 300. It would be impossible to chronicle all the forms in which the practical energy displays itself. It is enough to notice that it includes reformatories, homes for waifs and strays, rescue societies, inebriates' homes, charity organizations, nursing institutions for the sick poor, holiday funds, boys' brigades, working men's clubs, reading rooms, athletic associations, homes for working girls, newspaper boys, bootblacks, drift children's missions, and others too numerous to mention. The work, though mainly directed towards the poor, does not overlook the wealthier classes: the sea-side camps and public school missions are evidence of this fact.

(ii.) *Individualism in Work.*—The practical direction of Christian activity has been accompanied by a great outburst of free and individual effort. The various Christian bodies have their agencies and societies for practical work, but one feature of modern Christian enthusiasm is its strong and marked individualism. Many of the most remarkable and successful efforts of practical energy have been due to individual rather than ecclesiastical initiative. Mr Müller's work at Bristol, Mr Quarrier's in Scotland, Dr Barnardo's in London, the enormous and world-wide organizations known as the Young Men's Christian Association, the Christian Endeavour Society, the St Andrew's Brotherhood, all owe their beginning to personal devotion.

(iii.) *Interdenominational Movements.*—There is a certain quantity of Christian energy and force which does not seem able to work through existing organizations. It is not for us to suggest reasons—we can only chronicle results. It may be that the advance of critical thought has made it impossible for certain minds to accept the real or supposed theological bondage of the churches, and that, as a consequence, a considerable portion of Christian and philanthropic earnestness has escaped into other channels; it may be that the discords or jealousies of the denominations have alienated certain ardent natures; but however this may be, there is no doubt of the great increase of independent and undenominational religious and humanitarian work.

IV. Conclusion.

The present force of Christianity in the world is the result of a steady growth in numbers and influence. The religion which was the religion of an obscure handful of men is now, after a lapse of nineteen hundred years, the religion of a third of the human race and by far the most vigorous and influential nations. Further, the religion which took its rise among the Semites has become the religion of the most powerful branch of the Aryan family; and, lastly, the race which is possessed of the greatest power of expression, the keenest sense of liberty, which possesses the freest institutions and the most marked individuality, is the race which includes the churches of the Reformation. It is in this race of strongly marked individuality that, as might be expected, the largest variety of denominations is to be found. These divisions are partly a strength and partly a weakness; in the past they have been of service in preserving intellectual independence, liberty of conscience, and religious toleration. It may be doubted, however, whether, now that the cause of freedom has been won, these divisions may not be a source of growing weakness, but against any possible ill results must be set the unifying influences now at work, the desire for reunion, the pressure of political circumstances, and the experiences of missionary enterprise. The modern spirit, moreover, if we may use a vague but useful term, tends to treat ecclesiastical and dogmatic differences as matters of lessening importance. The value of denominational barriers is depreciated in public esteem. With larger views of life and nature, of the world's history and of human interests, the minds of men are seeking the common principles on which the denominations are united, and are willing to minimize matters of difference. There is arising a powerful religious movement which is bent on service and not on controversial theology. Vast organizations on this basis are appearing in all parts of the world. In the view of some these non-denominational organizations are the seminal principles of the future Christian brotherhood—the church of the latter days—destined to grow larger and more vigorous while the more formal ecclesiastical systems slowly wither away. These are conjectures. The simple and striking fact which meets our view is not merely the widespread character of Christianity, but the marvellous way in which the forces and influences of the world are gathered into the hands of Christian nations.

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(W. B. R.)

**Christian Science,** a system of theosophic and therapeutic doctrine, which was originated in America about 1866 by Mrs Mary Baker Eddy, of Lynn, Massachusetts, and has in recent years obtained a number of adherents both in the United States and in European countries. Mrs Eddy based her teaching on the Bible, and on the principles that man's essential nature is spiritual, and that the Spirit of God being Love and Good, moral and physical evil are contrary to that Spirit, and represent an absence of the True Spirit which was in Jesus Christ. There is but one Mind, one God,

one Christ, and nothing real but Mind. Matter and sickness are subjective states of error, delusions which can be dispelled by the mental process of a true knowledge of God and Christ, or Christian science. Jesus himself healed by those means, which were therefore natural and not miraculous, and promised that those who believed should do curative works like his. About the year 1867 Mrs Eddy came forward as a healer by Mind-cure, and rapidly obtained fellow-workers and students. In 1876 a Christian Scientist Association was organized. Mrs Eddy had published in the preceding year a book entitled *Science and Health, with Key to the Scriptures.* In 1879 she became the pastor of a "Church of Christ, Scientist" in Boston, and also founded there her "Massachusetts Metaphysical College" for the purpose of medical instruction. In 1883 she started an official organ of her teaching, *The Christian Science Journal.* The first denominational chapel was built at Oconto, Wisconsin, in 1886; and in 1894 a great memorial church was erected in Boston. Mrs Eddy's publications also include *Retrospection and Introspection* (1891), *Unity of Good and Unreality of Evil* (1887), *Rudimental Divine Science* (1891), *Christian Healing* (1886).

**Christiania,** the capital of Norway, forming a county (*amt*) to itself, and situated on the Aker river, at the head of Christiania Fjord, in 59° 54′ 44″ N. lat. and 10° 43′ 28″ E. long. During the second half of the 19th century the city grew rapidly, many buildings of wood giving place to structures of brick or stone. New suburbs, spread over a wide area, were built on the rising ground to the west and north-west, around and beyond the royal park. This rapid expansion was due for the most part to the increase in the population. It was also due in part to the advance which the people made in material prosperity. For instance, in the ten years ending with 1898 it was estimated that the gross value of the property owned in Christiania had increased by 68 per cent. and the gross value of the incomes of the inhabitants by 83 per cent. In the year 1898 alone the gross value of the property was estimated to have risen from $17\frac{1}{4}$ millions sterling to nearly $20\frac{1}{4}$ millions sterling, and the gross value of the incomes from 4 millions to over $4\frac{1}{2}$ millions sterling—remarkable figures for a place of only 200,000 inhabitants. The university, which had in 1897 some 60 professors and 1200 students (1600 in 1889), embraces five faculties (theology, law, medicine, history and philology, mathematics and natural sciences), and possesses several valuable collections—a library of 350,000 vols.; museum of Norse antiquities, especially rich in objects of the Viking age, including two ancient viking ships; an ethnographical museum, a numismatic collection, a cabinet of minerals, a botanical collection, and a zoological collection. In 1899-1900 a large historical museum was built to shelter the Norwegian National Museum, the museum of northern antiquities, and certain of the university collections. Other buildings deserving mention are the national theatre (1899); the sculpture museum (1882), an Italian Renaissance building; the industrial arts museum (1876); the new Freemasons' lodge (1894), one of the handsomest structures in the city; and a conservatory of music (1883). The city is tolerably well adorned with monuments to distinguished Norwegians—Wergeland, Asbjörnsen, Eilert Sundt, Schweigaard, Kjerulf, besides King Christian IV. and others.

On the east side of the river Aker is the suburb of Oslo, with the existing episcopal palace, and an old bishop's palace, in which James VI. of Scotland (I. of England) was betrothed to Princess Anne of Denmark. In the environs of the city are the royal pleasure castle of Oscarshal (1847-52), on the peninsula Bygdö (Ladugaard) to the west of the city, with a historical museum (1881), and some ancient churches and houses brought there from different parts of the country. On Hovedö (Head Island) in the fjord, immediately opposite to Akershus (not Agershus), are the ruins of a Cistercian monastery, founded in 1147 by monks from Kirkstead (Lincolnshire), and burnt down in 1532. Then there are the pleasure resorts of St Hans Haugen (150 ft.), Frognersæter (1362 ft.), Holmenkollen sanatorium (1116 ft.), where the famous *ski* (snow-shoe) races are held in February, and Voksenkollen sanatorium (1650 ft.), opened in 1900.

Christiania is a place of considerable industrial activity, which developed rapidly in the last two decades of the 19th century. Except for two large shipbuilding yards, one with a floating dock, the other with a dry dock, most of the manufactories are concentrated in the suburb of Sagene, on the north side of the city, deriving their motive power from the numerous falls of the river Aker. They embrace factories for cotton and woollen spinning and weaving, paper, flour, soap and oil, bricks and tiles, matches, nails (especially horse-shoe nails), margarine, foundries and engineering shops, wood-pulp, tobacco, matches, linen, glass, sail-cloth, hardware, gunpowder, chemicals, with sawmills, breweries, and distilleries. In 1898 there were 375 factories at work in Christiania, and they employed 17,383 hands. There is also a busy trade in the preparation of granite paving-stones, and in the storing and packing of ice. From about the middle of the 19th century Christiania has been the principal emporium of South Norway, and has long since far outstripped Bergen in the volume of its commerce. The total value of the trade of the port increased from £4,958,600 (imports, £3,862,000; exports, £1,096,600) in 1872, to £5,492,000 in 1882, to £7,738,000 in 1892, and to £8,567,200 in 1898. The imports are more than four times the exports in respect of value, the figures for 1898 being £7,987,600 and £1,579,600 respectively. The former consist principally of grain and flour (£550,000 to £650,000), woollens (£450,000 to £550,000), coffee (£425,000 to £475,000), iron—raw and manufactured (£750,000 in 1898; £367,000 in 1894), cottons (£350,000 to £400,000), coal (£250,000 to £275,000), bacon and salt meat (£250,000 to £275,000), oils (£175,000 to over £250,000), sugar (£185,500 to £230,000), machinery (£362,000 in 1898; £149,000 in 1894), flax, jute, and hemp, paper-hangings, paints, colours, &c., wines and spirits, raw tobacco, copper, zinc, lead, and tin, silk, molasses, and other commodities. The principal exports are wood-pulp (£225,000 to £325,000), timber (£155,000), nails, paper, butter and margarine (£103,000), matches, condensed milk, fish, leather and hides, ice, sealskins, &c. Of the imports, Great Britain supplies the greater part of the cotton and woollen yarn, the machinery (including ships), and the raw metals; the United States about one-half of the oils and fats, and a large proportion of the food-stuffs, and skins, feathers, &c. Of the exports, almost the whole of the timber goes to Great Britain, together with the larger portion of the paper and food-stuffs (butter, &c.). In 1872 the port was entered by 1787 vessels of 393,600 tons burden; in 1891 by 2078 vessels of 817,800 tons; and in 1899 by 2710 vessels of 1,000,740 tons. Although Christiania owns a smaller merchant fleet than Bergen, her shipping increased from 264 vessels of 104,000 tons in 1881 to 401 vessels of 206,150 tons in 1892, and to 398 vessels of 380,525 tons in 1900. Early in 1899 the municipality voted £47,000 for the construction of a pier, a harbour for fishing-boats, protected by a mole and a quay, 345 ft. long, on the shore

underneath the fortress of Akershus. These works are intended to be the first in a general rearrangement of the entire harbour of the city. Population (1885), 128,301, counting in the suburbs; (1891), 151,239; (1898), 203,337, of whom 93,695 males, 109,642 females; (1900), 225,686.

**Christiansand,** a fortified seaport town of Norway, on the S. coast. It is an important port of call for the Baltic steamboats, and a fishing centre. It was burnt down in 1892, and subsequently rebuilt of brick. It exports timber (nearly 3 million cubic feet annually), wood-pulp, paper, fish, and felspar. The total trade is under half a million sterling. Christiansand owns about 100 vessels of 52,000 tons. An impetus was given to the trade and tourist traffic by the opening of the Sætersdal railway, tapping the interior, in 1895-96. Sawmills, wood-pulp factories, shipbuilding yards, and mechanical workshops are the principal industrial works. The cathedral was rebuilt after a fire in 1880. Population (1875), 11,766; (1900), 14,007.

**Christianstad,** a fortified town of Sweden, on a peninsula which juts out into Lake Sjövik, an expansion of the river Helge, 10 miles from the Baltic and 66 miles E. from Helsingborg by rail. It is the headquarters of several railway companies, and has flour mills, engineering works, distilleries, a weaving mill, sugar factory, &c., and exports granite and wood-pulp, and imports coal (40,000 to 70,000 tons), and wheat and rye. In 1896-97 its harbour at Ahus (pop. 1547) was enlarged and deepened to admit vessels drawing 18 ft., and a new entrance channel made. In 1899 it was entered by 530 vessels of 100,150 tons. A new town hall was built in 1889. Population (1880), 9203; (1900), 10,318.

**Christiansund,** a seaport town of Norway, co. Romsdal, 83 miles W.S.W. from Trondhjem. It exports cod-fish, herrings, cod-liver oil, fish manure, &c., to the annual value of £350,000 to £550,000, and imports salt, coal, and colonial wares to about £55,000. Since 1894 butter has been exported to Great Britain. In 1892 an outlook tower was erected to commemorate the 150th anniversary of the founding of the town. Population (1875), 8251; (1898), 11,68

**Christina, Maria Christina Henrietta Désirée Félicité Rénière,** QUEEN-REGENT OF SPAIN (1858- ——), widow of Alfonso XII. and mother of Alfonso XIII., was born at Gross Seelowitz, in Austria, on 21st July 1858, being the daughter of the Archduke Charles Ferdinand and the Archduchess Elizabeth of Austria. She was brought up by her mother as a rigid Catholic, and great care was taken with her education. At eighteen she was appointed, by the Emperor Francis Joseph, abbess of the House of Noble Ladies of Saint Theresa in Prague, where she made herself very popular and distinguished herself by her intellectual parts. It is said that at the Court of Vienna the archduchess saw the young Prince Alfonso of Spain when he was only a pretender in exile, before the restoration of the Bourbons. A few years later, when Alfonso XII. had lost his first wife and cousin, Queen Mercedes, daughter of the duc de Montpensier, his ministers, especially Señor Canovas, urged him to marry again. He told them that if he did so it would only be with the young Austrian Archduchess Maria Christina. After some negotiations between the two Courts and Governments, it was agreed that the Archduchess Elizabeth and her daughter should meet Alfonso XII. at Arcachon, in the south of France, where a few days' personal acquaintance was sufficient to make both come to a decision. The duke of Bailen went officially to Vienna to get the emperor of Austria's authorization, and on 14th November 1879, in the throne-room of the Imperial palace, the archduchess solemnly abdicated all her rights of succession in Austria, in accordance with the law obliging all princesses of the Imperial house to do so when they wed a foreign prince. On 17th November the archduchess and her mother, with a numerous suite, started for Spain, arriving at the royal castle of El Pardo, near Madrid, on 24th November. The wedding took place in the Atocha cathedral, on 29th November, in great state, and was followed by splendid festivities. Queen Christina bore her husband two daughters, before he died in 1885—Dona Mercedes, born 11th September 1880, and Dona Maria Theresa, born 12th November 1882. During her husband's lifetime the young queen kept studiously apart from politics, so much so that her inexperience caused much anxiety in November 1885, when she was called upon to take the arduous duties of regent. During the long minority of the posthumous son of Alfonso XII., the present King Alfonso XIII., the Austrian Queen-Regent acted in a way that obliged even the adversaries of the throne and the dynasty to respect the mother and the woman. The people of Spain, and the ever-restless civil and military politicians, found that the gloved hand of their constitutional ruler was that of a strong-minded and tenacious regent, who often asserted herself in a way that surprised them much, but always, somehow, commanded obedience and respect. More could not be expected by a foreign ruler from a nation little prone to waste attachment or demonstrative loyalty upon anybody not Castilian born and bred.

**Christinehamn,** or KRISTINEHAMN, a town of the province of Vermland, Sweden, near the N.E. corner of Lake Wener, 25 miles by rail E. by S. from Carlstad. It has ironworks, a tobacco factory, &c., and large fairs are held every April and October. A part of the town was burnt down in 1893. Population (1880), 5039; (1900), 6775.

**Christison, Sir Robert,** BART. (1797-1882), Scottish toxicologist and physician, was born in Edinburgh on 18th July 1797. After graduating at the university of that city in 1819, he spent a short time in London, studying under Abernethy and Lawrence, and in Paris, where he learnt analytical chemistry from Robiquet and heard lectures by Orfila, the famous toxicologist. In 1822 he returned to Edinburgh as professor of Medical Jurisprudence, and set to work to organize the study of his subject on a sound basis. On poisons in particular he speedily became a high authority; his well-known book on them was published in 1829, and in the course of his inquiries he did not hesitate to try such daring experiments on himself as taking large doses of Calabar bean. His attainments in medical jurisprudence and toxicology procured him the appointment, in 1829, of medical officer to the Crown in Scotland, and from that time till 1866 he was called as a witness in many celebrated criminal cases. In 1832 he gave up the chair of Medical Jurisprudence and accepted that of Medicine and Therapeutics, which he held till 1877; at the same time he became professor of Clinical Medicine, and continued in that capacity till 1855. His fame as a toxicologist and medical jurist, together with his work on the pathology of the kidneys and of fevers, secured him a large private practice, and he succeeded to a fair share of the honours that commonly attend the successful physician, being appointed physician to Queen Victoria in 1848 and receiving a baronetcy in 1871. Among the books which he published were a treatise on *Granular Degeneration of the Kidneys* (1839), and a *Commentary on the Pharmacopœias of Great Britain* (1842). Sir Robert Christison, who retained remarkable physical vigour and activity

down to extreme old age, died at Edinburgh on 23rd January 1882.

**Christmas Island,** a British possession under the government of the Straits Settlements, situated in the eastern part of the Indian Ocean (in 10° 25′ S. lat., 105° 42′ E. long.), about 190 miles S. of Java. It is not known when and by whom the island was discovered, but under the name of *Moni* it appears on a Dutch chart of 1666. It was first visited in 1688 by Dampier, who found it uninhabited. In 1886 Captain Maclear of H.M.S. *Flying Fish*, having discovered an anchorage in a bay which he named Flying Fish Cove, landed a party and made a small but interesting collection of the flora and fauna. In the following year Captain Aldrich on H.M.S. *Egeria* visited it, accompanied by Mr J. J. Lister, F.R.S., who formed a larger biological and mineralogical collection. Among the rocks then obtained and submitted to Sir John Murray for examination there were detected specimens of nearly pure phosphate of lime, a discovery which eventually led, in June 1888, to the annexation of the island to the British Crown. Soon afterwards a small settlement was established in Flying Fish Cove by Mr G. Clunies Ross, the owner of the Keeling Islands, which lie about 750 miles to the westward. In 1891 Mr Ross and Sir John Murray were granted a lease, but on the further discovery of phosphatic deposits they disposed of their rights in 1897 to the company now in possession. In the same year a thorough scientific exploration was made, at the cost of Sir John Murray, by Mr C. W. Andrews, of the British Museum.

*Physical Features and Geology.*—The island is a quadrilateral with hollowed sides, about 12 miles in greatest length and 9 in extreme breadth. It is about 190 miles from the nearest land, and is probably the only tropical island that had never been inhabited by man. When the first settlers arrived, in 1897, it was covered with a dense forest of great trees and luxuriant undershrubbery. The settlement in Flying Fish Cove now numbers some 250 inhabitants, consisting of Europeans, Sikhs, Malays, and Chinese, by whom roads are being cut and patches of cleared ground cultivated. The island is the flat summit of a submarine mountain more than 15,000 feet high, the depth of the platform from which it rises being about 14,000 feet, and its height above the sea being upwards of 1000 feet. The submarine slopes are steep, and within 20 miles of the shore the depth of the sea reaches 2400 fathoms. It consists of a central plateau descending to the water in three terraces, each with its "tread" and "rise." The shore terrace descends by a steep cliff to the sea, forming the "rise" of a submarine "tread" in the form of fringing reef which surrounds the island and is never uncovered, even at low water, except in Flying Fish Cove, where the only landing-place exists. The central plateau is a plain whose surface presents "rounded, flat-topped hills and low ridges and reefs of limestone," with narrow intervening valleys. On its northern aspect this plateau has a raised rim having all the appearances of being once the margin of an atoll. On these rounded hills occurs the deposit of phosphate of lime which gives the island its commercial value. The phosphatic deposit has doubtless been produced by the long-continued action of a thick bed of sea-fowl dung, which converted the carbonate of the underlying limestone into phosphate. The flat summit is formed by a succession of limestones—all deposited in shallow water—from the Eocene (or Oligocene) up to recent deposits in the above-mentioned atoll with islands on its reef. The geological sequence of events appears to have been the following:—After the deposition of the Eocene (or Oligocene) limestone—which reposes upon a floor of basalts and trachytes—basalts and basic tuffs were ejected, over which, during a period of very slow depression, orbitoidal limestones of Miocene age—which seem to make up the great mass of the island—were deposited; then elapsed a long period of rest, during which the atoll condition existed and the guano deposit was formed; from then down to the present time there has succeeded a series of sea-level subsidences, resulting in the formation of the terraces and the accumulation of the detritus now seen on the first inland cliff, the old submarine slope of the island. The occurrence of such a series of Tertiary deposits appears to be unknown elsewhere. The whole series was evidently deposited in shallow water on the summit of a submarine volcano standing in its present isolation, and round which the ocean floor has probably altered but a few hundred feet since the Eocene age. Thus although the rocks of the southern coast of Java in their general characters and succession resemble those of Christmas Island, there lies between them an abysmal trough 15,000 feet in depth, which renders it scarcely possible that they were deposited in a continuous area, for such an enormous depression of the sea-floor could hardly have occurred since Miocene times without involving also Christmas Island. One of the main purposes of the exploration was to obtain light on the question of the foundation of atolls. As a result of the investigation it has been found that "the great thickness of reef limestone required by the Darwinian theory of atoll formation" does not exist, and "although there may be some evidence that subsidence did occur in the earlier history of the island, it is clear that it was neither continuous for any long period nor of any great extent" (*Andrews*). If Christmas Island cannot, perhaps, be proved to have been a typical atoll, it can, however, "be shown that at one time it must have consisted of reefs and islands approximating very nearly to those seen on atolls which are regarded as typical, and the determination of the nature of the foundation upon which those reefs and islands rested is, at least, a step in the right direction" (*Andrews*).

*Flora and Fauna.*—The flora consists of 129 species of angiosperms, 1 *Cycas*, 22 ferns, and a few mosses, lichens, and fungi, 17 of which are endemic, while a considerable number—not specifically distinct—form local varieties nearly all presenting Indo-Malayan affinities, as do the single *Cycas*, the ferns, and the cryptogams. As to its fauna, the island contains 319 species of animals—54 only being vertebrates—145 of which are endemic. A very remarkable distributional fact in regard to them, and one not yet fully explained, is that a large number show affinity with species in the Austro-Malayan rather than in the Indo-Malayan, their nearer, region. The ocean currents, the trade-winds blowing from the Australian mainland, and north-westerly storms from the Malayan islands, are no doubt responsible for the introduction of many, but not all, of these Malayan and Australasian species.

*Climate.*—The climate is healthy, the temperature varying from 75° to 84° F. The prevailing wind is the S.E. trade, which blows the greater part of the year. The rainfall in the wet season is heavy, but not excessive, and during the dry season the ground is refreshed with occasional showers and heavy dews. Malarial fever is not prevalent, and it is interesting to note that there are no swamps or standing waters on the island.

See ANDREWS, C. W. *A Monograph of Christmas Island (Indian Ocean)*, London, 1900, to which the present writer has been greatly indebted. (H. O. F.)

**Chronographs.**—In the article GUNNERY (*Ency. Brit.* vol. xi.) descriptions were given of some chronographs adapted for the determination of the velocities of projectiles. Some additional forms of instruments both for this and for other purposes are here described.

*Gun Chronographs.*—Probably the earliest forms of chronographs, not based on the ballistic pendulum method, are due to Colonel Grobert, 1804, and Colonel Dabooz, 1818, both officers of the French army.

In the instrument by Grobert two large discs, attached to the same axle 13 ft. apart, were rapidly rotated; the shot pierced each disc, the angle between two holes giving the time of flight of the ball, when the angular velocity of the discs was known. In the instrument by Colonel Dabooz a cord passing over two light pulleys, one close to the gun, the other at a given distance from it, was stretched by a weight at the gun end and by a heavy screen at the other end. Behind this screen there was a fixed screen. The shot cut the cord and liberated the screen, which was perforated during its fall. The height of fall was measured by superposing the hole in the moving screen upon that in the fixed one. This gave the approximate time of flight of the shot over a given distance, and hence its velocity.

In the early form of chronoscope invented by Wheatstone in 1840 the period of time was measured by means of a species of clock, driven by a weight; the dial pointer was started and stopped by the action of an electromagnet which moved a pawl engaging with a toothed wheel fixed on the axle to which the dial pointer was attached. The instrument applied to the determination of the velocity of shot is described thus by Wheatstone:—

"A wooden ring embraced the mouth of the gun, and a wire connected the opposite sides of the ring. At a proper distance the target was erected, and so arranged that the least motion given to it would establish a permanent contact between two metal points. One of the extremities of the wire of the electromagnet (before mentioned) was attached to one pole of a small battery; to the other extremity of the electromagnet were attached two wires, one of which communicated with the contact piece of the target, and the other with one of the ends of the wire stretched across the mouth of the gun; from the other extremity of the voltaic battery

two wires were taken, one of which came to the contact piece of the target, and the other to the opposite extremity of the wire across the mouth of the gun. Before the firing of the gun a continuous circuit existed, including the gun wire; when the target was struck the second circuit was completed; but during the passage of the projectile both circuits were interrupted, and the duration of this interruption was indicated by the chronoscope."

Professor Henry (*Journal Franklin Inst.*, 1886) employed a cylinder driven by clockwork, making ten revolutions per second. The surface was divided into 100 equal parts, each equal to $\frac{1}{1000}$ second. The time marks were made by two galvanometer needles, when successive screens were broken by a shot. Henry also used an induction-coil spark to mark the cylinder, the primary of the coil being in circuit with a battery and screen. This form of chronograph is in many respects similar to the instrument of Konstantinoff, which was constructed by Breguet and has been sometimes attributed to him (*Les Comptes Rendus*, 1845). This chronograph consisted of a cylinder 1 m. in circumference and 0·36 m. long, driven by clockwork, the rotation being regulated by a governor provided with wings. A small carriage geared to the wheelwork traversed its length, carrying electromagnetic signals. The electric chronograph signal usually consists of a small armature (furnished with a style which marks a moving surface) moving in front of an electromagnet, the armature being suddenly pulled off the poles of the electromagnet by a spring when the circuit is broken (*Journal of Physiology*, vol. ix. p. 408). The signals in Breguet's instrument were in a circuit, including the screens and batteries of a gun range. The measurement of time depended on the regularity of rotation of the cylinder, on which each mm. represented $\frac{1}{1000}$ second.

In the Navez chronograph (1848) the time period is found by means of a pendulum held at a large angle from the vertical by an electromagnet, which is in circuit with a screen on the gun range. When the shot cuts this screen, the circuit is broken and the pendulum liberated and set swinging. When the next screen on the range is broken by the shot, the position of the pendulum is recorded and the distance it has passed through measured on a divided arc. From this the time of traversing the space between the screens is deduced. By means of an instrument known as a disjunctor (*Ency. Brit.* vol. xi. p. 300) the instrumental time-loss or latency of the chronograph is determined. In Benton's chronograph (1859) two pendulums are liberated, in the same manner as in the instrument of Navez, one on the cutting of the first screen, the other on the cutting of the second. The difference between the swings of the two pendulums gives the time period sought for. The disjunctor is also used in connexion with this instrument. In Vignotti's chronograph (1857) again a pendulum is employed, furnished with a metal point, which moves close to paper impregnated with ferro-cyanide of potassium. The gun-range screens are included in the primary circuits of induction coils; when these circuits are broken a spark from the pointer marks the paper. From these marks the time of traverse of the shot between the screens is determined.

Colonel Sebert (*Extraits du Mémorial de l'Artillerie de la Marine*) devised a chronograph to indicate graphically the motion of recoil of a cannon when fired. A pillar fixed to the ground at the side of the gun-carriage supported a tuning-fork, the vibration of which was maintained electrically. The fork was provided with a tracing point attached to one of the prongs, and so adjusted that it drew its path on a polished sheet of smoke-blackened metal attached to the gun-carriage, which traversed past the tracing point, when the gun ran back. The fork used made 500 complete vibrations per second. A central line was drawn through the curved path of the tracing point, and every entire vibration cut the straight line twice, the interval between each intersection equalling $\frac{1}{1000}$ second. The diagram so produced gave the total time of the accelerated motion of recoil of the gun, the maximum velocity of recoil, and the rate of acceleration of recoil from the beginning to the end of the motion. By means of an instrument furnished with a microscope and micrometers, the length and amplitude, and the angle at which the curved line cut the central line, were measured. At each intersection (according to the inventor) the velocity could be deduced. The motion at any intersection being compounded of the greatest velocity of the fork, while passing through the midpoint of the vibration and the velocity of recoil, the tangent made by the curve with the straight line represents the ratio of the velocity of the fork to the velocity of recoil. If $a$ be the amplitude of vibration, considered constant, $v$ the velocity of the fork at the midpoint of its path, $r$ the velocity of recoil, $\alpha$ the angle made by the tangent to the curve with the straight line at the point of intersection, and $t$ the line of a complete vibration; then,

$$v=\frac{2\pi a}{t}; \quad r=\frac{v}{\tan \alpha}.$$

In Colonel Watkin's chronograph ("Chronographs and their Application to Gun Ballistics," *Proc. Roy. Inst.*, 1896) a metal drum, divided on its edge so that when a vernier is used a minute of angle may be read, is rotated rapidly by a motor at a practically uniform speed. The points of a r[illegible] pins, screwed into a frame of ebonite, can be [illegible] inch of the surface of the drum. Each pin is a part of the secondary circuit of an induction coil, the space between the pins and the drum forming spark gaps. The drum is rubbed over with a weak solution of paraffin wax in benzol, which causes the markings produced by the sparks to be well defined. The records are read by means of a fine hair stretched along the drum and just clear of it, the dots being located under the hair by means of a lens. The velocity of rotation is found by obtaining spark marks, due to the primary circuits of two induction coils being successively broken by a weight falling and knocking over two light levers. The distance between the levers is about 3·77 inch, and the time of fall between the levers is 0·018948 sec. In practice two drop weights are used, to avoid the chance of an experiment being wasted. This chronograph has been used for finding the velocity of projectiles after leaving the gun, and also for finding the rate at which a shot traverses the bore. For the latter purpose the shot successively cuts insulated wires fixed in plugs screwed into the gun at known intervals; each wire forms a part of the primary of an induction coil, and as each is cut a dot is made on the rotating drum by the induced spark.

Jervis-Smith's [illegible] periods of time varying fr[illegible] part of a second (*Proc. Roy. Soc.* vol. xlv. p. [illegible] from Pat. 1894. *The Tram Chronograph*, by [illegible], F R.S.). It consists of a metal girder having a T-shaped end. This carries two parallel steel rails, the edges of which lie in the same vertical plane. The girder is supported at its end, and at the extremities of the T-piece, on the V-groove, trihedral hole, and plane system. A carriage or tram furnished with three grooved wheels runs on the rails, and a slightly-smoked glass plate is attached to its vertical side. The tram in the original instrument was propelled by a falling weight, but in an improved form one or more spiral springs are employed. All time traces are made immediately after the propelling force has ceased to act. The tram is brought to rest by a gradually applied brake, consisting of two crossed leather bands stretched by two springs; a projection from the tram runs between the bands, and [illegible] with but little lateral pressure. When, for certain physiological experiments, a low velocity of traverse is required, a heavy flywheel is mounted on the tram and geared to its wheels. A pillar also mounted on the hole, groove and plane method, is placed vertically in front of the glass, to carry the electromagnetic signals, which can be brought into contact with the glass by means of a tangent-screw. A standard fork by Koenig fixed to a pillar also makes a trace on the glass, being automatically thrown into vibration. Tuning-forks may be calibrated by obtaining two signal markings on the plate, controlled by a standard clock of known rate. Two motions of a slide on the pillar, viz., of rotation and translation, allow a number of observations to be made. The traces are counted out on a sloping glass desk, and the time of flight of a projectile between two or more screens is found. When very close readings are required, they are made by means of a traversing micrometer microscope. If the instrument is used for gun work, the tram is driven at full speed; when the distance between the screens is known, and also the time of flight, the midpoint velocity is found by applying Bashforth's formula. When the velocity of shot from a shot-gun has to be found, a thin wire stretched across the muzzle takes the place of the first screen, and a thin sheet of metal or cardboard carrying an electric contact, or a Branly coherer, takes the place of the second screen. The electric firing circuit is provided with a safety key attached by a cord to the man who loads the gun and prepares the electric fuse, thus preventing him from getting into the line of fire when the gun is fired by the chronograph. (*Pat. Record*, 1897.) The tram, when the instrument is adjusted, has a practically constant velocity of traverse.

The polarizing photo-chronograph, designed and used by Dr A. Cushing Crehore and Dr G. Owen Squier at the United States Artillery School (*Journal United States Artillery*, 1895, vol. vi. p. 271), depends for its indications upon the rotation of a beam of light by a magnetic field, produced by a solenoidal current, which is opened and closed by the passage of the projectile. The general arrangement is as follows:—A beam of light from an electric lamp traverses a lens, then a Nicol prism, next a glass cylinder furnished with plane glass ends and coiled with insulated wire, then an analyser and two lenses, finally impinging on a photographic plate to which rotation is given by an electric motor, the plane of rotation being perpendicular to the direction of the beam of light. The same plate also records the shadow of a pierced projection attached to a tuning-fork, light from the electric lamp being diverted by a mirror for this purpose. The solenoid used to produce a magnetic field across the glass cylinder, which is filled with carbon bisulphide, is in circuit with a dynamo, resistances, and

the screens on the gun range. It is a well-known phenomenon in physics that when, with the above-mentioned combination of polarizing Nicol prism and analyser, the light is shut off by [illegible] analyser, it is instantly restored when the carbon bisulphide is placed in a magnetic field. This phenomenon is utilized in this instrument. The projectile, by cutting the wire screens, causes the magnetic field to cease and light to pass. By means of an automatic switch the projectile, after cutting a screen, restores the electric circuit, so that successive records are registered. After a record has been made it is read by means of a micrometer microscope, the angle moved through by the photographic disc is found, and hence the time period between two events. In the photo-chronograph described in *Untersuchungen uber die Vibration des Gewehrlaufs*, by C. Cranz and K. R. Koch, Munchen, 1899, also note on the same, *Nature*, vol. lxi. p. 58, a sensitive plate moving in a straight line receives the record of the movement of the barrels of firearms when discharged. It was mainly used to determine the "angle of error of departure" in ballistics.

*Astronomical Chronographs.*—The astronomical chronograph is an instrument whereby an observer is enabled to register the time of transit of a star on a sheet of paper attached to a revolving cylinder. A metal cylinder covered with a sheet of paper is rotated by clockwork controlled by a conical pendulum, or by a centrifugal clock governor such as is used for driving a telescope. By means of a screw longer than the cylinder, mounted parallel with the axis of the cylinder and rotated by the clockwork, a carriage is made to traverse close to the paper. In some instruments this carriage is furnished with a metal point, and in others with a stylographic ink pen. The point or pen is made to touch the paper by an electromagnet the electric current of which is closed by the observer at the transit instrument, and a mark is recorded on the revolving cylinder. The movement of the same point or pen is also controlled by a standard clock, so that at the end of each second a mark is made. The cylinder makes one revolution per minute, and the minute is indicated by the omission of the mark. In Dent's form (*Nature*, vol. xxiii. p. 59) continuous observations can be recorded for $6\frac{3}{8}$ hours. The conical pendulum used to govern the rotation of the cylinder was the invention of Sir G. B. Airy. The lower end is geared to a metal plate which sweeps through an annular trough filled with glycerine and water. When the path of the pendulum exceeds a certain diameter it causes the plate to enter the liquid more deeply, its motion being thereby checked; also, when the pendulum moves in a smaller circle, the plate is lifted out of the liquid and the resistance is diminished in the same proportion as the force. The compensatory action is considerable; doubling the driving power produces no perceptible difference in the time. To prevent the injury of the conical pendulum and the wheel work by any sudden check of the cylinder, a ratch-wheel connexion is placed between the cylinder and the train of wheel work; this enables the pendulum to run on until it gradually comes to rest. The pendulum, which weighs about 18 lb, is compensated, and makes one revolution in two seconds; it is suspended from a bracket by means of two flexible steel springs placed at right angles to one another.

In the astronomical chronograph designed by Sir Howard Grubb, F.R.S. (*Proc. Inst. Mech. Eng.*, July 1888), the recording cylinders —two in number—are driven by a weight acting on a train of wheel work controlled by an astronomical telescope governor. The peculiar feature of this instrument is that the axle is geared to a shaft which communicates motion to the cylinders through a mechanism whereby the speed of rotation is constantly corrected by a standard clock. Should the rotation fall below the correct speed, it is automatically accelerated, and if its speed of rotation rises above the correct one, it is retarded. The accelerator and retarder are thrown into action by electromagnets, controlled by a "detector" mounted on the same shaft. The rather complicated mechanism employed to effect the correction is described and fully illustrated in the reference given. The cylinders are covered with paper, but all the markings are made with a stylographic pen. The marks indicating seconds are dots, but those made by the observer are short lines. When an observation is about to be made, the observer first notes the hour and minute, and, by pressing a contact key attached to a flexible cord at the transit instrument, marks the paper with a letter in Morse telegraph characters, indicating the hour and minute; he then waits till a micrometer wire cuts a star and at the instant closes the circuit, so that the second and fraction of a second are registered on the chronograph paper. When a set of observations have been taken, the paper is removed from the cylinder, and the time results are obtained by applying a suitably divided rule to the marked paper, fractions of a second being estimated by applying a piece of glass ruled with eleven straight lines converging to a point. The ends of these lines on the base of the triangle so formed are equidistant on one edge of the glass, so that when the first and last lines are so placed as to coincide with the beginning and end of the markings of a second, that second is divided into ten equal parts. The base of the triangle is always kept parallel with the line of dots. The papers, after they have been examined and the results registered, are kept for reference.

The observatory of Washburn, University of Wisconsin, is furnished with a chronograph of the same type as that of Dent (*Annals Harvard Coll. Obs.* vol. i. pt. ii. p. 34), but in this instrument the rotation of the cylinder is controlled by a double conical pendulum governor of peculiar construction. When the balls fly out beyond a certain point, one of them engages with a hook attached to a brass cylinder which embraces the vertical axle loosely. When this mass is pulled aside the work done on it diminishes the speed of the governor. The pendulum ball usually strikes the hook from 60 to 70 times per minute. Governors on this principle were adopted by Alvan Clark for driving heliostats in the United States Transit of Venus Expedition, 1874.

*Acoustic Chronographs.*—A chronograph was devised by Regnault (*Acad. des Sc.*, 1868) to determine the velocity of sound propagated through a great length of pipe. A band of paper 27 mm. wide was continuously unrolled from a bobbin by means of an electromagnetic engine In its passage over a pulley it passed over a smoky lamp flame, which covered it with a thin deposit of carbon. It next passed over a cylinder in contact with the style of a tuning-fork kept in vibration by electromagnets placed on either side of its prongs, the current being interrupted by the fork; it was also in contact with an electric signal controlled by a standard clock. Also an electromagnetic signal marked the beginning and end of a time period. Thus three markings were registered on the band, viz., the time of the pendulum, the vibrations of the fork, and the marking of the signal due to the opening and closing of the current by electrical contacts attached to diaphragms on which the sound wave acted. The contacts consisted of minute hammers resting on metal points fixed to the centre of diaphragms which closed the end of the experimental pipes. The signal marked the instant at which a sound wave impinged on a diaphragm. The markings on the paper band gave the period of time between two events, and the number of vibrations of the tuning-fork per second were estimated by means of markings due to the clock. The sound wave was usually originated by firing a pistol into the pipe furnished with diaphragms and contact pieces.

In the chronographic use of the Morse telegraph instrument (Stewart and Gee, *Elementary Practical Phys.* p. 234) a circuit is arranged which includes a seconds pendulum furnished with a fine platinum wire below the bob, which sweeps through a small mass of mercury forming a part of the circuit. There is a Morse key for closing the circuit. A fast-running Morse instrument and a battery are placed across this circuit as a shunt. A succession of dots is made on the paper ribbon by the circuit being closed by the pendulum, and the space between each adjacent dot indicates a period of one second's duration. Also, when the key is depressed, a mark is made on the paper. To measure a period of time, the key is depressed at the beginning and end of the period, causing two dots to be made on the ribbon; the interval between these, when measured by the intervals due to the pendulum, gives the length of the period in seconds, and also in fractions of a second, when the seconds' interval is subdivided into convenient equal parts. This apparatus has been used in determination of the velocity of sound. In the break circuit arrangement of pendulum key and Morse instrument the markings appear as breaks in a line which would otherwise be continuous. This combination was employed by Professors Ayrton and Perry in their determination of the acceleration of gravity at Tokio, 1877-78 (*Proc. Phys. Soc.* London, vol. iii. p. 268).

In the tuning-fork electro-chronograph attributed to Hipp a metal cylinder covered with smoked glazed paper is rotated uniformly by clockwork, a tuning-fork armed with a metallic style being so adjusted that it makes a clear fine line on the smoked paper. The tuning-fork is placed in the secondary circuit of an induction coil, so that when the primary circuit is broken an induced spark removes a speck of black from the paper and leaves a mark. The time period is deduced by counting the number of vibrations and fractions of vibration of the tuning-fork as recorded by a sinuous line on the cylinder. In later forms of this instrument the cylinder advances as it rotates, and a spiral line is traced. To obtain good results the spark must be very small, for when large it often leaps laterally from the end of the style, and does not give the true position of the style when the circuit is broken. The same arrangement of tuning-fork and revolving cylinder, with the addition of a standard clock, has been used by Mayer (*Trans. National Academy of Sciences U.S.A.* vol. iii.) and others for calibrating tuning-forks, and comparing their vibrations directly with the beats of the pendulum of a standard clock the rate of which is known. The pendulum makes and breaks the primary circuit by carrying a small platinum wire through a small mercury meniscus. Better and apparently certain contacts can be obtained from platinum contact-pieces,

brought together above the pendulum by means of a toothed wheel on the scape-wheel arbor. Sparking at the contact points is greatly reduced by placing a couple of lead plates in dilute sulphuric acid as a shunt across the battery circuit.

*For physiological purposes.*—Fick's pendulum myograph or muscle-trace recorder is described in *Vierteljahrschr. der Naturforsch. Ges. in Zurich*, 1862, s. 307, and in *Text-book of Physiology*, M. Foster, pp. 42, 45. It was used to obtain a record of the contraction of a muscle when stimulated. In many respects the instrument is similar to the electro-ballistic chronograph of Navez. A long pendulum, consisting of a braced metal frame, carries at its lower end a sheet of smoked glass. The pendulum swings about an axis supported by a wall bracket. Previous to an experiment, the pendulum is held on one side of its lowest position by a spring catch; when this is depressed it is free to swing. At the end of its swing it engages with another spring catch. In front of the moving glass plate a tuning-fork is fixed, also a lever actuated by the muscle to be electrically stimulated. When the pendulum swings through its arc, it knocks over the contact key in the primary circuit of an induction coil, the secondary of which is in connexion with the muscle. The smoked plate receives the traces of the style of the tuning-fork and of the lever attached to the muscle, and also the trace of an electromagnetic signal which marks the instant at which the primary circuit is broken. After the traces are made, they are ruled through with radial lines, cutting the three traces, and the time intervals between different parts of the muscle curve are measured in terms of the period of vibration of the tuning-fork, as in other chronographs in which the tuning-fork is employed.

In the spring myograph of Du Bois Reymond (Munk's *Physiologie der Menschen*, p. 398) a smoked glass plate attached to a metal rod is shot by a spiral spring along two guides with a velocity which is not uniform. The traces of a style moved by the muscle under examination, and of a tuning-fork, are recorded on the glass plate, the shooter during its traverse knocking over one or more electric keys, which break the primary circuit of an induction coil, the induced current stimulating the muscle.

In the photo-electric chronograph devised by Mr G. J. Burch (*Journal of Physiology*, vol. xviii. p. 125; *Electrician*, vol. xxxvii. p. 436) the rapid movements of the column of mercury in a capillary electrometer used in physiological research are recorded on a sensitive plate moving at a uniform angular velocity. The trace of the vibrating prongs of a tuning-fork of known period is also recorded on the plate, the light used being that of the electric arc. The images of the meniscus of the mercury column and of the moving fork are focussed on the plate by a lens. Excellent results have been obtained with this instrument.

An important development of a branch of chronography is due to Marey (*Comptes Rendus*, 7 Août 1882, and *Le Mouvement*, par E. S. Marey, Paris, 1894), who employed a photographic plate for receiving successive pictures of moving objects, at definite times, when investigating the movements of animals, birds, fishes, insects, and also microscopic objects such as vorticellæ. The instrument in one of its forms consisted of a camera and lens. In front of the sensitive plate and close to it a disc, pierced with radial slits, revolved at a given angular velocity, and each time a slit passed by the plate was exposed. But since, in the time of passage of the space between the slits, the object had moved by a certain amount across the field of view, a fresh impression was produced at each exposure. The object, well illuminated by sunlight, moved in front of a black background. Since the angular velocity of the disc was known, and the number of slits, the time between the successive positions of the object was also known.

Marey (*La Méthode graphique*, pp. 133, 142, 456), by means of pneumatic signals and a rotating cylinder covered with smoked glazed paper, measured the time of the movements of the limbs of animals. The instrument consists of a recording cylinder rotated at a uniform angular velocity by clockwork controlled by a fan governor, and pneumatic signal, constructed thus. One end of a closed shallow cylinder, about 4 cm. dia., is furnished with a stretched rubber membrane. A light lever, moving about an axis near the edge of the cylinder, is attached to the centre of the membrane by a short rod, its free end moving as the membrane is distended. The cylinder is connected by a flexible tube with a similar cylinder and membrane, but without a lever, which is attached to that part of the body of the animal the movement of which is under investigation. The system is full of air, so that when the membrane attached to the animal is compressed, the membrane which moves the lever is distended and the lever moved. Its end, which carries a scribing point, marks the smoked paper on the rotating cylinder. The pneumatic signal is called by Marey "tambour à levier."

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**Chronological Table.**—The following table of the leading events in every country in the world has been prepared in continuation of the table published in the ninth edition of this work, which brought down the record to the close of 1875. It must always be difficult to determine what events should or should not appear in such a chronicle, but in this brief abstract the aim has been to include rather than to exclude, with a view to making the table a really useful *aide-mémoire*:—

1876. Chapter of Knights of the Star of India held by the Prince of Wales in Calcutta, January 1. Death of Francis Deák, January 28. Administrative reform Note presented to Turkey by the Great Powers, January 31. Perak River insurgents defeated by the British, February 4. Prince Bismarck's reply to the charge of warlike designs, February 10. Purchase of Suez Canal shares voted by the House of Commons, February 21. Don Carlos retires from Spain, February 27. Incorporation of Khokand in the Russian Empire, March 13. Royal Titles Bill passed by the House of Commons, March 23. Philadelphia Centennial Exhibition opened, May 10. British fleet arrives in Besika Bay, May 26. Turkish massacres in Bulgaria, May. Deposition of Sultan Abdul Aziz, May 30. First railway opened in China, June 3. Death of Lord Sandhurst, June 23 (born, 1819). Slaughter of United States troops by Sioux Indians, June 25. Death of Miss Harriet Martineau, June 27 (born, 1802). Servia and Montenegro declare war against Turkey, July 2. Mr Disraeli created Earl of Beaconsfield, August 16. Deposition of Sultan Murad V., August 31. Sir T. Wade's treaty with China ratified, September 17. General Tchernaieff proclaims Prince Milan King of Servia, September 20. Mr Göschen's financial mission to Egypt, October 14. Spanish army under General Martinez Campos sent to Cuba to suppress the insurrection, October 15. Capture of Alexinatz by the Turks: Russian demand for an armistice between Turkey and Servia, October 31. Speech by Lord Beaconsfield on the Turkish question, November 9. Porfirio Diaz, having defeated the Government troops, becomes Provisional President of Mexico, November 20. Death of the Duke of Saldanha, November 21 (born about 1790). Mr Hayes elected President of the United States, December 6. Meeting in Constantinople of the Plenary Conference on Turkish affairs, December 24.

1877. Queen Victoria proclaimed Empress of India at Delhi, January 1. Turkish issue of £7,000,000 paper money, January 5. National Defence Society formed in Athens, January 7. German general election: majority for National Liberal party, January 10. Continued famine in India announced, January 12. The Porte declines the administrative reform proposals of the Powers, January 20. Anti-clerical Bill passed by the Italian Chamber of Deputies, January 24. Banishment of Midhat Pasha, Grand Vizier of Turkey, February 5. Death of Sir W. Fergusson, February 10 (born, 1808). Col. Gordon appointed Governor of the Sudan, February 12. Death of Gen. Changarnier, February 14 (born, 1793). Gen. Porfirio Diaz elected President of Mexico, February 18. Defeat of Japanese rebels near Kagosima, February 23. Death of Sir Jung Bahadur of Nepal, February 25. Peace treaty between Turkey and Servia, March 1. Papal allocution on restriction of liberty, March 12. Protocol signed by the Great Powers regarding the Eastern question, March 31. Arrival of Sir Bartle Frere at Cape Town as High Commissioner, March 31. Annexation o

the Transvaal to the British Empire, April 12. Russia declares war against Turkey, April 24. British reply to Prince Gortchakoff's circular, May 1. Defeat of Mr Gladstone's motion censuring the Eastern policy of the Government, May 14. Resignation of the French Ministry as the result of a reproof by Marshal MacMahon, May 16. Rumania proclaimed independent, May 21. Death of Marshal Cabrera, May 24 (born, 1810). Death of Mr J. L. Motley, May 29 (born, 1814). Bombardment of Kars by the Russians, June 1. Death of Lord Justice Mellish, June 15 (born, 1814). Russians cross the Danube, June 24. Dissolution of the French Chamber of Deputies by Marshal MacMahon, June 25. Russian loan of 200,000,000 roubles, June 26. British fleet returns to Besika Bay, July 5. Death of Yakub Beg of Kashgar, July 11. Turkish massacre at Yeni Saghra, July 15. Russian assault on Plevna repulsed, July 30. Rumanian army crosses the Danube, August 9. Insurrection in Crete, August 17. Russian defeat at Kizil Tepe by Mukhtar Pasha, August 25. Death of Brigham Young, August 29 (born, 1800). Death of Thiers, September 3 (born, 1797). Prosecution of Gambetta, September 11. Death of Admiral Canaris, September 14 (born, 1787). Turkish defeat in the Shipka Pass by General Gourko, September 17. Rout of the Turkish army under Mukhtar Pasha at Aladja Dagh by the Russians, October 15. Resignation of the Duc Decazes, October 30. Death of Field-Marshal von Wrangel, November 1 (born, 1784). Kars stormed by the Russians, November 18. Marshal MacMahon's "Cabinet of Business," November 23. Canadian fisheries award, November 24. Bill abolishing capital punishment passed by the Italian Chamber of Deputies, November 28. Fall of Plevna, December 10. Turkish appeal to the Powers to mediate, December 12. Servian declaration of independence and war against Turkey, December 13. State visit of Queen Victoria to Lord Beaconsfield at Hughenden, December 15. Passage of the Balkans by General Gourko, December 29.

1878. Native rising in the Transvaal, January 1. Death of General la Marmora, January 5 (born, 1804). Death of King Victor Emmanuel, January 9 (born, 1820). Surrender of Vesoul Pasha's army to the Russians in the Shipka Pass, January 9. Russian occupation of Adrianople, January 20. Arrival of Cleopatra's Needle in the Thames, January 21. Marriage of King Alfonso XII., January 23. British fleet at the Dardanelles; resignation of Lord Carnarvon, January 25. Great famine in China reported, January 26. Commission of inquiry into Egyptian finances ordered, January 29. Armistice between Russia and Turkey, January 31. Greek troops ordered to occupy Thessaly, Epirus, and Macedonia, February 1. Death of George Cruikshank, February 1 (born, 1791). Vote of £6,000,000 by the House of Commons to strengthen the army and navy, February 7. Death of Pope Pius IX., February 7 (born, 1792). Occupation of Erzerum by the Russians, February 13. Passage of the Dardanelles by British fleet, February 13. Mr Bland's Silver Bill passed by the U.S. Senate, February 16. Election of Pope Leo XIII., February 20. Peace between Turkey and Servia, March 2. Treaty of San Stefano, March 3. Bill for the abolition of capital punishment defeated in the House of Commons, March 13. Indian Vernacular Press Act passed, March 14. Loss of the *Eurydice*, March 24. Death of Sir Gilbert Scott, March 27 (born, 1814). Resignation of Lord Derby, March 28. Circular to the Powers by Lord Salisbury regarding the treaty of San Stefano; British reserves called out, April 1. Murder of Lord Leitrim, April 2. Indian troops ordered to Malta, April 17. Opening of the Paris Exhibition, May 1. Attempted assassination of the German Emperor by Hödel, May 11. Death of Earl Russell, May 28 (born, 1792). Foundering of the German ironclad *Grosser Kurfürst*, May 31. Attempt on the life of the German Emperor by Dr Nobiling, June 2. Anglo-Turkish Convention signed; Cyprus to be occupied by Great Britain, June 4. Death of King George of Hanover, June 12 (born, 1819). Opening of the Berlin Congress, June 13. Death of Charles Mathews, actor, June 24 (born, 1803). Death of Queen Mercedes of Spain, June 26 (born, 1860). Fête de la République in France, June 30. Berlin Treaty signed, July 13. Cyprus annexed to the British Empire, July 14. Return of Lord Beaconsfield from the Berlin Congress—"peace with honour," July 16. Russian mission at Kabul, July 22. Austrian occupation of Bosnia and Herzegovina, August. Nihilist trials at Odessa, August 5. Orange riots at Ottawa, August 12. Death of Queen Christina of Spain, August 21 (born, 1806). Earthquakes in Holland, Belgium, and Germany, August 27. Reforms promised by the Khedive of Egypt, August 30. *Princess Alice* disaster, about 700 lives lost, September 3. Abercarne colliery explosion, September 11. Cleopatra's Needle erected on the Thames Embankment, September 12. British mission to Afghanistan stopped on the frontier, September 22. City of Glasgow Bank failure, October 1. Death of Lord Chelmsford, October 5 (born, 1794). Marquis of Lorne appointed Governor-General of Canada, October 14. German Anti-Socialist Bill passed, October 19. Attempt on the life of King Alfonso XII., October 25. British ultimatum to Afghanistan, November 1. Death of Samuel Phelps, actor, November 6 (born, 1806). Attempted assassination of King Humbert, November 17. Halifax award paid by America, November 21. War with Afghanistan announced; capture of Ali Mesjid by the British, November 22. Rumania occupies the Dobrudja, November 26. Peiwar Pass crossed by General Roberts, December 1. Flight of the Ameer Shere Ali, December 13. Death of Princess Alice, Grand Duchess of Hesse, December 14 (born, 1843). British occupation of Jalalabad, December 20. Bulgarian Assembly of Notables elected, December 31. Invention of the microphone and phonograph.

1879. Resumption of specie payments in America, January 2. Marriage of King William III. of Holland to Princess Emma of Waldeck, January 7. General Roberts enters Kandahar, January 8. Death of Marshal Espartero, January 8 (born, 1791). British advance into Zululand, January 19. Battle of Isandlwhana; defence of Rorke's Drift, January 22. Resignation of Marshal MacMahon, January 30. Russo-Turkish treaty of peace signed, February 8. Death of General Peel, February 13 (born, 1799). Numerous assassinations ordered by the King of Burma, February 16. Death of Field-Marshal Count von Roon, February 23 (born, 1803). Rejection of the "Muzzling Bill" by the German Reichstag, March 7. Marriage of the Duke of Connaught, March 13. Russian evacuation of Adrianople, March 20. Zulu defeat at Ginghilova, April 2. Chile declares war against Peru, April 5. Dismissal of European advisers by the Khedive, April 7. Attempted assassination of the Tsar, April 14. Prince Alexander of Battenberg elected Prince of Bulgaria, April 29. Anglo-German treaty for suppression of the African slave trade, April 30. Russian ukase against Nihilism, May 8. Naval engagement between Chilians and Peruvians off Iquique, May 21. American Silver Bill passed, May 24. Anglo-Afghan treaty of Gandamak, May 26. Sir G. Wolseley appointed High Commissioner for Natal and the Transvaal, May 26. Prince Louis Napoleon killed by Zulus, June 1 (born, 1856). Death of the Prince of Orange, June 11 (born, 1840). Deposition of Ismail Pasha; Tewfik appointed Khedive, June 26. Death of Lord Lawrence, June 27 (born, 1811). Battle of Ulundi, July 4. Protective Tariff Bill passed by the German Reichstag, July 13. Bombardment of Iquique by the Chilians, July 16. Death of Mr Fechter, actor, August 5 (born, 1823). Resignation of Count Andrassy, August 14. European controllers appointed for Egypt, August 25. Death of General Lazareff, commanding the Russian expedition in Central Asia, August 25. Capture of Cetywayo, August 28. Massacre of Sir L. Cavagnari, suite, and escort at Kabul, September 3. New insurrection in Cuba, September 14. International Exhibition opened at Sydney, N.S.W., September 17. British rupture with Burma, October 7. General Roberts enters Kabul, October 12. Abdication of Yakub Khan, Ameer of Afghanistan, October 21. First Legislative Assembly of Bulgaria opened, October 30. Chilian victory at Pisagua, November 2. Administrative reforms in Asiatic Turkey ordered by the Sultan, November 20. Death of Mr J. T. Delane, editor of *The Times*, November 22 (born, 1817). Capture of Moirosi's Mountain, Zululand, by the British, November 24. Mr Gladstone's Midlothian campaign: Edinburgh Music Hall speech, November 25. Marriage of King Alfonso XII., November 29. Attempt on the life of the Tsar near Moscow, December 2. Attempted assassination of Lord Lytton, December 12. Rout of the Afghans by General Roberts, December 23. The Tay Bridge disaster, December 28. Direct telegraphic communication opened between Great Britain and South Africa, December 29. Attempt to shoot the King and Queen of Spain, December 30.

1880. Death of the Duc de Gramont, January 14 (born, 1819). British defeat of Mohmunds near Dakka, January 15. Spanish Bill abolishing slavery in Cuba passed, January 16. Death of M. Jules Favre, January 20 (born, 1809). Parliament opened by the the Queen, February 5. Attempt to blow up the Tsar at the Winter Palace, February 17. Supreme Executive Commission of protection appointed in Russia, February 24. Irish Distress Relief Bill passed, March 1. Attempt to assassinate Count Loris Melikoff, dictator of Russia, March 3. Capture of Mollendo by the Chilians, March 12. Grand Shereef of Mecca assassinated, March 14. Dissolution of Parliament, March 24. M. Tricoupis Prime Minister of Greece, March 27. French anti-Jesuit decree, March 29. New German Army Bill passed, April 9. Death of Lord Hampton, April 9 (born, 1799). Death of Dr Kenealy, April 16 (born about 1818). Albanian proclamation of independence, April 19. Afghan defeat at Ahmedkhel, April 19. Great fire at Hull, Ottawa, April 21. Resignation of Lord Beaconsfield, April 21. Mr Gladstone appointed Prime Minister, April 23. Afghan defeat at Charasiab, April 25. Expulsion of foreign Jews from St Petersburg, April 30. French amnesty decree, May 10. Mr Goschen's special mission to Constantinople, May 28. Death of the Empress Maria of Russia, June 3 (born, 1824). Death of Sir Stephen Cave, June 7 (born, 1820). Conference in Berlin as to the Greek and Montenegrin frontiers, June 16. Tichborne claimant's appeal dismissed, June 25. Capture of the Kelly gang of bushrangers in Victoria, June 28. Diplomatic rupture between Belgium

and the Vatican, June 28. French annexation of Tahiti, June 29. Death of Mr Tom Taylor, July 12 (born, 1817). Abdurrahman proclaimed Ameer of Afghanistan, July 22. British disaster at Maiwand, July 27. French General Councils election; 240 Republican gains, August 1. Sir Bartle Frere recalled from the Cape, August 1. General Roberts's march from Kabul to Kandahar, August 9. Death of Lord Stratford de Redcliffe, August 14 (born, 1788). Cologne Cathedral completed, August 14. Defeat of Ayub Khan by General Roberts, September 1. Rising in Basutoland, September 13. Death of Sir Fitzroy Kelly, September 17 (born, 1796). Naval demonstration of the Powers at Dulcigno, September 17. Landslip at Naini Tal, September 18. Land League persecution of Captain Boycott, September 22. Murder of Lord Mountmorres, September 25. Melbourne Exhibition opened, October 1. Death of Jacques Offenbach, October 4 (born, 1819). Death of Baron Ricasoli, October 23 (born, 1809). Rev. Pelham Dale imprisoned under the Public Worship Act, October 30. General Garfield elected President of the United States, November 2. Kurd invasion of Persia, November 3. Arrest of Mr Parnell for conspiracy, November 3. Great earthquake at Agram, Croatia, November 9. Trial of Nihilists in St Petersburg, November 10. Death of Lord Chief Justice Cockburn, November 20 (born, 1802). Death of Field-Marshal Sir C. Yorke, November 20 (born, 1790). Surrender of Dulcigno to Montenegro by Turkey, November 26. Penygraig colliery explosion, December 10. The Transvaal proclaimed a republic by Mr Kruger and others, December 16. Boer attack on British troops at Bronker's Spruit, December 20. Death of George Eliot, December 22 (born, 1820). Greek refusal of arbitration on the frontier question, December 26. Serious floods in Holland, December 30. Land League agitation in Ireland; numerous agrarian outrages.

1881. Employers' Liability Act in force, January 1. Great strike of Lancashire miners, January 14. Attempt to blow up Salford barracks, January 14. Capture of Geok Tepe by the Russians, January 16. Lima taken by the Chilians, January 21. End of the trial of Mr Parnell and his associates for conspiracy: disagreement of the jury, January 25. Repulse of Sir G. Colley by the Boers at Lang's Nek, January 28. Panama Canal begun, February 1. Removal of Mr Parnell and thirty-four other Irish members from the House of Commons for obstruction, February 3. Death of Thomas Carlyle, February 6 (born, 1795). Battle of Ingogo, February 8. Battle of Majuba; death of Sir G. Colley, February 27. Irish Coercion Bill passed, March 2. Armistice with the Boers, March 6. Assassination of the Tsar Alexander II., March 13. Peace with the Boers; surrender of Potchefstroom, March 21, 22. Earthquake at Chios, 5000 lives lost, April 3. European Note to Turkey on the Greek question, April 19. Death of Lord Beaconsfield, April 19 (born, 1805). International monetary conference in Paris, April 19. British evacuation of Kandahar, April 21. French occupation of Bizerta, April 30. H.M.S. *Doterel* blown up in the Strait of Magellan, May 4. Expulsion of Mr Bradlaugh from the House of Commons, May 10. Marriage of the Crown Prince Rudolph of Austria, May 10. French treaty with Tunis, May 12. Attempt to blow up the Central Police Station, Liverpool, May 16. Revised edition of the New Testament published, May 17. Prince Leopold created Duke of Albany, May 23. Prince of Rumania crowned king, May 23. Johann Most, proprietor of *Die Freiheit*, found guilty of incitement to murder, May 25. Fortune Bay fishery award: Great Britain to pay America £15,000, May 28. Great fire at Quebec, June 8. *Scrutin de liste* rejected by the French Senate, June 9. Attempt to blow up Liverpool Town Hall, June 10. Death of M. Dufaure, June 27 (born, 1798). President Garfield shot, July 2; died, September 20 (born, 1831). Death of Lord Hatherley, July 10 (born, 1801). Capture of Sfax (Tunis) by the French, July 16. Death of Dean Stanley, July 18 (born, 1815). Convention with the Transvaal: British suzerainty reserved, August 3. Irish Land Bill becomes law, August 22. Mutiny of Egyptian troops under Arabi Bey, September 9. Evacuation of Thessaly by the Turks, September 15. Meeting of the German and Russian Emperors at Danzig, September 16. General Arthur sworn President of the United States, September 22. Defeat of Ayub Khan by the Ameer Abdurrahman of Afghanistan, September 22. Severn tunnel borings completed, September 27. Death of Baron Haymerle, October 10 (born, 1828). Arrest of Mr Parnell, October 13. Swansea docks opened by the Prince and Princess of Wales, October 18. "No rent" manifesto by the Irish Land League, October 18. The Land League proclaimed an illegal association, October 20. First meeting of the Irish Land Courts, October 20. Death of Professor Bluntschli, October 21 (born, 1808). Arrest of the Maori chief Te Whiti for sedition, November 6. British North Borneo Company receives a charter, November 8. M. Gambetta becomes French Premier, November 12. Burning of the Ring Theatre, Vienna, several hundred lives lost, December 8. "Reign of Terror" in Ireland.

1882. Death of Mr W. Harrison Ainsworth, January 3 (born, 1805). Death of Mr Bernal Osborne, January 4 (born, 1814). Anglo-French Note supporting the authority of the Khedive, January 8. Death of Mr John Linnell, artist, January 20 (born, 1792). Resignation of M. Gambetta's Ministry, January 26. Arabi Pasha appointed Egyptian Minister of War, February 2. Nihilist trials in St Petersburg, February 28. Prince of Wales proposes to found a Royal College of Music, February 28. Attempt to shoot the Queen by R. Maclean at Windsor, March 2. Servia proclaimed a kingdom, March 6. Death of Longfellow, March 24 (born, 1807). Retirement of Prince Gortchakoff from the Russian Ministry for Foreign Affairs, April 9. Death of Dante Gabriel Rossetti, April 9 (born, 1828). Death of Darwin, April 19 (born, 1809). Marriage of the Duke of Albany to Princess Helen of Waldeck-Pyrmont, April 27. Death of Ralph Waldo Emerson, April 27 (born, 1803). Earl Spencer appointed Lord-Lieutenant of Ireland, April 28. Murder of Lord Frederick Cavendish, Secretary for Ireland, and Mr T. A. Burke, Under-Secretary, in Phœnix Park, Dublin, May 6. Death of General Kaufmann, conqueror of Turkestan, May 12 (born, 1818). New Eddystone Lighthouse opened by the Duke of Edinburgh, May 18. Anglo-French ultimatum to Egypt; removal of Arabi Pasha and resignation of the Ministry demanded, May 25. Reappointment of Arabi Pasha as Egyptian Minister of War, May 28. Death of Garibaldi, June 2 (born, 1807). Riot at Alexandria, many Europeans killed, June 11. Death of General Skobeleff, July 7 (born, 1843). Bombardment of the Alexandria forts by the British fleet, July 11; marines landed, July 17. Irish Prevention of Crimes Bill passed, July 11. British vote of credit for an expedition to restore order in Egypt, July 27. The French Chamber decline to furnish funds for the protection of the Suez Canal, July 29. Death of Professor Jevons, August 13 (born, 1835). Arrival in Egypt of Sir G. Wolseley, commanding the British expedition against Arabi Pasha, August 15. Massacre of the Joyce family at Maamtrasna, Galway, August 17. Suez Canal held by British troops, August 19. Battle of Kassassin, August 28. Death of Sir G. Grey, September 9 (born about 1798). Rout of the Egyptian army at Tel-el-Kebir, September 13. Occupation of Cairo by the British and surrender of Arabi Pasha, September 14. Death of Dr Pusey, September 16 (born, 1800). Return of the Khedive to Cairo, September 25. Attempted assassination of Mr Justice Lawson in Dublin, November 12. Review of the army from Egypt by the Queen in St James's Park, November 18. Arabi Pasha banished from Egypt for life, December 3. Death of Archbishop Tait, December 3 (born, 1811). Royal Courts of Justice opened by the Queen, December 4. Death of Louis Blanc, December 6 (born, 1811). Death of Anthony Trollope, December 6 (born, 1815). Great fire in Wood Street, Cheapside, December 8. Belt *v.* Lawes libel case: £5000 damages for plaintiff, December 28. Death of Gambetta, December 31 (born, 1838).

1883. Married Women's Property Act in force, January 1. Death of General Chanzy, January 4 (born, 1823). Arrest of Prince Napoleon for publishing a manifesto against the Republic, January 16. Death of Gustave Doré, January 22 (born, 1832). Cetywayo restored King of Zululand, January 29. Mr Davitt, Mr Healy, and Mr Quinn imprisoned for sedition, February 8. Death of Sir Salar Jung, February 8. Death of Professor Henry Smith, February 9 (born, 1827). Murderers of Lord F. Cavendish and Mr Burke identified, February 10; James Carey turns informer, February 11. Death of Richard Wagner, February 13 (born, 1813). M. Jules Ferry, Premier of France, February 21. Orleanist princes removed from the French army, February 25. Death of Mr J. R. Green, historian, March 7 (born, 1837). Death of Prince Gortchakoff, March 11 (born, 1798). Death of Karl Marx, March 14 (born, 1818). Attempts to blow up the Local Government Board office and *The Times* office with dynamite, March 15. Lord Dufferin's Egyptian reform scheme published, March 20. Death of Sir G. Jessel, March 21 (born, 1824). Two infernal machines seized at Liverpool, March 28. Murder of M. de Majlath, Chief Justice of Hungary, March 29. Louise Michel arrested in Paris for incitement to plunder, March 29. Explosives Bill passed, April 9. Trial of Irish "Invincibles," April 10. Impeachment of the Norwegian Ministry, April 23. Death of Prince Batthyany, April 25 (born, 1804). Amsterdam International Exhibition opened, May 1. Death of Lord Justice Deasy, May 6 (born, 1812). Opening of the Royal College of Music by the Prince of Wales, May 7. Mr Kruger elected President of the Transvaal, May 9. Condemnation of the Land League by the Pope, May 11. International Fisheries Exhibition, South Kensington, opened by the Prince of Wales, May 12. Execution of five of the Phœnix Park murderers, May 14–June 9. Lord Lansdowne appointed Governor-General of Canada, May 21. French force under Commander Rivière destroyed by "Black Flags" at Ha Noi, Tongking, May 20. French bombardment of Mojanga, Madagascar, May 24. Coronation of the Tsar Alexander III., May 27. Bombardment and capture of Tamatave, Madagascar, by the French, June 13. Death of Bishop Colenso, June 20 (born, 1814). Death of Sir Wm. Knollys, June 24 (born, 1797). Death of Mr W. Spottiswoode, June 27 (born, 1825). Prussian modification of the "Falk

Laws," July 2. Captain Webb drowned in attempt to swim Niagara Rapids, July 24. James Carey, Irish informer, shot, July 29. Spanish military risings suppressed, August 4–9. Death of Dr R. Moffat, August 9 (born, 1796). Death of the Comte de Chambord, August 24 (born, 1820). French protectorate over Tongking and Annam, August 25. Eruption of Krakatoa; many thousand lives lost, August 27. Death of Ivan Turguenieff, September 3 (born, 1818). Riot at Canton, European quarter sacked, September 11. German war monument unveiled on the Niederwald, Rudesheim, September 27. King Alfonso of Spain insulted by a Paris mob; apology by President Grévy, September 29, 30. Surrender of Cetywayo to the British, October 16. Death of Captain Mayne Reid, October 22 (born, 1819). Peace between Chile and Peru, October 20. Hicks Pasha's army destroyed by the Mahdi at El Obeid, November 3. Death of Lord Overstone, November 17 (born, 1796). Death of Sir William Siemens, November 18 (born, 1823). Death of Signor Mario, December 11. Irish "national tribute" of £38,000 presented to Mr Parnell in Dublin, December 11. Capture of Son Tai, Tongking, by the French, December 18. Ten dynamiters sentenced to penal servitude at Glasgow, December 21. Assassination of Colonel Soudeikin, chief of the Russian police, by Nihilists, December 28. Australian federation movement. Internal troubles in Austria-Hungary.

1884. Dismissal of the Egyptian Ministry of Sherif Pasha, January 7. The Poet Laureate created Lord Tennyson, January 16. General Gordon sent to Khartum on a special mission, January 18. The Ilbert Bill passed by the Calcutta Legislative Council, January 25. Death of M. Rouher, February 3 (born, 1814). Defeat of Baker Pasha by Osman Digna near Tokar, February 4. Death of King Cetywayo, February 8. Arrival of General Gordon at Khartum, February 18. Death of Mr T. Chenery, editor of *The Times*, February 12 (born, 1826). Retirement of Sir H. Brand from the Speakership of the House of Commons; Mr A. Peel chosen to succeed him, February 25, 26. Dynamite explosion at Victoria railway station, February 26. Convention between Great Britain and the Transvaal signed in London, February 27. Sudanese defeated at El Teb by General Graham, February 29. Defeat of Osman Digna at Tamanieb by General Graham, March 13. Death of the Duke of Albany at Cannes, March 28 (born, 1853). Great fire at Mandalay, April 2. Death of Charles Reade, April 11 (born, 1814). Death of Sir Michael Costa, April 29 (born, 1810). German Protectorate over Angra-Pequeña, April 24. Health Exhibition opened at South Kensington, May 8. Provisional treaty of peace between France and China, May 11. Fall of Berber, May 23. Admiral Hewett's treaty with Abyssinia, May 26 (about). Death of Sir Bartle Frere, May 29 (born, 1815). Dynamite explosions in St James's Square and Scotland Yard, May 30. Marriage of the Grand Duke Serge of Russia to Princess Elizabeth of Hesse, June 15. Railways sanctioned by the Chinese Government, June 20. Death of the Prince of Orange, June 21 (born, 1851). Collision between French and Chinese at Lang Son, June 23. European conference on Egypt meets in London, June 28. International Forestry Exhibition opened in Edinburgh, July 1. Death of General Todleben, July 1 (born, 1818). Death of the Rev. Mark Pattison, July 30 (born, 1813). International Conference on Education opened at South Kensington, August 4. Bombardment of Ki-lung, Formosa, by the French, August 6. Death of Sir Erasmus Wilson, August 8 (born, 1809). Death of Lord Ampthill, August 25 (born, 1829). French attack on Foo-chow, August 26–28. Lord Northbrook leaves London for Egypt on a financial mission, August 31. Political riots in Brussels and Antwerp, September 7. Arrival of Lord Wolseley in Cairo to command an expedition to Khartum, September 9. Lord Dufferin appointed Viceroy of India in succession to Lord Ripon, September 10. Revival of the "League of the Three Emperors," September 15. Wreck of H.M.S. *Wasp* at Tory Island, 52 lives lost, September 22. Colonel Stewart, Mr Power, M. Herbin, and about forty men massacred by Arabs on the Nile, reported October 6. Death of Mr Fawcett, November 6 (born, 1833). British protectorate over part of New Guinea, November 6. Mr Cleveland elected President of the United States, November 7. Berlin Conference on West African affairs opened, November 15. Imperial Federation League formed, November 18. Finney *v.* Garmoyle, breach of promise case, plaintiff awarded £10,000, November 20. Adams *v.* Coleridge, libel case, plaintiff awarded £3000 damages; verdict reversed by Mr Justice Manisty, November 22. Rising in Korea, December 4. Franchise Bill passed, December 6. Attempt to blow up London Bridge with dynamite, December 13. Arrival of Lord Wolseley at Korti, on the Nile, December 15. Earthquakes in Spain, over 1000 lives lost, December 25–31. Sir P. Lumsden's Afghan frontier mission. British expedition to Bechuanaland under Sir C. Warren. Skye crofters' agitation.

1885. Death of Cluny Macpherson, January 10 (born, 1805). Battle of Abu Klea; Colonel Fred. Burnaby killed, January 17 (born, 1842). Battle near Metammeh; General Stewart wounded, January 19. Dynamite outrages at the Houses of Parliament and the Tower, January 24. Fall of Khartum: General Gordon killed, January 26 (born, 1833). Wreck of Sir C. Wilson's steamers returning from Khartum; rescue by Lord Charles Beresford, January 28–February 9. Defeat of Sudanese at Kirbekan; General Earle killed, February 10 (born, 1833). Capture of Lang Son, Tongking, by the French, February 12. Death of General Sir H. Stewart at Gakdul, February 16 (born, 1843). Sir C. Warren Military Governor of Bechuanaland, February 23. New South Wales troops leave Sydney for the Sudan, March 3. Lord Wolseley's army at Korti, March 12. Arab attack on Sir J. M'Neill's force near Suakin, March 22. Death of Sir Harry Parkes, March 22 (born, 1828). British reserve forces called out, March 26. Chinese recapture Lang Son, March 28. Fall of M. Ferry's Ministry, March 30. Russians under General Komaroff attack Afghan positions on the Kushk, March 30. Visit of the Ameer of Afghanistan to Lord Dufferin at Rawal Pindi, March 31. Death of Lord Cairns, April 2 (born, 1819). Prince and Princess of Wales visit Ireland, April 7. Rising of half-breeds and Indians under Louis Riel in Canada, April 24. Opening of the International Inventions Exhibition, South Kensington, May 4. Death of Sir Watkin Williams Wynn, May 9 (born, 1820). Capture of Louis Riel, May 15. Publication of the Revised Version of the Bible, May 18. Vote of credit of £11,000,000 passed, May 20. Death of Victor Hugo, May 22 (born, 1802). Death of Sir Julius Benedict, June 5 (born, 1804). Peace between France and China, June 9. Redistribution Bill passed, June 12. Resignation of Mr Gladstone, June 12. Lord Salisbury appointed Prime Minister, June 15. Evacuation of Dongola by the British, June 15. Death of Prince Frederick Charles of Prussia, June 15 (born, 1828). Death of Field-Marshal Manteuffel, June 17 (born, 1809). Death of the Mahdi reported, about June 20. Opening of the Hull and Barnsley Railway, July 16. Death of General Grant, July 23 (born, 1822). Marriage of Princess Beatrice to Prince Henry of Battenberg, July 23. Death of Sir Moses Montefiore, July 28 (born, 1784). Panjdeh surrendered to Russia. German occupation of one of the Caroline Islands, August 14. Expiration of the Crimes Act, August 14. Sir H. D. Wolff's Egyptian mission to Constantinople, August 22. Meeting of the Austrian and Russian Emperors at Kremsier, August 25. Severn tunnel completed, September 5. First international yacht race off New York, won by the American yacht *Puritan*, September 14. Union of Eastern Rumelia to Bulgaria proclaimed, September 18. Death of Lord Shaftesbury, October 1 (born, 1801). Death of Lord Strathnairn, October 16 (born, 1803). Conference in Constantinople on the Eastern question, November 5. British ultimatum to Burma; advance of General Prendergast's force, November 9. War declared between Servia and Bulgaria, November 13. Battle of Slivnitza, November 17–19. Dissolution of Parliament, November 18. Death of Marshal Serrano, November 25 (born, 1810). Death of King Alfonso XII., November 26 (born, 1857). Surrender of King Thebaw of Burma; occupation of Mandalay, November 27, 28. Death of Mr W. H. Vanderbilt, December 8 (born, 1821). Federation favoured by the Australasian Colonies, excepting New South Wales and New Zealand, December 9. Death of King Ferdinand of Portugal, December 15 (born, 1816). M. Grévy re-elected President of the French Republic, December 28. Sudanese defeat at Kosheh, December 30. British general election; Liberal success. Revival of Irish Nationalist tyranny.

1886. Upper Burma annexed by Great Britain, January 1. Mersey tunnel opened by the Prince of Wales, January 20. Parliament opened by the Queen, January 21. Defeat of Lord Salisbury's Government on the agricultural labourers' holdings question; return of Mr Gladstone to power, January 28–February 1. Social Democratic riots in London, February 8. Crawford *v.* Crawford and Dilke divorce case, decree *nisi* granted, February 12. Death of Randolph Caldecott, February 12 (born, 1846). Death of Lord Cardwell, February 15 (born, 1813). Suspension of the Commercial Bank of South Australia, February 24. Peace signed between Servia and Bulgaria, March 3. Death of Archbishop Trench, March 28 (born, 1807). Guildhall meeting to protest against the proposed Irish Home Rule Bill, April 2. Death of Mr W. E. Forster, April 5 (born, 1818). Conference of the Powers in Constantinople; Prince Alexander of Battenberg nominated Governor-General of Eastern Rumelia, April 5. European ultimatum to Greece to cease arming against Turkey, April 26. Colonial and Indian Exhibition opened by the Queen, May 4. Socialist riots at Chicago and Milwaukee, May 4, 5. European blockade of Greek ports, May 8. British evacuation of Suakin, May 16. Death of Lord Farnborough, May 17 (born, 1815). Death of Leopold von Ranke, historian, May 23 (born, 1795). Serious riots in Belfast, June 6. Irish Home Rule Bill rejected by the House of Commons, June 8. Eruption of Mount Tarawera, New Zealand; the "Pink Terraces" destroyed, June 9. Suicide of King Ludwig of Bavaria at Tegernsee, June 15 (born, 1845). Death of the Maharajah Holkar of Indore, June 17 (born, 1832). Death of the Maharajah Scindia of Gwalior, June 20 (born, 1835). French Princes' Expulsion Bill passed, June 22.

Dissolution of Parliament, June 26. General election; Conservative victory. Resignation of the Gladstone Cabinet, July 21. British convention with China, July 24. Death of Liszt, July 31 (born, 1811). Lord Salisbury's Ministry accept seals of office: Lord R. Churchill Chancellor of the Exchequer, August 3. Conspiracy at Sofia; Prince Alexander kidnapped, August 21. Abdication announced, September 4. Death of the Duc Decazes, September 16 (born, 1819). Death of Mr J. L. Hatton, September 20 (born, 1809). Death of Lord Monkswell, October 27 (born, 1817). Irish "Plan of Campaign" proclaimed unlawful, December 18. Lord R. Churchill resigns the Chancellorship of the Exchequer, December 23.

1887. Death of Serjeant Ballantine, January 9 (born, 1812). Death of Lord Iddesleigh, January 12 (born, 1818). Meetings at St James's Palace and the Mansion House to found an Imperial Institute, January 12. Meeting of the "Round Table Conference" at Sir W. Harcourt's house, January 14. Mr H. M. Stanley leaves London to relieve Emin Pasha, January 21. Death of Sir Joseph Whitworth, January 22 (born, 1803). Serious riots at Belfast, January 29. Queen Victoria's Jubilee celebrated in India, February 16. Earthquake on the Riviera, many lives lost, February 22. Death of Father Beckx, formerly "General" of the Jesuits, March 4 (born, 1794). German Army Bill passed by the Reichstag, March 9. Triple Alliance said to have been signed, March 13. British Colonial Conference at the Foreign Office, April 4. Arrest of M. Schnaebele, French Commissary at Pagny, by Germans on the frontier, April 20. Defeat of dervishes by Egyptians at Sarras, April 29. Jubilee Exhibition at Manchester opened by the Prince and Princess of Wales, May 4. Address of congratulation presented to the Queen by the Lord Mayor and Corporation of London, May 9. Inaugural stone of the North Sea and Baltic Canal laid by the German Emperor, June 3. Fiftieth anniversary of Queen Victoria's accession to the throne, June 20. General celebration of the Queen's jubilee; State procession from Buckingham Palace to Westminster Abbey, June 21. British annexation of East Zululand, June 21. Metropolitan school children visited by the Queen in Hyde Park, June 22. "Women's Jubilee Offering" of £75,000 accepted by the Queen, June 22. Jubilee thanksgiving in St Paul's Cathedral, June 23. Review of volunteers by the Queen at Buckingham Palace, July 2. First stone of the Imperial Institute laid by the Queen, July 4. Prince Ferdinand of Saxe-Coburg elected Prince of Bulgaria, July 7. Irish Crimes Bill passed by the House of Commons, July 8. Great review at Aldershot by the Queen, July 9. Death of Herr Krupp, July 13 (born, 1810). Russo-Afghan boundary settled, July 20. Naval review at Spithead, July 23. Death of Michael Katkoff, editor of the *Moscow Gazette*, August 1 (born, 1820). Meeting of the German and Austrian Emperors at Gastein, August 6. Offer by the Nizam of Haidarabad of £200,000 a year for three years for Indian North-West frontier defences, August 26. Trafalgar Square demonstration against the proclamation of the Irish National League, August 27. Nationalist riot at Mitchelstown, September 9. Centenary of the United States Constitution celebrated, September 15–17. Mr W. O'Brien, M.P., sent to prison for incitement to resist the law, September 24. Anglo-French Convention neutralizing the Suez Canal, October 24. French agree to withdraw from the New Hebrides, October 24. Lord Lytton appointed British Ambassador to France, October 29. Death of Sir G. Macfarren, October 31 (born, 1813). Death of Jenny Lind, November 2 (born, 1820). Death of Lord Wolverton, November 6 (born, 1824). Surrender of Ayub Khan to the Indian Government, November 9. Great riot in Trafalgar Square, November 13. Death of Lord and Lady Dalhousie, November 24, 25. Quetta and other districts incorporated as British Baluchistan, November. Resignation of M. Grévy, President of the French Republic; succeeded by M. Sadi Carnot, December 2. Death of Lord Lyons, December 5 (born, 1817). Attempt to murder M. Jules Ferry, December 10. Articles on "Parnellism and Crime" published by *The Times*, March–June.

1888. One hundredth anniversary of *The Times*, January 1. New South Wales centenary celebrated, January 24. Death of Sir Henry Maine, February 3 (born, 1822). Austro-German alliance of 1879 published, February 3. German Army Bill (increase of 700,000 men) passed, February 8. Resignation of the Viceroyalty of India by Lord Dufferin; Lord Lansdowne appointed, February 8. Canadian Fisheries Treaty signed in Washington, February 15. Death of the Emperor William I., March 9 (born, 1797). General Boulanger removed from the French army, March 27. Death of Matthew Arnold, April 15 (born, 1822). Panama Canal Lottery Loan Bill passed by the French Chamber of Deputies, April 28. Glasgow International Exhibition opened by the Prince of Wales, May 8. Tibetans defeated by the British at Gnatong, May 23. Death of Marshal Lebœuf, June 7 (born, 1809). Lord Stanley of Preston sworn in as Governor-General of Canada, June 11. Death of the Emperor Frederick, June 15 (born, 1831). Duel between M. Floquet and General Boulanger, July 13. Death of Sir J. H. Brand, President of the Orange Free State, July 14 (born, 1823). Armada tercentenary, July 19. Meeting of the Emperor William II. and the Tzar off Kronstadt, July 19. Death of General Sheridan, August 5 (born, 1831). Local Government Bill passed, August 9. Defeat of Italians by Abyssinians at Saganeiti, August 13. Meeting between Prince Bismarck and Signor Crispi at Friedrichsruh, August 21. Retaliatory measures against Canada recommended by President Cleveland, August 24. Imperial British East Africa Company chartered, September 7. Defeat of Ishak Khan by the Ameer of Afghanistan, September 29, 30. Black Mountain Expedition: British successes, October 4, 5, 9, and 18; final submission of tribes, November 18. Visit of the German Emperor to the Pope, October 12. Opening of the Special Commission appointed to examine into the charges made by *The Times* in "Parnellism and Crime," October 22. Marriage between King Milan and Queen Natalie dissolved, October 24. General Harrison elected President of the United States, November 6. Death of Lord Lucan, November 10 (born, 1800). Death of Sir R. Baggallay, November 13 (born, 1813). Anglo-German blockade of Zanzibar on account of the slave trade, December 2. British victory at Suakin, December 20. Death of Count Loris Melikoff, December 22 (born, 1835). Suez Canal Convention ratified by the Powers, December 22. Death of Lord Eversley, December 28 (born, 1794). Rising in Zululand; surrender of Dinizulu, July–November. Continued Irish agitation. Separation movement in Wales.

1889. Death of the Crown Prince of Austria, January 30 (born, 1858). Anti-rent riot near Gweedore; District-Inspector Martin murdered by the mob, February 3. Mr Parnell's Scottish action against *The Times* dismissed, February 5. New Japanese constitution proclaimed, February 12. Collapse of the Paris copper syndicate; panic checked by Government and other support, March 5–9. Abdication of King Milan of Servia, March 6. French decree of banishment against the Duc d'Aumale dismissed, March 9. Abyssinians defeated by the Mahdi, March 10–12. Death of Mr John Bright, March 27 (born, 1811). Meeting between Queen Victoria and the Queen-Regent of Spain at San Sebastian, March 27. Flight of General Boulanger from Paris, April 1. Death of the Duchess of Cambridge, April 6 (born, 1797). Death of Father Damien, missionary to the Sandwich Island lepers, April 10 (born, 1841). Conference on Samoa in Berlin, April 29. Murder of Dr Cronin in Chicago by members of the Clan-na-Gael, May 4. Centennial celebration of the opening of the States General at Versailles, May 4. Opening of the Paris Exhibition, May 6. Death of Lord Sidney Godolphin Osborne, May 9 (born, 1808). Great floods in Pennsylvania, about 10,000 lives lost, May 31. Delagoa Bay railway seized by Portugal, June 25. Arrival of the Shah of Persia at Gravesend, July 1. Defeat of dervishes at Arguin by Colonel Wodehouse, July 2. Marriage of the Princess Louise of Wales and the Duke of Fife, July 27. Visit of the German Emperor to Queen Victoria at Osborne, August 2. Rout of dervishes at Toski by General Grenfell, August 4. Mrs Maybrick convicted of poisoning her husband at Liverpool, August 7. Death of Signor Cairoli, Italian statesman, August 8 (born, 1826). Sentence of perpetual imprisonment passed upon General Boulanger by the Paris High Court, August 12. Great strike of London dock labourers, August 15 (ended September 16). French general election; Republican success, September 22. Death of Wilkie Collins, September 23 (born, 1824). Death of General Faidherbe, September 29 (born, 1818). Death of the King of Portugal, October 9 (born, 1838). Charter granted to the British South Africa Company, October 15. Visit of the German Emperor and Empress to Constantinople, November 2. Death of Lord Falmouth, November 6 (born, 1819). Forth Bridge completed, November 6. Revolution in Brazil; deposition of the Emperor, republic proclaimed, November 15. Anti-slavery Conference opened in Brussels, November 18. Close of the Parnell Commission, after sitting for 129 days, November 22. Arrival of Mr Stanley and Emin Pasha at Bagamoyo from Central Africa, December 4. Death of Jefferson Davis, December 6 (born, 1808). Death of Robert Browning, December 12 (born, 1812). Collapse of the Panama Canal Company, December 14. Death of Count Karolyi, December 26 (born, 1825). Disturbances in Crete.

1890. Death of Dr Döllinger, January 10 (born, 1799). British ultimatum respecting East Africa accepted by Portugal, January 12. Death of Lord Napier of Magdala, January 14 (born, 1810). Death of Sir William Gull, January 29 (born, 1816). Federation of shipowners formed, February 4. South Metropolitan Gas Company's strike ended, February 5. Parnell Commission report issued, February 13. Death of Count Julius Andrassy, February 18 (born, 1823). Forth Bridge opened, March 4. Resignation of Prince Bismarck, March 17. General von Caprivi appointed German Chancellor, March 19. Arrival of Mr H. M. Stanley in England from Africa, April 26. Return of Prince Albert Victor from India, May 2. Anglo-German agreement with reference to Africa and Heligoland signed in Berlin, July 1. Anti-Jewish edicts in Russia, July 25. Anglo-French Convention with refer-

ence to Africa signed in Paris, August 5. Heligoland formally transferred to Germany, August 9. Death of Cardinal Newman, August 12 (born, 1801). Death of M. Chatrian, September 3 (born, 1826). Revolution in Manipur, September 21. M'Kinley Tariff Bill became law, October 1. Death of Sir Richard Burton, October 20 (born, 1821). Constitution of West Australia proclaimed, October 22. Financial crisis in London; suspension of Baring Brothers averted by the help of the Bank of England and leading financial houses, November 14, 15. Decree in the divorce suit of O'Shea *v.* O'Shea and Parnell, November 17. Judgment by the Archbishop of Canterbury in the Bishop of Lincoln's case, November 21. Death of King William III. of the Netherlands, November 23 (born, 1817). Letter from Mr Gladstone to Mr John Morley regarding Mr Parnell's leadership of the Irish party, November 24. Disruption of the Irish parliamentary party, December 6. Arrival of the Cesarevitch at Bombay, December 24. Death of Dr Schliemann, December 27 (born, 1822). Death of Octave Feuillet, December 29 (aged 70).

1891. Death of A. W. Kinglake, January 2 (aged 79). Naval revolt in Chile against President Balmaceda, January 7. Death of Charles Bradlaugh, January 27 (born, 1833). Death of Meissonier, January 31 (aged 75). Death of General Sherman, February 14 (born, 1820). Tokar captured by Egyptian troops, February 19. Successes of Chilian insurgents, February 15–20. Australasian Federal Convention at Sydney opened, March 2. Death of Dr Windthorst, March 14. Reverse to British troops in Manipur, March 25. Boer trek into Mashonaland stopped, April 22. Death of Field-Marshal Count von Moltke, April 24. Manipur occupied by British expedition, April 27. Death of Sir J. Macdonald, June 6 (born, 1815). Anglo-Portuguese treaty with reference to East Africa signed at Lisbon, June 11. Regent and Senaputty of Manipur found guilty of waging war against the Queen, June 20. Triple Alliance renewed for six years, June 28. Arrival of the German Emperor and Empress in England, July 4. Free Education Bill read a third time in the Commons, July 8. Visit of the French fleet to Kronstadt, July 23. Death of J. R. Lowell, August 12 (born, 1819). Execution of the Senaputty of Manipur, August 13. Arrival of French squadron at Spithead, August 19. Capture by Chilian insurgents of Valparaiso, August 27, and Santiago, August 31. Death of ex-President Grévy, September 9 (born, 1807). Suicide of ex-President Balmaceda, September 19. Suicide of General Boulanger, September 30 (born, 1837). Meeting of the National Liberal Federation at Newcastle-on-Tyne, October 1. Death of Mr W. H. Smith, October 6 (born, 1825). Death of Mr C. S. Parnell, October 6 (born, 1846). Mr A. J. Balfour becomes leader of the House of Commons, October 15. Severe earthquake in Japan, October 28. Death of the Earl of Lytton, November 24 (born, 1831). Mongolian rebels defeated by Chinese, December 5. Betrothal of the Duke of Clarence to Princess May of Teck announced, December 7.

1892. Death of the Khedive Tewfik, January 7 (born, 1852). Death of the Duke of Clarence, January 14 (born, 1864). Death of Cardinal Manning, January 14 (born, 1808). Death of Mr C. H. Spurgeon, January 31 (born, 1834). Death of Professor Freeman, March 16 (born, 1823). Death of Walt Whitman, March 26 (born, 1819). Bering Sea *modus vivendi* ratified, April 18. Ravachol, French dynamiter, condemned to penal servitude for life for murder and conspiracy, April 26. Terrible hurricane at Mauritius, April 29. Death of Lord Bramwell, May 9 (born, 1808). Irish Local Government Bill read a second time in the Commons, May 24 (abandoned, June 13). Durham miners' dispute settled after lasting ninety days, June 1. Ravachol sentenced to death for murder, June 23. British Parliament dissolved, June 28. Great fire at St Johns, Newfoundland, July 8. Execution of Ravachol, July 11. Archbishop of Canterbury's decision in Bishop of Lincoln's case upheld by the Privy Council, August 2. Meeting of Parliament, August 4. Defeat of Lord Salisbury, August 11, Mr Gladstone forming a Liberal administration. Death of J. G. Whittier, September 7 (born, 1807). Failure of companies connected with the Liberator Building Society, September 8. Behanzin, King of Dahomey, defeated by the French under Colonel Dodds, October 4. Death of Lord Tennyson, October 6 (born, 1809). Lancashire cotton strike, October 5. Mr Cleveland, Democrat, elected President of the United States, October 8. Defeat of the French Ministry in connexion with the Panama scandals, November 21. Warrants issued for arrest of Panama directors, December 16. Death of Sir Richard Owen, December 18 (born, 1804).

1893. Khedive's anti-British Ministers dismissed, January 17. MM. Lesseps sentenced for Panama frauds by Court of Appeal, February 9. Home Rule Bill introduced in the Commons, February 13. Death of John Pettie, R.A., February 21 (born, 1839). Death of M. Taine, March 5 (born, 1828). Death of M. Jules Ferry, March 17 (born, 1832). Sir G. Portal's mission reaches Mengo (Uganda), March 17. Panama bribery trial concluded, March 21. Australian bank failures, April 4–May 9. Hull dock strike riots, April 5. Death of Lord Derby, April 11 (born, 1826). Serious earthquake in Zante, April 17. Home Rule Bill passed second reading, April 21. Chicago World's Fair opened, May 1. Hull dock strike ended, May 19. Loss of H.M.S. *Victoria*, June 22. Nansen's Polar expedition started, June 24. Indian legislation fixing value of rupee, June 26. Death of Guy de Maupassant, July 4 (aged 43). Marriage of the Duke of York, July 6. French ultimatum to Siam, July 20. Great colliery strike began, July 28. French ultimatum accepted by Siam, August 1. Bering Sea award delivered, August 15. Duke of Edinburgh succeeded to duchy of Coburg, August 22. Home Rule Bill read a third time in the Commons, September 1. Featherstone strike riot, September 7. Home Rule Bill rejected by the Lords, September 8. War with the Matabele begun, October 2. Sir M Durand's mission at Kabul, October 2. Death of Ford Madox Brown, October 6 (born, 1821). Russian fleet at Toulon, October 13. Death of Marshal MacMahon, October 17 (born, 1808). Death of M. Gounod, October 18 (born, 1818). Decisive victory over the Matabele, November 2. Death of Peter Tschaikowsky, November 4 (aged 53). Coal strike ended, November 17. Death of Prince Alexander of Bulgaria, November 17 (born, 1857). Major Wilson and thirty-four men pursuing Lo-Bengula surrounded and killed on Shangani river, December 3. Death of John Tyndall, December 4 (born, 1820). Bomb outrage in French Chamber by Vaillant, December 9. Death of Benjamin Jowett, December 12 (born, 1817). Collision between British and French troops at Waima, West Africa, December 23. Matabeleland thrown open to prospectors, December 25. Rio bombarded by Brazilian rebels, December 28.

1894. Manchester Ship Canal opened for traffic, January 1. Serious riots in Sicily, January 2. Death of M. Waddington, January 13 (born, 1826). Jabez Balfour arrested in Argentina, January 22. Death of Sir Gerald Portal, January 25 (born, 1858). Vaillant guillotined, February 5. Bomb outrage at Terminus Café, Paris, February 12. Anarchist killed in Greenwich Park by bomb explosion, February 15. Death of Lo-Bengula, February 16. Resignation of Mr Gladstone, March 3, Lord Rosebery succeeding as Prime Minister. Bomb outrage at the Madeleine, Paris, March 15. Death of Louis Kossuth, March 20 (born, 1802). Bomb explosion at Café Foyot, Paris, April 4. Sir W. Harcourt's Budget introduced, April 16. Violent earthquakes in Greece, April 21–27. Mr Coxey, United States labour leader, arrested at Washington, May 2. Finance Bill second reading, May 10. Chicago railway strike begun, May 11. Bomb explosion in the Avenue Kléber, Paris, May 11. *Coup d'État* in Servia, May 20. Resignation of M. Stambuloff, May 29. Death of Lord Coleridge, June 14 (born, 1821). Attempt on Signor Crispi, June 16. British Protectorate of Uganda, June 19. Prince Edward of York born, June 23. Death of Mme. Alboni, June 23 (born, 1828). President Carnot assassinated by Caserio, June 24 (born, 1837). Coal strike in Scotland, June 26. M. Casimir-Perier elected President of the French Republic, June 27. Brazil rebels finally defeated, June 27. Inter-Colonial Conference at Ottawa, June 28. Tower Bridge opened, June 30. United States railway strike ended, July 13. Death of Leconte de Lisle, July 17 (aged 75). Finance Bill third reading, July 17. Transport *Kowshing* sunk by Japanese, July 25. War against China declared by Japan, August 1. Discovery of gold at Coolgardie, August 9. Lord Rayleigh's paper on argon at the British Association, August 13. Caserio executed, August 16. New commercial treaty with Japan, August 25. Death of the Comte de Paris, September 8 (born, 1838). Death of Professor Helmholtz, September 8 (aged 73). Chinese defeated at Ping-yang (Korea) on land, and in the battle of the Yalu by sea, September 16. Death of Oliver Wendell Holmes, October 7 (born, 1809). Death of Earl Grey, October 9 (born, 1802). Death of J. A. Froude, October 20 (born, 1818). Scottish coal strike ended, October 22. Count von Caprivi resigned, October 26. Prince Hohenlohe appointed German Chancellor, October 30. Death of Tsar Alexander III., November 1 (born, 1845), succeeded by Nicholas II. Death of John Walter, of *The Times*, November 3 (born, 1818). Death of Anton Rubinstein, November 20 (born, 1829). Port Arthur captured by Japanese, November 21. Death of R. L. Stevenson, December 3 (born, 1850). Death of Ferdinand Lesseps, December 7 (born, 1805). Captain Dreyfus, of the French army, condemned for treason, December 22. Death of Christina Rossetti, December 29 (born, 1830). Plague epidemic in Hong-kong, May to August. Turkish outrages on Armenians in Sassun district.

1895. Captain Dreyfus degraded, January 4. President Casimir-Perier resigns, January 15. M. Félix Faure elected President, January 17. Death of Lord Randolph Churchill, January 24 (born, 1849). Death of M. de Giers, Russian Chancellor, January 26 (born, 1820), succeeded by Prince Lobanof, February 27. Death of Marshal Canrobert, January 28 (born, 1809). Japanese naval victory off Wei-hai-wei, February 4. Death of Archduke Albrecht of Austria, February 18 (born, 1817). Mr Stokes, an Englishman, hanged in Congo State by order of Captain Lothaire,

in February. Death of Ismail Pasha, March 2 (born, 1830). Death of Professor Blackie, March 2 (born, 1809). Niu-chwang captured by Japanese, March 4. Sir R. Low's advance to relieve Chitral begun, April 1. Mr Gully appointed Speaker to succeed Lord Peel, April 10. Treaty of Shimonoseki signed, April 15. Chitral relieved by Colonel Kelly, April 20. Death of Lord Selborne, May 4 (born, 1812). French expedition under General Duchesne arrives at Madagascar, May 6. Kiel Canal opened, June 21. Resignation of the Rosebery Ministry, June 22. Lord Salisbury appointed Prime Minister, June 25. Death of T. H. Huxley, June 29 (born, 1825). Parliament dissolved, July 12. Murderous assault on M. Stambuloff, July 15; he died July 19 (born, 1852). Death of Professor von Gneist, July 21 (born, 1816). Anglo-Russian Pamirs Commission completes its work, September 18. Death of M. Pasteur, September 28 (born, 1822). Antananarivo captured by the French, September 30. Lord Wolseley became Commander-in-Chief, November 1. Clyde shipping strike, November 6. Sir F. Scott, commanding Ashanti expedition against King Prempeh, leaves England, November 22. Death of Barthélemy St Hilaire, November 25 (born, 1805). Death of A. Dumas, *fils*, November 27 (born, 1824). Jabez Balfour sentenced for Liberator frauds, November 28 Defeat of Italians in Abyssinia, December 7. President Cleveland's Venezuela message to Congress, December 17. Dr Jameson with Chartered Company's troops invades the Transvaal, December 29.

1896. Mr Alfred Austin made Poet Laureate, January 1. Dr. Jameson's force defeated by the Boers near Krugersdorp, January 1. Surrender of Dr Jameson, January 2. Kaiser's telegram to Kruger published, January 3. Resignation of Mr Rhodes as Premier of Cape Colony, January 6. Dr Jameson and officers surrendered by Boers to British authorities, January 7. British flying squadron commissioned, January 7. Death of Paul Verlaine, January 8 (aged 51). Arrest of Johannesburg reformers, January 9, 10. Anglo-French difficulty regarding Siam settled, January 15. Kumassi occupied by British, January 18. Death of Prince Henry of Battenberg, January 20 (born 1858). Clyde shipping strike settled, January 21. Death of Lord Leighton, January 24 (born, 1830). General Weyler leaves Spain to command against rebels in Cuba, January 25. Sir J. E. Millais elected President of the Royal Academy, February 20. Mr Steyn made President of the Orange Free State, February 21. Italians defeated by Abyssinians at Adowa, March 1. General Kitchener leaves Cairo to command Dongola expedition, March 22. Rising of the Matabele, March 25. Li Hung-chang left China to visit Europe, March 28. Johannesburg reformers sentenced, April 28; death sentences commuted same day. Major Lothaire acquitted in connexion with the hanging of Mr Stokes, April 28. Shah of Persia assassinated, May 1. Dervishes defeated near Akasheh, Sudan, May 1. Hungarian millenary exhibition, May 2. Matabele defeated at Gwelo, May 9. Tsar's coronation, May 26. Dervishes defeated at Ferkeh, June 7. Death of Jules Simon, June 8 (born, 1814). Dr Jameson and officers committed for trial, June 15. Japanese towns destroyed by sea wave, June 15. Madagascar declared a French colony, June 20. Death of Mrs Beecher Stowe, July 1 (born, 1812). Dr Jameson and officers convicted under Foreign Enlistment Act, July 28. Li Hung-chang arrived in England, August 2. Defeat of the Matabele, August 5. Death of Sir J. E. Millais, August 13 (born, 1829). Conference by Mr Rhodes with Matabele chiefs, August 20; followed by submission of natives. Zanzibar bombarded by British, August 27. Massacre of Armenians in Constantinople, August 25–27. Death of Prince Lobanof, August 30 (born, 1824). Return of Dr Nansen to Christiania, September 9. Dongola occupied by Egyptian troops, September 23. Death of William Morris, October 3 (born, 1834). Tsar's arrival in Paris, October 6. Death of Archbishop Benson, October 11 (born, 1829). Bishop Temple made Archbishop of Canterbury, October 26. Treaty of peace between Italy and Abyssinia, October 26. Mr M'Kinley elected President of the United States, November 3. Anglo-American agreement about Venezuela announced, November 9. Russo-Chinese treaty *re* Manchurian railway published, December 8.

1897. Unarmed British party attacked and massacred near Benin, January 2. Niger Company's expedition against Nupé and Ilorin starts, January 6. Olney-Pauncefote arbitration treaty signed, January 11. Death of Sir I. Pitman, January 22 (aged 84). Submission of Nupé, February 5. Greek force under Colonel Vassos landed in Crete, February 14. South Africa Committee's sittings begun, February 16. Submission of Ilorin, February 18. Benin city captured by British, February 18. International force sent to Crete by the Powers, March 18. Death of Johannes Brahms, April 3 (aged 63). War declared by Turkey against Greece, April 17. Maluna Pass captured by the Turks, April 18. Canadian Differential Tariff Bill introduced, April 23. Greek retreat from Larissa, April 25. Disastrous fire at a charity bazaar in Paris, causing great loss of life, including the Duchesse d'Alençon, May 4. Olney-Pauncefote arbitration treaty rejected by United States Senate, May 5. Greek retreat from Phersala, May 6. Death of the Duc d'Aumale, May 7 (born, 1822). Arrival of Sir A. Milner in South Africa as High Commissioner, May 7. Intervention of the Powers between Turkey and Greece, May 11. Disaster to a British force in the Tochi Valley, Indian frontier, June 10. Severe earthquakes in Assam and other parts of India, June 12. Queen Victoria's Diamond Jubilee, June 22. British plague officials murdered near Bombay, June 22. Death of Mrs Oliphant, June 25 (born, 1828). Naval review at Spithead, June 26. Death of Henri Meilhac, July 7 (aged 66). Herr Andrée's balloon expedition started for the North Pole, July 10. South Africa Committee's report issued, July 13 Death of Jean Ingelow, July 20 (aged 71). Excitement over Klondike gold discoveries, July 23. Rising in the Swat Valley, July 26. Capture of Abu Hamed, Sudan, August 7. Assassination of Señor Canovas del Castillo, Spanish Premier, August 8. General cessation of Swat Valley hostilities, August 21. Rising of Afridis, August 23. Arrival of President Faure at Kronstadt to visit the Tsar, August 23. Farewell luncheon on board the *Pothuau* at Kronstadt, August 26. Berber occupied by Egyptian troops, September 13. Severe fighting with the Mamunds, September 17. Preliminary treaty of peace between Turkey and Greece signed, September 18. General Weyler recalled from Cuba, October 8. Advance against Afridis begun by Sir W. Lockhart, October 19. Dargai heights stormed, October 20. Herr von Bulow appointed German Foreign Minister, October 22. Death of the Duchess of Teck, October 27 (born, 1833) Dreyfus *bordereau* published by the *Matin*, November 10. Kiao-chow Bay occupied by Germans, November 14. Great fire in Cripplegate, November 19. Final treaty of peace between Turkey and Greece signed, December 4. Departure of Prince Henry of Prussia for China, December 16. Death of Alphonse Daudet, December 16 (born, 1840). British retirement from Tirah highlands to winter quarters, about December 20. Famine and plague very severe in India during the year.

1898. Major Esterhazy acquitted of treason by court-martial, January 11. M. Zola's letter, "J'accuse," published in the *Aurore*, January 13. Death of "Lewis Carroll," January 14 (aged 65). Death of Mr C. P. Villiers, January 16 (born, 1802). Uganda rebels defeated, January 29. The United States warship *Maine* blown up in Havana harbour, February 15. M. Zola convicted for libel, February 23. Death of Sir Henry Bessemer, March 15 (born, 1813). Port Arthur and Ta-lien-wan ceded to Russia, March 23. Great coal strike in South Wales, April 1. Submission of Khaibar tribesmen, April 1; the frontier pacified. Wei-hai-wei ceded to Great Britain, April 2. Dervishes defeated on the Athara, April 8. War between the United States and Spain, April 21. Spanish fleet at Manila destroyed by Commodore Dewey, May 1. Serious riots in Milan, May 7. Death of W. E. Gladstone, May 19 (born, 1809). Spanish fleet under Admiral Cervera arrived at Santiago de Cuba, May 19. The *Merrimac* sunk by Lieutenant Hobson at the entrance to Santiago harbour, June 3. Bankruptcy of Mr E. T. Hooley, June 8. Agreement with France *re* West Africa signed, June 14. Resignation of M. Méline, French Premier, June 15, succeeded by M. Brisson. Death of Sir E. Burne-Jones, June 17 (born, 1833). Cervera's squadron destroyed by Admiral Sampson near Santiago, July 3. Major Marchand reached Fashoda, July 10. Santiago occupied by Americans, July 17. Death of Prince Bismarck, July 30 (born, 1815). Canadian preferential tariff in favour of Great Britain came into operation, August 1. Sudanese troops decisively defeated in Uganda by Major Martyr, August 4; they had been in mutiny since October 1897. Spanish-American peace preliminaries settled, August 12. Manila surrendered to Americans, August 13. United States and Canadian Conference at Quebec opened, August 23. Tsar's disarmament proposal issued, August 21. Suicide of Colonel Henry while under arrest for forging evidence in the Dreyfus case, August 30. Complete defeat of the Khalifa at Omdurman, September 2. Assassination of the Empress of Austria at Geneva, September 10. Terrible hurricane in the West Indies, September 11. Death of Sir George Grey, September 19 (born, 1812). Meeting between the Sirdar and Major Marchand at Fashoda, September 21. *Coup d'État* in China, Dowager-Empress becoming regent, September 22. Dreyfus case remitted to the Court of Cassation, September 26. Death of Puvis de Chavannes, October 25 (aged 72). Resignation of M. Brisson, October 25; succeeded by M. Ch. Dupuy. Arrival of the Kaiser at Haifa on his tour in the Holy Land, October 27. French Government decided to evacuate Fashoda, November 4. Prince George of Greece nominated High Commissioner of Crete, November 26. Spanish-American treaty of peace signed, December 10. Death of William Black, December 10 (born, 1841). Withdrawal of Major Marchand from Fashoda, December 11. Retirement from the Liberal leadership by Sir W. Harcourt announced, December 13. Imperial penny postage came into force, December 25. Plague was again prevalent in India this year, especially in Bombay.

1899. Native disturbances in Samoa, January 1. Anglo-Egyptian agreement regarding the Sudan, January 19. Fighting at

Manila between United States troops and Filipinos, February 4. Death of Count von Caprivi, February 6 (born, 1831). Death of President Faure, February 15 (born, 1841). Émile Loubet elected French President, February 18. Russian manifesto issued limiting Finnish autonomy, February 20. Death of Lord Herschell, March 1 (born, 1837). Agreements regarding railways and telegraphs in Africa negotiated with the German Government by Mr Rhodes in Berlin, March 10–16. Apia shelled by British and American warships, March 16. Anglo-French convention signed regarding possessions in Africa, March 21. Death of Édouard Pailleron, April 20 (born, 1834). British and Italian squadrons reviewed in Aranci Bay by King Humbert, April 22. The Hague Peace Conference opened, May 18. Death of Señor Castelar, May 25 (born, 1832). Death of Rosa Bonheur, May 25 (born, 1823). Conference opened at Bloemfontein between Sir A. Milner and President Kruger, May 31. Sale announced of Spanish Pacific islands to Germany, June 2. Death of Johann Strauss, June 3 (born, 1826). Dreyfus verdict annulled by Court of Cassation and new court-martial ordered, June 3. Bloemfontein Conference concluded without result, June 6. Provisional Government for Samoa appointed, June 9. Defeat of French Ministry, June 12. Venezuela arbitration proceedings begun in Paris, June 15. French Ministry formed by M. Waldeck-Rousseau, June 22. Dreyfus landed in France for retrial at Rennes, July 1. Death of Victor Cherbuliez, July 1 (born, 1829). London Government Bill passed the Lords, July 4. Lieutenant-Colonel Klobb, of the French marines, killed in the Sudan by Captain Voulet's troops, July 14. Close of The Hague Conference, July 29. Retrial of Dreyfus begun, August 7. M. Labori, counsel for Dreyfus, shot in the back, August 14. Death of Professor Bunsen, August 16 (born, 1811). Dreyfus found guilty by the Rennes court-martial, September 9; pardoned, September 19. Last British despatch in Transvaal negotiations succeeding the Bloemfontein Conference, September 22. Decision of the Venezuela Arbitration Court, October 3. Boer ultimatum, October 9; war begun, October 11. Battle of Talana Hill, October 20; Sir W. P. Symons mortally wounded. Battle of Elandslaagte, October 21. British disaster at Nicholson's Nek, October 30. Arrival of Sir R. Buller at the Cape, October 31. Anglo-German Samoa Convention signed, November 14. Successful advance by Lord Methuen, driving the Boers from Belmont, November 23; Graspan, November 25; and Modder River, November 28; but with severe British losses. Defeat and death of the Khalifa at Om Debrika, November 25. Serious reverse to General Gatacre at Stormberg, December 10. Lord Methuen repulsed at Magersfontein, December 11; General Wauchope killed. Sir R. Buller repulsed at Colenso, December 15; eleven guns lost. Lord Roberts appointed to chief command in South Africa, with Lord Kitchener Chief of the Staff, December 16. New South Wales, Victoria, South Australia, Queensland, and Tasmania this year agreed on a scheme of federation. Famine and distress in Russia.

1900. Enrolment of members of the C.I.V. corps, January 1. Boer assault on Ladysmith repulsed, January 6. Arrival of Lord Roberts and staff at Cape Town, January 10. Osman Digna captured near Tokar, January 19. Death of John Ruskin, January 20 (born, 1819). Death of R. D. Blackmore, January 20 (born, 1825). Fresh advance by General Buller repulsed after heavy fighting at Spion Kop, January 24. Lord Roberts's advance from Modder River begun, February 11. Relief of Kimberley by General French, February 15. Indian Famine Mansion House Fund opened, February 15. Severe fighting in Natal by General Buller's force, February 18–23. Surrender of Cronje and 4000 Boers at Paardeberg, February 27. Relief of Ladysmith, February 28. Théâtre Français destroyed by fire, March 8. Bloemfontein occupied, March 13. Death of General Sir W. Lockhart, March 18 (born, 1841). Death of Commandant General Joubert, March 27. Delagoa Bay award issued after eleven years, March 29. British force caught in ambush at Sanna's Post, March 31. Surrender of 600 British at Reddersburg, April 3. Queen's visit to Dublin, April 4. Attempt on the Prince of Wales by Sipido at Brussels, April 4. Death of Ghazi Osman Pasha, April 4 (aged 68). News received of a rising in Ashanti, April 9. Paris Exhibition opened, April 14. Death of the Duke of Argyll, April 24 (born, 1823). Death of M. de Munkacsy, May 1 (born, 1844). Advance from Bloemfontein begun, May 2. Relief of Mafeking, May 17. Anxiety in Peking over the Boxer outbreak, May 20. Orange Free State annexed, May 26. Johannesburg occupied, May 31. Pretoria occupied, June 5. Start of Admiral Seymour's expedition to relieve Peking Legations, June 10; forced to retreat, June 19; returned to Tientsin, June 26. Resignation of Mr Schreiner's Cape Ministry, June 13; succeeded by Sir J. Gordon Sprigg. Massacre of native Christians in Peking, June 13. Taku forts captured by the allied squadrons, June 17. Baron von Ketteler, German Minister, murdered in Peking, June 20; siege of the Legations begun. Death of Count Muravieff, Russian Chancellor, June 21 (born, 1845); succeeded by Count Lamsdorff. Australian Commonwealth Bill received the royal assent, July 9. Earl of Hopetoun appointed Governor-General of Australian Commonwealth, July 13. Russians attacked by Chinese in Eastern Siberia, July 14; resulting operations ended in occupation of Manchuria by Russian troops. Native city of Tientsin captured by the allies, July 14. Kumassi garrison relieved by Colonel Willcocks, July 15. Assassination of King Humbert of Italy, July 29 (born, 1844). Death of the Duke of Coburg, July 30 (born, 1844). Surrender of General Prinsloo and 3000 Boers, July 30–31. West Australia decided to join the Commonwealth, August 2. Death of Lord Russell of Killowen, August 10 (born, 1832). Relief of the Peking Legations, August 14. Mansion House War Fund exceeded £1,000,000, September 3. Komati Poort occupied by the British, September 24. Parliament dissolved, September 25; the Unionists again returned, with a majority of 134. Lord Roberts appointed Commander-in-Chief, September 30. Anglo-German agreement regarding China, October 16. Resignation of Prince Hohenlohe, German Chancellor, October 17; succeeded by Count von Bulow. Mr Kruger sailed for Europe, October 20. Transvaal annexed by Royal proclamation, October 25. Death of Mr Sims Reeves, October 25 (born, 1822). Death of Professor Max Muller, October 28 (born, 1823). Defeat of De Wet near Bothaville, November 5. Re-election of President M'Kinley, November 6. Death of Sir Arthur Sullivan, November 22 (born, 1842). Arrival of Mr Kruger at Marseilles, November 22. Dewetsdorp captured by De Wet, November 23. Command in South Africa handed over to Lord Kitchener, November 29. Mr Kruger left Paris for Germany, December 1; refused an interview by the German Emperor; proceeded to Holland. Attempted invasion of Cape Colony by De Wet foiled, December 2–8. Mr Healy expelled by the Irish Nationalist party, December 11. Reverse to General Clements's force at Nooitgedacht, December 13. Invasion of Cape Colony by Boers under Kritzinger and Hertzog, December 16. Hay-Pauncefote Treaty ratified by the United States Senate with amendments, December 20. Death of Field-Marshal Count von Blumenthal, December 22 (born, 1810). Death of Lord Armstrong, December 27 (born, 1810). Mr Barton appointed first Premier of the Australian Commonwealth, December 30. Allies' terms to China accepted in principle, December 30. Proposed Russo-Chinese agreement *re* Manchuria known in Peking, December 31. Terribly severe famine in India this year.

(W. W. S.*)

# CHRONOLOGY, BIBLICAL.

## 1. Old Testament.

A SENSE of the importance of a fixed standard of chronology was only acquired gradually in the history of the world. Nations in a primitive state of civilization were not, and are not, conscious of the need. When the need began to be felt events were probably at first dated by the regnal years of kings; the reigns of successive kings were then arranged in order, and grouped, if necessary, in dynasties, and thus a fixed standard was gradually constructed. Particular states also not unfrequently introduced fixed eras, which obtained a more or less extensive currency, as the era of the first Olympiad (776 B.C.), of the foundation of Rome (753 B.C.), and of the Seleucidæ at Antioch (312 B.C.), which is followed by the Jewish author of the first book of Maccabees. Some of the earliest documents which we possess are dated by the year in which some noticeable event took place, as in contract-tablets of the age of Sargon of Agadè (3800 B.C., or, according to other authorities, 2800 B.C.), "In the year in which Sargon conquered the land of Amurru [the Amorites]"; or, "In the year in which Samsu-satana [*c.* 2200 B.C.] made the statue of Marduk": Is. vi. 1 ("In the year of King Uzziah's death"), xiv. 28, xx. 1, are examples of this method of dating found even in the Old Testament. In process of time, however, the custom of dating by the regnal year of the king became general. The Babylonians and Assyrians were probably the first to construct and

employ a fixed chronological standard; and the numerous contract-tablets, and lists of kings and yearly officials, discovered within recent years, afford striking evidence of the precision with which they noted chronological details. Biblical chronology is, unfortunately, in many respects uncertain. Prior to the establishment of the monarchy the conditions for securing an exact and consecutive chronology did not exist; the dates in the earlier period of the history, though apparently in many cases precise, being in fact added long after the events described, and often (as will appear below) resting upon an artificial basis, so that the precision is in reality illusory. And after the establishment of the monarchy, though the conditions for an accurate chronology now existed, errors by some means or other found their way into the figures; so that the dates, as we now have them, are in many cases at fault by as much as two to three decades of years. The *exact* dates of events in Hebrew history can be determined only when the figures given in the Old Testament can be checked and, if necessary, corrected by the contemporary monuments of Assyria and Babylonia, or (as in the post-Exilic period) by the knowledge which we independently possess of the chronology of the Persian kings. In the following parts of this article the chronological character of each successive period of the Old Testament history will be considered and explained as far as the limits of space at the writer's disposal permit.

I. *From the Creation of Man to the Exodus.*—In the whole of this period the chronology, in so far as it consists of definite figures, depends upon that part of the Pentateuchal narrative which is called by critics the "Priestly Code" (see PENTATEUCH in *Ency. Brit.*, ninth edition, vol. xviii.). The figures are in most, if not in all cases artificial, though the means now fail us of determining upon what principles they were calculated. It is also to be noted that in the Samaritan text of the Pentateuch, and in the LXX., the figures, especially in the period from the Creation to the birth of Abraham, differ considerably from those given in the Hebrew, yielding in Sam. a lower, but in the LXX. a much higher total. The following tables will make the details clear:—

(1) *From the Creation of Man to the Flood* (Gen. v., and vii. 11).

| | Age of each at birth of next. | | |
|---|---|---|---|
| | Heb. | Sam. | LXX. |
| Adam (930) | 130 | 130 | 230 |
| Seth (912) | 105 | 105 | 205 |
| Enosh (905) | 90 | 90 | 190 |
| Kenan (910) | 70 | 70 | 170 |
| Mahalalel (895) | 65 | 65 | 165 |
| Jared (962) | 162 | 62 | 162 |
| Enoch (365) | 65 | 65 | 165 |
| Methuselah (969) | 187 | 67 | 187 [1] |
| Lamech (777) | 182 | 53 | 188 |
| Noah (950); age at Flood | 600 | 600 | 600 |
| Total from the Creation of Man to the Flood | 1656 | 1307 | 2262 |

The figures in parentheses indicate the entire ages assigned to the several patriarchs; these are generally the same in the three texts. The Sam., however, it will be noticed, makes in three cases the father's age at the birth of his eldest son less than it is in the Heb. text, while the LXX. makes it in several cases as much as 100 years higher, the general result of these differences being that the total in the Sam. is 349 years less than in the Heb., while in the LXX. it is 606 years more. The names, it need hardly be remarked, belong to the prehistoric period, and equally with the figures are destitute of historical value.

(2) *From the Flood to the Call of Abraham* (Gen. xi.).

| | Age of each at birth of next. | | |
|---|---|---|---|
| | Heb. | Sam. | LXX. |
| Arphaxad (438) [2] | 35 [3] | 135 | 135 |
| Cainan (460) [cf. Luke iii. 27] | .. | ... | 130 |
| Shelah (433) | 30 | 130 | 130 |
| Eber (464) | 34 | 134 | 134 |
| Peleg (239) | 30 | 130 | 130 |
| Reu (239) | 32 | 132 | 132 |
| Serug (230) | 30 | 130 | 130 |
| Nahor (148) | 29 | 79 | 79 |
| Terah (205) | 70 | 70 | 70 |
| Abraham (175); age at Call (Gen. xii. 4) | 75 | 75 | 75 |
| Total from the Flood to the Call of Abraham | 365 | 1015 | 1145 |

The variations are analogous to those under (1), except that here the birth-years of the patriarchs in both Sam. and LXX. differ more consistently in one direction, being, viz., almost uniformly higher by 100 years. It has been much debated, in both cases, which of the three texts preserves the original figures. In (2) it is generally agreed that the Heb. does this, the figures in Sam. and LXX. having been arbitrarily increased for the purpose of lengthening the entire period. The majority of scholars hold the same view in regard also to (1); but Dillmann gives here the preference to the figures of the Sam. The figures, of course, in no case possess historical value: accepting even Ussher's date of the Exodus, 1491 B.C., which (see below) is earlier than is probable, we should obtain from them for the creation of man 4157 B.C., or (LXX.) 5328,[4] and for the confusion of tongues, which, according to Gen. xi. 1-9, immediately followed the Flood, 2501 B.C., or (LXX.) 3066 B.C. But the monuments of Egypt and Babylonia make it certain that man must have appeared upon the earth long before either 4157 B.C. or 5328 B.C.; and numerous inscriptions, written in three distinct languages—Egyptian, Sumerian, and Babylonian—are preserved, dating from an age considerably earlier than either 2501 B.C. or 3066 B.C.[5] The figures of Gen. v. and xi. thus merely indicate the manner in which the author of the priestly narrative—and probably to some extent tradition before him—pictured the course of these early ages of the world's history. The ages assigned to the several patriarchs (except Enoch) in Gen. v. are much greater than those assigned to the patriarchs mentioned in Gen. xi., and similarly the ages in Gen. xi. 10-18 are higher than those in Gen. xi. 19-26; it is thus a collateral aim of the author to exemplify the supposed gradual diminution in the normal years of human life.

The Babylonians, according to Berossus, supposed that there were ten antediluvian kings, who they declared had reigned for the portentous period of 432,000 years: 432,000 years, however, it has been ingeniously pointed out by Oppert (*Gött. Gel. Nachrichten*, 1877, p. 205 *ff.*) = 86,400 *lustra*, while 1656 years (the Heb. date of the Flood) = 86,400 *weeks* ($1656 = 72 \times 23$; and 23 years being = 8395 days + 5 intercalary days = 8400 days = 1200 weeks); and hence the inference has been drawn that the two periods have in some way been developed from a common basis, the Hebrews taking as their unit a week, where the Babylonians took a *lustrum* of 5 years.

[1] Or, according to some MSS., 167.

[2] Shem, the father of Arphaxad, is aged 100 at the time of the Flood, and lives for 600 years.

[3] Disregarding the "two years" of Gen. xi. 10: see v. 32, vii. 11.

[4] Taking account of the reading of LXX. in Ex. xii. 40 (p. 75).

[5] See further the present writer's essay in Hogarth's *Authority and Archæology* (1899), pp. 32-34.

(3) *From the Call of Abraham to the Exodus.*

| | |
|---|---|
| From the Call of Abraham to the birth of Isaac (Abraham being then aged 100, Gen. xxi. 5). | 25 years |
| Age of Isaac at the birth of Esau and Jacob (Gen. xxv. 26) . . . . . . . | 60 ,, |
| Age of Jacob when he went down into Egypt (Gen. xlvii. 9) . . . . . . | 130 ,, |
| The period of the Patriarchs' sojourn in Canaan was thus . . . . . . . | 215 ,, |
| But the period of the Israelites' sojourn in Egypt, according to Ex. xii. 40, 41, was . . . . | 430 ,, |

We thus get—

| | |
|---|---|
| From the Call of Abraham to the Exodus (Heb. text) . . . . . . . 215 + 430 = | 645 years |
| From the Flood to the Call of Abraham (Heb. text) . . . . . . . . . . | 365 ,, |
| From the Creation of Man to the Flood (Heb. text) . . . . . . . . . . | 1656 ,, |
| From the Creation of Man to the Exodus (Heb. text) . . . . . . . . . . | 2666 ,, |

On these figures the following remarks may be made :—(i.) In Genesis the chronology of the Priestly Code ("P") is not consistent with the chronology of the other parts of the book ("JE"). Three or four illustrations will suffice: (*a*) The author of Gen. xii. 10-20 evidently pictures Sarai as a comparatively young woman, yet, according to P (xii. 4, xvii. 17) she was 65 years old. (*b*) In Gen. xxi. 15 it is clearly implied that Ishmael has been *carried* by his mother, yet according to xvi. 16, xxi. 5, 8, he must have been at least 15 years old. (*c*) In Gen. xxvii. Isaac is to all appearance on his deathbed (cf. ver. 2), yet according to P (xxv. 26, xxvi. 34, xxxv. 28) he survived for *eighty* years, dying at the age of 180. Ussher and others, arguing back from the dates in xlvii. 9, xlv. 6, xli. 46, xxxi. 41, infer that Jacob's flight to Haran took place in his 77th year. This reduces the 80 years to 43 years, though that is scarcely less incredible. It involves, moreover, the incongruity of supposing that *thirty-seven* years elapsed between Esau's marrying his Hittite wives (xxvi. 34) and Rebekah's expressing her apprehensions (xxvii. 46) lest Jacob, then aged *seventy-seven*, should follow his brother's example. (*d*) In Gen. xliv. 20 Benjamin is described as a "little one"; in P, almost immediately afterwards (xlvi. 21), he appears as the father of ten sons; for a similar anomaly in xlvi. 12, see the *Oxford Hexateuch*, i. p. 25 *n*. (ii.) The ages to which the various patriarchs lived (Abraham, 175; Isaac, 180; Jacob, 147), though not so extravagant as those of the antediluvian patriarchs, or (with one exception) as those of the patriarchs between Noah and Abraham, are much greater than is at all probable in view of the structure and constitution of the human body. (iii.) The plain intention of Ex. xii. 40, 41 is to describe the Israelites as having dwelt in Egypt for 430 years, which is also in substantial agreement with the earlier passage, Gen. xv. 13 ("shall sojourn in a land that is not theirs, . . . and they shall afflict them 400 years"). It does not, however, accord with other passages, which assign only four generations from Jacob's children to Moses (Ex. vi. 16-20; Num. xxvi. 5-9; cf. Gen. xv. 16), or five to Joshua (Josh. vii. 1); and for this reason, no doubt, the Sam. and LXX. read in Ex. xii. 40, "The sojourning of the children of Israel in the land of Egypt, *and in the land of Canaan*, was 430 years," reducing the period of the sojourn in Egypt to half of that stated in the Hebrew text, viz., 215 years. This computation attained currency among the later Jews (Josephus and others; cf. the "400 years" of Gal. iii. 17). The forced and unnatural rendering of Ex. xii. 40 in the A.V. (contrast R.V.), which was followed by Ussher, is intended for the purpose of making it possible. (iv.) The interval between Abraham and the Exodus appears to be greater than is permitted by the synchronisms with external history. It is difficult (see below) to place the Exodus much earlier than *c.* 1200 B.C. If, however, the Amraphel of Gen. xiv. is rightly identified by scholars with the Babylonian king Khammurabi (whose reign is assigned variously by Assyriologists to dates ranging between 2376-2333 B.C. to 2120-2065 B.C.),[1] and if, further, the part ascribed to Abraham in the same chapter is historical, the interval between Abraham's entry into Canaan and the Exodus cannot be less than *c.* 900 years, and may very possibly be more, as against the 645 years allowed by the Hebrew text, or the still shorter period of 430 years allowed by Ussher's computation. From the facts that have been here briefly noted it must be evident how precarious and, in parts, how impossible the Biblical chronology of this period is. (v.) It has been observed as remarkable that 2666, the number of years (in the Hebrew text) from the Creation of Man to the Exodus is, in round numbers, just two-thirds of 4000; and the fact has suggested the inference that the figure was reached by artificial computation.

*The Date of the Exodus.*—Is it possible to determine this, even approximately, upon the basis of external *data?* (i.) The correspondence between the Egyptian governors established in different parts of Palestine and the Egyptian kings Amen-hôtep III. and IV. of the 18th dynasty, which was discovered in 1887 at Tel el-amarna, makes it evident that Palestine could not yet have been in the occupation of the Israelites. It was still an Egyptian province, and the Babylonian language, in which the correspondence is written, shows that the country must have been for a considerable time past, before it came into the possession of Egypt, under Babylonian influence. One of the kings, now, who corresponds with Amen-hôtep IV. is Burnaburiash II., king of Babylon, and Egyptologists and Assyriologists are agreed that the date of these monarchs was *c.* 1400 B.C. The conquest of Canaan, consequently, could not have taken place till after 1400 B.C. (ii.) It is stated in Ex. i. 11 that the Israelites built in Egypt for the Pharaoh two store-cities, Pithom and Raamses. The excavations of M. Naville have, however, shown that Ramses II. of the 19th dynasty was the builder of Pithom; and though the other city has not at present been certainly identified, its name is sufficient to show that he was its builder likewise. Hence the Pharaoh of the Exodus is commonly supposed to have been Ramses II.'s successor, Merenptah. Egyptian chronology is unfortunately imperfect, but Professor Petrie, who has paid particular attention to the subject, and who assigns the reign of Amen-hôtep IV. to 1383-1365 B.C., assigns Ramses II. to 1275-1208 B.C.[2] In Merenptah's fifth year the Delta was invaded by a formidable body of Libyans and other foes;[3] and it has been

[1] Early Babylonian chronology is itself, in some of its details, difficult and uncertain, the figures given in the two important dynastic lists discovered by Mr Pinches in 1874 and 1880 (see *Records of the Past*, 2nd ser. vol. i. p. 13 *ff.*) not harmonizing completely with statements made by later Assyrian and Babylonian kings as to the years which had elapsed since the reigns of certain of their predecessors. The figures in the dynastic lists would lead most naturally to such dates as 2376-2333 B.C. (Sayce, *Early Israel*, 1899, p. 281), 2342-2288 (R. W. Rogers, *Hist. of Babylonia and Assyria*, New York, 1900, i. 338—at least approximately, p. 387 *n.*), 2287-2232 (Maspero, *Struggle of the Nations*, 1897, p. 27), *c.* 2285 (L. W. King, *Encycl. Biblica*, 1899, i. 445); but other scholars argue with much force that there are errors in some of the transmitted figures, and so arrive at the dates 2248-2194 (Lehmann, *Zwei Hauptprobleme der Altor. Chronologie*, 1898, p. 99 and tab. 3), 2120-2065 (Rost, *Untersuchungen zur Altor. Gesch.* 1897, p. 23), or 2130-2087 (Hommel, *Expository Times*, x. 1898, p. 210 *f.*). On Khammurabi himself, see further Maspero, *op. cit.* pp. 39-44; and on the chronological question Rogers, *op. cit.* pp. 312-348.

[2] Petrie, *Hist. of Egypt*, i. (1895), p. 251; ii. (1897), p. 29.

[3] See Merenptah's account of the defeat of these invaders in Maspero, *op. cit.* pp. 432-437.

conjectured that the Israelites took the opportunity of escaping during the unsettlement that was thus occasioned.

Alternative dates for Ramses II.: Sayce, *Early Israel*, p. 277, 1348-1281 B.C. (the Exodus [p. 286], 1276); Maspero, *op. cit.* p. 449, *c.* 1320-1255; Lehmann, 1324-1258 (at earliest). Attempts have been made to identify the *Khabiri*, who are mentioned often in the Tel el-amarna letters as foes, threatening to invade Palestine and bring the Egyptian supremacy over it to an end, with the Hebrews. The Exodus, it has been pointed out, might then be placed under Amen-hotep II. (1490-1474 B.C., Maspero; 1449-1423, Petrie), the successor of Thothmes, and more time would be allowed for the events between the Exodus and the time of David (*c.* 1000), which, if the date given above be correct, have been thought to be unduly compressed (see Orr in the *Expositor*, March 1897, p. 161 *ff.*); but there are difficulties attaching to this view, and it has not been adopted generally by scholars.

The mention of Israel on the stele of Merenptah, discovered by Petrie in 1896 ("Israel is desolated; its seed [*or* fruit] is not"), is too vague and indefinite in its terms to throw any light on the question of the Exodus. See the discussion (with the references) in Hogarth's *Authority and Archæology*, pp. 62-65.

II. *From the Exodus to the Foundation of the Temple* (*in the fourth year of Solomon*, 1 Kings vi. 1).—In the chronological note, 1 Kings vi. 1., this period is stated to have consisted of 480 (LXX. 440) years. Is this figure correct? If the years of the several periods of oppression and independence mentioned in the Book of Judges (Judges iii. 8, 11, 14, 30; iv. 3; v. 31; vi. 1; viii. 28; ix. 22; x. 2, 3, 8; xii. 7, 9, 11, 14; xiii. 1; xv. 20; xvi. 31) be added up, they will be found to amount to 410 years; to these must be added further, in order to gain the entire period from the Exodus to the foundation of the Temple, the 40 years in the wilderness, $x$ years under Joshua and the elders (Judges ii. 7), the 20 years' judgeship of Eli (1 Sam. iv. 18), the judgeship of Samuel (perhaps 20 years; cf. 1 Sam. vii. 2), the $y$ years of Saul (the two years of Sam. xiii. 1 [R.V.] seem too few), the 40 years of David (1 Kings ii. 11), and the first four years of Solomon, *i.e.*, $144+x+y$ years, in all 554 years, + two unknown periods denoted by $x$ and $y$—in any case considerably more than the 480 years of 1 Kings vi. 1. This period might no doubt be reduced to 480 years by the supposition, in itself not improbable, that some of the judges were local and contemporaneous; the suggestion has also been made that, as is usual in Oriental chronologies, the years of foreign domination were not counted, the beginning of each judge's rule being reckoned, not from the victory which brought him into power, but from the death of his predecessor; we should in this case obtain for the period from the Exodus to the foundation of the Temple $440+x+y$ years,[1] which if 30 years be assigned conjecturally to Joshua and the elders, and 10 years to Saul, would amount exactly to 480 years. The terms used, however ("and the land *had rest* forty years," iii. 11; similarly, iii. 30; v. 31; viii. 28), seem hardly to admit of the latter supposition; and even if they did, it would still be scarcely possible to maintain the correctness of the 480 years: it is difficult to harmonize with what, as we have seen, appears to be the most probable date of the Exodus; it is, moreover, open itself to the suspicion of having been formed artificially, upon the assumption that the period in question consisted of twelve generations[2] of 40 years each. In the years assigned to the different judges, also, the frequency of the number 40 (which certainly appears to have been regarded by the Hebrews as a round number) is suspicious. On the whole no certain chronology of this period is at present attainable.[3]

III. *From the Fourth Year of Solomon to the Captivity of Judah.*—During this period the dates are both more abundant, and also, approximately, far more nearly correct, than in any of the earlier periods; nevertheless in details there is still much uncertainty and difficulty. The Books of Kings are a compilation made at about the beginning of the Exile, and one object of the compiler was to give a consecutive and complete chronology of the period embraced in his work. With this purpose in view, he not only notes carefully the length of the reign of each king in both kingdoms, but also (as long as the northern kingdom existed) brings the history of the two kingdoms into relation with one another by equating the commencement of each reign in either kingdom with the year of the reign of the contemporary king in the other kingdom.

The following are examples of the standing formulæ used by the compiler for the purpose:—"In the twentieth year of Jeroboam king of Israel began Asa to reign over Judah. And forty and one years reigned he in Jerusalem" (1 Kings xv. 9, 10). "In the third year of Asa king of Judah began Baasha the son of Ahijah to reign over all Israel in Tirzah, (and reigned) twenty and four years" (*ibid.* ver. 33).

In these chronological notices the lengths of the reigns were derived, there is every reason to suppose, either from tradition or from the state annals—the "book of the chronicles of Israel" (or "Judah"), so constantly referred to by the compiler as his authority (*e.g.*, 1 Kings xv. 23, 31; xvi. 5); but the "synchronisms"—*i.e.*, the corresponding dates in the contemporary reigns in the other kingdom—were derived, it is practically certain, by computation from the lengths of the successive reigns. Now in some cases, perhaps, in the lengths of the reigns themselves, in other cases in the computations based upon them, errors have crept in, which have vitiated more or less the entire chronology of the period. The existence of these errors can be demonstrated in two ways: (1) The chronology of the two kingdoms is not consistent with itself; (2) the dates of various events in the history, which are mentioned also in the Assyrian inscriptions, are in serious disagreement with the dates as fixed by the contemporary Assyrian chronology.

(1) That the chronology of the two kingdoms is inconsistent with itself is readily shown. After the division of the kingdom the first year of Jeroboam in Israel coincides, of course, with the first year of Rehoboam in Judah; and after the death of Jehoram of Israel and Ahaziah of Judah in battle with Jehu (2 Kings ix. 24, 27), the first year of Jehu in Israel coincides similarly with the first year of Athaliah in Judah: there are thus in the history of the two kingdoms two fixed and certain synchronisms. Now, if the regnal years of the kings of Israel from Jeroboam to Jehoram be added together, they will be found to amount to 98, while if those of the kings of Judah for the same period (viz., from Rehoboam to Ahaziah) be added together, they amount only to 95. This discrepancy, if it stood alone, would not, however, be serious. But when we proceed to add up similarly the regnal years in the two kingdoms from the division after Solomon's death to the fall of Samaria in the sixth year of Hezekiah (2 Kings xviii. 10), we find in the southern kingdom 260 years, and in the northern kingdom only 241 years 7 months. This is a formidable discrepancy. Ussher, in order to remove it, has recourse to the doubtful

[1] Namely, 40 years in the wilderness; Joshua and the elders (Judges ii. 7), $x$ years; Othniel (iii. 11), 40 years; Ehud (iii. 30), 80 years; Barak (v. 31), 40 years; Gideon (viii. 28), 40 years; Jephthah and five minor judges (x. 2, 3; xii. 7, 9, 11, 14), 76 years; Samson (xvi. 31), 20 years; Eli (1 Sam. iv. 18), 40 years; Samuel (vii. 2), 20 years; Saul, $y$ years; David, 40 years; and Solomon's first four years, —in all $440+x+y$ years.

[2] Namely, Moses (in the wilderness), Joshua, Othniel, Ehud, Deborah, Gideon, Jephthah, Samson, Eli, Samuel, Saul, and David.

[3] The "300 years" of Judges xi. 26 agrees very nearly with the sum of the years (namely, 319) given in the preceding chapters for the successive periods of oppression and independence. The verse occurs in a long insertion (xi. 12-28) in the original narrative; and the figure was most probably arrived at by computation upon the basis of the present chronology of the book.

expedient of artificially lengthening the northern series of years, by assuming (without any authority in the text) an "interregnum of 11 years" after the death of Jeroboam II., and an "anarchy for some years" between Pekah and Hoshea (see the margin of A.V. at 2 Kings xiv. 29; xv. 8, 29).

(2) As we now know, the methods of chronological computation adopted by the Assyrians were particularly exact. Every year a special officer was appointed, who held office for that year, and gave his name to the year; and "canons," or lists, of these officers have been discovered, extending from 893 to 666 B.C.[1] The accuracy of these canons can in many cases be checked by the full annals which we now possess of the reigns of many of the kings—as of Asshur-nazir-abal (885-860 B.C.), Shalmaneser II. (860-825), Tiglath-pileser III. (745-727), Sargon (722-705), Sennacherib (704-781), Esarhaddon (681-668), and Asshurbanipal (668-626). Thus from 893 B.C. the Assyrian chronology is certain and precise. Reducing now both the Assyrian and Biblical dates to a common standard,[2] and adopting for the latter the computations of Ussher, we obtain the following singular series of discrepancies:—

| | Dates according to Ussher's Chronology. B.C. | Dates according to Assyrian Inscription. B.C. |
|---|---|---|
| Reign of Ahab | 918-897 | |
| Ahab mentioned at the battle of Karkar | ... | 854 |
| Reign of Jehu | 884-856 | |
| Jehu pays tribute to Shalmaneser II. | ... | 842 |
| Reign of Menahem | 772-761 | |
| Menahem mentioned by Tiglath-pileser III. | ... | 738 |
| Reign of Pekah | 759-739 | |
| Reign of Hoshea | 730-721 | |
| Assassination of Pekah and succession of Hoshea, mentioned by Tiglath-pileser III. | ... | 733 (or 732)[3] |
| Capture of Samaria by Sargon in Hezekiah's sixth year (2 Kings xviii. 10) | 721 | 722 |
| Invasion of Judah by Sennacherib in Hezekiah's fourteenth year (ibid. ver. 13) | 713 | 701 |

Manifestly all the Biblical dates earlier than 733-32 B.C. are too high, and must be considerably reduced: the two events, also, in Hezekiah's reign—the fall of Samaria and the invasion of Sennacherib—which the compiler of the Book of Kings treats as separated by an interval of *eight* years, were separated in reality by an interval of *twenty-one* years.[4]

Much has been written on the chronology of the kings and many endeavours have been made to readjust the Biblical figures so as to bring them into consistency with themselves and at the same time into conformity with the Assyrian dates. But, though the fact of there being errors in the Biblical figures is patent, it is not equally clear at what points the error lies, or how the available years ought to be redistributed between the various reigns. It is in any case evident that the accession of Jehu and Athaliah must be brought down from 884 to 842 B.C.; and this will involve, naturally, a corresponding reduction of the dates of the previous kings of both kingdoms, and of course, at the same time, of those of Solomon, David, and Saul. The difficulty is, however, greatest in the 8th century. Here, in Judah, from the accession of Athaliah to the accession of Ahaz, tradition gives 143 years, whereas, in fact, there were but 106 years (842-736); and in Israel, from the death of Menahem to the fall of Samaria, it gives 31 years, whereas from 738 (assuming that Menahem died in that year) to 722 there are actually only 16 years. The years assigned by tradition to the reigns in both kingdoms in the middle part of the 8th century B.C. have thus to be materially reduced. But in the following period, from the fall of Samaria in 722 to the capture of Jerusalem by the Chaldæans in 586, the Biblical dates, so far as we can judge, are substantially correct. (See further the table beginning below.)

IV. *From the Destruction of Jerusalem in 586 to the close of the Old Testament History.*—Here, though it is true that there are events in the Biblical history which are not fully or unambiguously dated, there is otherwise no difficulty. The lengths of the reigns of Nebuchadnezzar and his successors on the throne of Babylon, and also, after the conquest of Babylon, of Cyrus and the following Persian kings, are known from the "Canon of Ptolemy," referred to above, the particulars in which, for the earlier part of this period, are also confirmed by the testimony of the monuments.

[1] See George Smith, *The Assyrian* [illegible] (1875), pp. 29 *ff.*, 57 *ff.*; Schrader, *Keilinschriftliche* [illegible] ... tions of Assyrian and Babylonian inscriptions), i. (1889), p. 204 *ff.*

[2] It may be explained here that the dates of the Assyrian and Babylonian kings can be reduced to years B.C. by means of the so-called "Canon of Ptolemy," which is a list of the Babylonian and Persian kings, with the lengths of their reigns, extending from Nabonassar, 747 B.C., to Alexander the Great, drawn up in the 2nd century A.D. by the celebrated Egyptian mathematician and geographer Ptolemy: as the dates B.C. of the Persian kings are known independently, from Greek sources, the dates B.C. of the preceding Babylonian kings can, of course, be at once calculated by means of the Canon. The recently-discovered contemporary monuments have fully established the accuracy of the Canon.

[3] Or, in any case, between 734 and 732; see Rost, *Die Keilschrifttexte Tiglathpilesers III.*, 1893, pp. xii. 39, 81, with the discussion, pp. xxxii.-xxxiv., xxxv.-xxxvi.

[4] This interval does not depend upon a mere list of Eponym years; we have in the annals of Sargon and Sennacherib full particulars of the events in all the intervening years.

CHRONOLOGICAL TABLE.

*The dates printed in black type are certain, at least within a unit.*

| Chronology of Ussher. | Probable Real Dates. | Biblical Events. | Events in Contemporary History. Babylonia. | Assyria. | Egypt.[3] |
|---|---|---|---|---|---|
| 4004 [4157[1]] | Indeterminable, but much before 7000 B.C. | Creation of man | 7-6000.[2] Temple of Bel et Nippur founded<br>c. 4000.[2] Lugal-zaggisi, king of Uruk (Erech, Gen. x. 10) | | **4777.** Menes, the first historical king of Egypt<br>[illegible] Pyramid built |

[1] The real Biblical dates, Ussher in Gen. xi. 26 interpolating 60 years, because it is said in Acts vii. 4 that Abraham left Haran *after* his father Terah's death (Gen. xi. 32), and also (as explained above) interpreting wrongly Ex. xii. 40

[2] Hilprecht's dates ([illegible] *University of Pennsylvania*, vol. i. pt. i. 1893, pp. 11, 12; pt. ii. 1896, pp. 23, 24, 43, 44).

[3] Petrie's dates (as f[illegible]), [illegible] l. i. (1895), pp. 20, 30, 233, 251, 252; vol. ii. (1897), p. 29.

CHRONOLOGICAL TABLE—*Continued.*

| Chronology of Ussher. | Probable Real Dates. | Biblical Events. | Events in Contemporary History. Babylonia. | Assyria. | Egypt. |
|---|---|---|---|---|---|
| | | | 3800.[1] Sargon of Agadè, who carries his arms as far as the Mediterranean Sea | | |
| 2348 [2501[2]] | .. | The Deluge | c. 2800.[3] Ur-bau and Dungi, kings of Uru (Ur, Gen. xi. 28, 31) | | |
| 1996-1821 [2211-2036[2]] | Between c. 2350 and c. 2100 (as determined by the synchronism with Khammurabi: see p. 801) | Abraham | Between 2376-2333 and 2120-2065[4] Khammurabi (unites Babylonia [illegible] great works) | | |
| | | | | | 2098-1587. *Fifteenth to Seventeenth Dynasties.* Rule of the Hyksos |
| | | | | c. 1820. Ishmi-dagan, priest-king of Nineveh | |
| | | | . | | 1587-1327. *Eighteenth Dynasty*<br>1503-1449. Thothmes III (leads victorious expeditions into Asia) |
| | | | | c. 1450. Asshur-bel-nishéshu, first king of Assyria at present known | |
| | | | c 1400. Burnaburiash II. Tel el-Amarna correspondence | | 1414-1383. Amen-hôtep III.<br>1383-1365. Amen-hôtep IV. |
| | | | | | 1327-1181. *Nineteenth Dynasty* |
| | | | | c. 1300 Shalmaneser I. (builder of Calah, Gen. x. 11) | 1275-1208. Ramses II<br>1208-1187. Merenptah II. |
| 1491 | c. 1200 (?) | The Exodus | . | .. | |
| 1090-1058 | c. 1020-1000[5] | Saul (2)[6] | | | |
| 1058-1017 | c. 1000-970 | David (40) | | | |
| 1017-977 | c. 970-933 | Solomon (40) | | | 960-810. *Twenty-second Dynasty* |
| | *Judah.* | *Israel* | | | |
| 977 | 933. Rehoboam (17) | 933. Jeroboam I. (22) | .. | . | 960-939. [illegible] in the fifth year of Rehoboam (1 Ki. xiv. 25 *f.*) |
| 959 | 916. Abijah (3) | | | | |
| 956 | 913. Asa (41) | | | | |
| 956 | .. | 912. Nadab (2) | | | |
| 954 | .. | 911. Baasha (24) | | | |
| 930 | .. | 888. Elah (2) | | | |
| 929 | .. | 887. Zimri (7 days) | | | |
| 929 | .. | 887. Omri (12) | .. | 885-860 Asshur-nazir-abal | |
| 918 | | 876. Ahab (22) | | | |
| 914 | 873. Jehoshaphat (25) | | | 860-825. Shalmaneser II. | |
| 898 | .. | 854. Ahaziah (2) | .. | 854. *Ahab* mentioned at the battle of Karkar | |
| 896 | .. | 853. Jehoram (12) | | | |
| 892 | 849. Jehoram (8) | | | | |
| 885 | 842. Ahaziah (1) | | | | |
| 884 | 842. Athaliah (6) | 842. Jehu (28) | .. | 842. *Jehu* pays tribute to Shalmaneser II. | |
| 878 | 836. Jehoash (40) | | | | |
| 856 | .. | 814. Jehoahaz (17) | .. | | |
| 841 | .. | 798. Jehoash (16) | | 825-812. Shamshi-Rammân | |
| 839 | 797. Amaziah (29) | .. | 747-733. Nabonassar | 812-783. Rammân-Nirâri III. | |
| 823 | | 783. Jeroboam II. (41) | | | |
| 810 | 779. Uzziah (52)<br>c. 750. Jotham (16), as regent (2 Ki. xv. 5) | .. | | | |
| | | | | 745-727. Tiglath-pileser III | |
| 773 | .. | 743. Zechariah (6 mo.) | | | |
| 772 | .. | 743. Shallum (1 mo.) | | | |
| 772 | .. | 743. Menahem (10) | | | |
| 758 | 740. Jotham, sole ruler | | | | |
| 761 | | 738. Pekahiah (2) | .. | 738. *Menahem* pays tribute to Tiglath-pileser III. (cf. 2 Ki. xv. 19) | |
| 759 | . | 737. Pekah (20) | | | |
| 742 | 736.[7] Ahaz (16) | | | | |
| 730 | | 733 (or 732). Hoshea (9) | . | 733 (or 732). Assassination of *Pekah*, and succession of *Hoshea*, mentioned by Tiglath-pileser III.<br>732. Capture of Damascus by Tiglath-pileser III. (2 Ki. xvi. 9; cf. Is. viii. 4, xvii. 1) | |
| 726 | 727.[7] Hezekiah (29) | | 729-724. Tiglath-pileser, under the name of *Pulu* (cf. 2 Ki. xv. 19), king of Babylon | 727-722. Shalmaneser IV. | |
| 721 | | 722. Fall of Samaria and end of the northern kingdom | .. | 722-705. Sargon<br>722. Capture of Samaria in Sargon's accession-year | |

[1] So Sayce, Rogers, and others. The date rests upon a statement of Nabu-na'id's, that Sargon reigned 3200 years before himself. Lehmann holds that there are reasons for believing that the engraver, by error, put a stroke too many, and that 2200 should be read instead of 3200.

[2] The real Biblical dates, Ussher in Gen. xi. 26 interpolating 60 years, because it is said in Acts vii. 4 that Abraham left Haran *after* his father Terah's death (Gen. xi. 32), and also (as explained above) interpreting wrongly Ex. xii. 40.

[3] Rogers, i. 373-75 (where Ur-bau is called Ur-gur).

[4] See p. 75, *n.* Many monuments and inscriptions of other kings in Babylonia, between B.C. 4000 and 2100 are also known.

[5] The dates of the kings are, in most cases, those given by Kautzsch in the table in his *Outline of the History of the Literature of the O. T.* (tr. by Taylor, 1898) p. 167 *ff.* The dates given by other recent authorities seldom differ by more than three or four years.

[6] The figures after a king's name indicate the number of years assigned to his reign in the Old Testament. For Saul, see 1 Sam. xiii. 2, R.V.

[7] If these dates are correct, there must be some error in the ages assigned to Ahaz and Hezekiah at their accession, viz., 20 and 25 respectively, for it would otherwise follow from them that Ahaz was born when his father was not more than 4 years old! The date 727 for Hezekiah's accession rests upon the assumption that of the two inconsistent dates (see p. 77) in 2 Ki. xviii. 10, 13, the one in ver. 10 (which places the fall of Samaria in Hezekiah's 6th year) is correct; but some scholars (as Wellhausen, Kamphausen, and Stade) suppose that the date in ver. 10 (which places Sennacherib's invasion in Hezekiah's 14th year) is correct, and assign accordingly Hezekiah's accession to 715. This removes, or at least mitigates, the difficulty referred to, and leaves more room for the reigns of Jotham and Ahaz; but it requires, of course, a corresponding reduction in the reigns of the kings succeeding Ahaz.

CHRONOLOGICAL TABLE—*Continued.*

| Chronology of Ussher. | Biblical Events. | Events in Contemporary History. | | |
|---|---|---|---|---|
| | | Babylonia. | Assyria. | Egypt. |
| | | 721-710. The Chaldaean prince, Merodach-baladan, king of Babylon (cf. 2 Ki. xx. 12 = Is. xxxix 1) | | |
| | | | | 716-666 (or 664) *Twenty-fifth (Ethiopian) Dynasty* |
| | | | | 716.[1] Sabako |
| | | | 711. Siege and capture of Ashdod (cf. Is. xx. 1) | |
| | | | 705-681. Sennacherib | |
| | | | | 704.[1] Shabitoku |
| | | | 701. Campaign against Phœnicia, Philistia, and Judah (2 Kings xviii. 13-xix. 35) | |
| 698 | 698. Manasseh (55) | | | |
| | | | | 692[1] (*al.* 690). Taharqa (Tirhakah, Is. xxxvii. 9) |
| | | | 681-668. Esarhaddon | |
| | | | 670. Esarhaddon conquers Egypt | 666 (or 664)-525 *Twenty-sixth Dynasty* |
| | | | 668-626. Asshur-banipal | 666 (*al.* 664). Psammetichus I. |
| | | | 663. Asshur-banipal invades Egypt, and sacks Thebes (Nah. iii. 8-10) | |
| 643 | 641. Amon (2) | | | |
| 641 | 639. Josiah (31) | | | |
| 629 | 626. *Call of the prophet Jeremiah* in Josiah's 13th year (Jer. i. 2; xxv. 3) | *Chaldæan Dynasty* | | |
| | | 625 Nabopolassar | | |
| 624 | 621. *Discovery of the Book of the Law* (Deuteronomy) in Josiah's 18th year (2 Kings xxiii. 3 *ff.*) | | | |
| | | | | 610 Necho |
| 610 | 608. Jehoahaz (3 mo.) | .. | .. | 608. *Battle of Megiddo*, and death of Josiah (2 Kings xxiii. 29) |
| 610 | 608. Jehoiakim (11) | | | |
| | | | 607. Destruction of Nineveh by the Medes, and end of the empire of Assyria | |
| | | 605. Defeat of Egyptians by Nebuchadnezzar (as his father's general) at Carchemish (Jer. xlvi. 2) | | |
| | | 604. Nebuchadnezzar | | |
| 599 | 597. Jehoiachin (3 mo.) *First* deportation of captives (including Jehoiachin) to Babylonia, in the 8th year of Nebuchadnezzar (2 Kings xxiv. 12-16) | | | |
| 599 | 597. Zedekiah (11) | | | |
| | | | | 594. Psammetichus II. (Psammis) |
| | | | | 589. Apries (Hophra, Jer. xliv. 30) |
| 588 | 586. Destruction of Jerusalem by the Chaldæans in the 19th year of Nebuchadnezzar (2 Kings xxv. 8). *Second* deportation of captives to Babylonia (2 Kings xxv. 4-21) | | | |
| | | | | 570. Amasis (jointly with Apries) |
| | | | | 564. Amasis alone |
| 562 | 561. Jehoiachin released from prison by Evil-merodach in the 37th year of his captivity (2 Kings xxv. 27-30) | 561. Amêl-marduk (Evil-merodach, 2 Kings xxv. 27) | | |
| | | 559. Nergal-sharuzur (Neriglissar) | | |
| | | 555. (9 months) Lâbashi-marduk (Laboriso-archod) | | |
| | | 555. Nabu-na'id (Nabonnēdus, Nabonidus) | | |
| | | 539. Capture of Babylon by Cyrus | | |
| | *Judah a province of the Persian Empire* | *Persian Kings* | | |
| 536 | 538. Edict of Cyrus, permitting the Jews to return to Palestine. Many return under the leadership of Zerubbabel (Ezra i.-ii.) | 538. Cyrus | | |
| | | 529. Cambyses | | |
| | | | | 526. Psammetichus III. |
| | | | | 525. Conquest of Egypt by Cambyses |
| | | 522. (7 months) Gaumâta (Pseudo-Smerdis) | | |
| | | 522. Darius Hystaspis | | |
| 515 | 516. Completion of the second Temple in the 6th year of Darius (Ezra vi. 15) | | | |
| | | 490. *Battle of Marathon* | | |
| | | 485. Xerxes | | |
| | | 480. *Battles of Thermopylæ and Salamis* | | |
| | | 465. Artaxerxes | | |
| 457 | 458. Return of exiles with Ezra, in the 7th year of Artaxerxes (Ezra vii 7) | | | |
| 445 | 445. Nehemiah's first visit to Jerusalem (Neh. i. 1; ii. 1) | | | |
| 434 | 432. Nehemiah's second visit to Jerusalem (Neh. xiii. 6) | | | |

[1] Maspero's dates (*Passing of the Empires*, 1900, p. 233).

CHRONOLOGICAL TABLE—*Continued.*

| Chronology of Ussher. | Biblical Events. | Events in Contemporary History. Babylonia. | Assyria. | Egypt. |
|---|---|---|---|---|
| | | 423. Darius II. (Nothus) | | |
| | | 404. Artaxerxes II (Mnemon) | | |
| | | 359. Artaxerxes III (Ochus) | | |
| | c. 350. Many Jews carried away captive to Hyrcania and Babylonia, probably on account of a revolt against the Persians | | | |
| | | 338. Arses | | |
| | | 336. Darius III. (Codomannus) | | |
| | | 333. Persian Empire overthrown by Alexander the Great | | |

*Palestine now becomes a province, first of the empire of Alexander, and afterwards of that of one or other of Alexander's successors.*

**332.** The Jews submit to Alexander the Great.
**323.** Death of Alexander in Babylon.
**322.** Alexander's general, Ptolemy Lagi, becomes Satrap of Egypt.
**320.** Ptolemy Lagi gains possession of Palestine, which, with short interruptions, continues in the hands of the Ptolemies till 198.
**312.** Beginning of the era of the Seleucidæ (reckoned from the time when Seleucus Nicator, Alexander's former heavy cavalry officer, finally established himself in the satrapy of Babylonia. He founded Antioch as his capital, 300 B.C.).
**305.** Ptolemy Lagi assumes the title of king.
**198.** Antiochus the Great, king of Syria (223-187), defeats Ptolemy Epiphanes at Panias (Bâniyas, near the sources of the Jordan), and obtains possession of Palestine.
**175-164.** Antiochus Epiphanes, king of Syria (Dan. xi. 21-45).
**168.** Antiochus's attempt to suppress the religion of the Jews (1 Macc. i. 41-63 ; cf. Dan. vii. 8, 21, 24-26 ; viii. 9-14 ; xii. 10-12). Public worship suspended in the Temple for three years.
**167.** Rise of the Maccabees (1 Macc. ii.).
**166-165.** Victories of Judas Maccabæus over the generals of Antiochus (1 Macc. iii.-iv.).
**165.** Re-dedication of the Temple on 25th Chisleu (December), 1 Macc. iv. 52-61.
**160.** Death of Judas Maccabæus (1 Macc. ix. 1-22).
**160-142.** Jonathan, younger brother of Judas, leader of the loyal Jews (1 Macc. ix. 23-xii. 53).
**142-135.** Simon, elder brother of Judas (1 Macc. xiii.-xvi.).
**135-105.** John Hyrcanus, son of Simon.
**105-104.** Aristobulus I. (son of Hyrcanus), king.
**104-78.** Alexander Jannæus (brother of Aristobulus), king.
**78-69.** Salome (Alexandra), widow of Alexander Jannæus.
**69.** Aristobulus II. (son of Alexandra).
**65.** Capture of Jerusalem by Pompey. Palestine becomes a part of the Roman province of Syria.

See, for further information on the subject, the article CHRONOLOGY in the *Encyclopædia Biblica*, cols. 773-799, with the literature referred to on col. 819 (especially the writings of Noldeke, Wellhausen, and Kamphausen there mentioned). (S. R. D.)

## II. NEW TESTAMENT.

The subject of the chronology of the New Testament falls naturally into two distinct sections—the chronology of the Gospels, that is, of the life of Christ; and the chronology of the Acts, that is, of the apostolic age.

### *The Chronology of the Gospels.*

The data group themselves round three definite points and the intervals between them: the definite points are the Nativity, the Baptism, and the Crucifixion; the age of Christ at the time of the Baptism connects the first two points, and the duration of His public ministry connects the second and third. The results obtained under the different heads serve mutually to test, and thereby to correct or confirm, one another.

1. The date of the Nativity as fixed according to our common computation of Anni Domini (first put forward by Dionysius Exiguus at Rome early in the 6th century) has long been recognized to be too late. The fathers of the primitive church had been nearer the truth with the years 3 or 2 B.C. (see Irenæus, *Hær.* III. xxi. 3 [xxiv. 2]; Clement of Alexandria, *Strom.* i. 21, p. 147 ; Hippolytus, *in Danielem*, iv. ed. Bonwetsch, p. 242 ; [Tertullian], *adv. Judæos*, 8). What may be called the received chronology during the last two centuries has pushed the date farther back to 4 B.C. But the considerations now to be adduced make it probable that the true date is earlier still.

(*a*) *Evidence of St Matthew's Gospel* (i. 18-ii. 22).—The birth of Christ took place before the death of Herod, and the evidence of Josephus fixes the death of Herod, with some approach to certainty, in the early spring of 4 B.C. Josephus, indeed, while he tells us that Herod died not long before Passover, nowhere names the exact year; but he gives four calculations which serve to connect Herod's death with more or less known points, namely, the length of Herod's own reign, both from his *de jure* and from his *de facto* accession, and the length of the reigns of two of his successors, Archelaus and Herod Philip, to the date of their deposition and death respectively. The various calculations are not quite easy to harmonize, but the extent of choice for the year of Herod's death is limited to the years 4 and 3 B.C., with a very great preponderance of probability in favour of the former. How long before this the Nativity should be placed the Gospel does not enable us to say precisely, but as Herod's decree of extermination included all infants up to two years of age, and as a sojourn of the Holy Family in Egypt of unknown length intervened between the massacre and Herod's death, it is clear that it is at least possible, so far as the evidence of this Gospel goes, that the birth of Christ preceded Herod's death by as much as two or three years. What is thus shown to be possible would, of course, be necessary if we went on, with the astronomer Kepler, to identify the star of the Magi with the conjunction of the planets Jupiter and Saturn which occurred, in the constellation Pisces, in May, October, and December of 7 B.C.[1]

(*b*) *Evidence of St Luke's Gospel* (ii. 1-8).—The birth of Christ took place at the time of a general census of the empire ordered by Augustus: "it was the first census, and was made at the time when Quirinius was governor of Syria." Against this account it has been urged that we know that the governorship of Syria from 10 or 9 B.C. down to and after Herod's death was held successively by M. Titius, C. Sentius Saturninus, and P. Quintilius Varus; and further, that when Judæa became a Roman province on the deposition of Archelaus in A.D. 6, Quirinius was governor of Syria, and did carry out an elaborate census. The notice in the Gospel, it is suggested, grew out of a confused recollection of the later (and only historical) census, and is devoid of any value whatever. At the other extreme Prof. W. M. Ramsay (*Was Christ Born at Bethlehem?* 1898, p. 149 *ff.*) defends the exact accuracy of St Luke's "first census" as witnessing to the (otherwise of course unknown) introduction into Syria of the periodic

[1] It is a curious coincidence that a mediæval Jew, R. Abarbanel, records that the conjunction of these particular planets in this particular constellation was to be a sign of Messiah's coming. It is just conceivable that his statement may ultimately depend on some such ancient tradition as may have been known to Chaldean magi.

fourteen years' census which the evidence of papyri has lately established for Egypt, at least from A.D. 20 onwards. Reckoning back from A.D. 20, the periodic census should fall in 9 B.C., but Ramsay alleges various causes for delay, which would have postponed the actual execution of the census till 7 B.C., and supposes that Quirinius was an imperial commissioner specially appointed to carry it out. The truth seems to rest midway between these extremes. St Luke's statement of a general census is in all probability erroneous, and the introduction of the name Quirinius appears to be due to confusion with the census of A.D. 6. But the confusion in question would only be possible, or at any rate likely, if there really was a census at the time of the Nativity; and it is no more improbable that Herod should have held, or permitted to be held, a local census than that Archelaus of Cappadocia in the reign of Tiberius (Tacitus, *Ann.* vi. 41) should have taken a census of his own native state "after the Roman manner." But St Luke's account, when the name of Quirinius is subtracted from it, ceases to contain any chronological evidence.

(*c*) *Evidence of Tertullian.*—Strangely enough, however, the missing name of the governor under whom the census of the Nativity was carried out appears to be supplied by an author who wrote more than a century after St Luke, and has by no means a good reputation for historical trustworthiness. Tertullian, in fact (*adv. Marcionem*, iv. 19), employs against Marcion's denial of the true humanity of Christ the argument that it was well known that Sentius Saturninus carried out a census under Augustus in Judæa, by consulting which the family and relationships of Christ could have been discovered. This Saturninus was the middle one of the three governors of Syria named above, and as his successor Varus must have arrived by the middle of 6 B C. at latest (for coins of Varus are extant of the twenty-fifth year of the era of Actium), his own tenure must have fallen about 8 and 7 B.C., and his census cannot be placed later than 7 or 7-6 B.C. The independence of Tertullian's information about this census is guaranteed by the mere fact of his knowledge of the governor's name; and if there was a census about that date, it would be unreasonable not to identify it with St Luke's census of the Nativity.

The traditional Western day for the Christmas festival, 25th December, goes back as far as Hippolytus, *loc. cit.*; the traditional Eastern day, 6th January, as far as the Basilidian Gnostics (but in their case only as a celebration of the Baptism), mentioned by Clement of Alexandria, *loc. cit.*

2. The interval between the Nativity and the Baptism.

*Evidence of St Luke's Gospel* (iii. 23).—At the time of His baptism Jesus was ἀρχόμενος ὡσεὶ ἐτῶν τριάκοντα, of which words two opposite misinterpretations must be avoided: (i.) ἀρχόμενος does not mean (as Valentinian interpreters thought, Iren. II. xxii. 5 [xxxiii. 3]; so also Epiphanius, *Hær.* li. 16) "beginning to be thirty years" in the sense of "not yet quite thirty," but "at the beginning of His ministry," as in Luke xxiii. 5, Acts i. 22, x. 37; (ii.) ὡσεὶ ἐτῶν τριάκοντα does not mean "on attaining the full age of thirty, before which he could not have publicly taught," for if there was by Jewish custom or tradition any minimum age for a teacher, it was not thirty, but forty (*Bab. Talm.* ed. 1715, fol. 19 *b*; Iren. *loc. cit.*). St Luke's phrase is a general one, "about thirty years old," and cannot be so pressed as to exclude some latitude in either direction.

3. The date of the Baptism.

(*a*) *Evidence of St Luke's Gospel* (iii. 1): a *terminus a quo* for the Baptism is the synchronism of the commencement of the Baptist's public ministry with the fifteenth year of the rule (ἡγεμονία) of Tiberius. Augustus died on 19th August, A.D. 14, and, reckoned from that point, Tiberius's fifteenth year might be, according to different methods of calculation, either A.D. 28, or 28-29, or 29. None of these alternatives would be at all easy to reconcile with the results yielded by other lines of investigation in this article, and the choice seems to lie between the following views: (i.) The years of Tiberius are here reckoned from some earlier starting-point than the death of his predecessor—probably from the grant to him of co-ordinate authority with Augustus over the provinces made in A.D. 11 (see, for the parallel with the case of Vespasian and Titus, Ramsay, *St Paul the Roman Traveller*, p. 387), so that the fifteenth year would be roughly A.D. 25; or (ii.) St Luke has made here a second error in chronology, caused perhaps in this case by reckoning back from the Crucifixion, and only allowing one year to the ministry of Christ.

(*b*) *Evidence of St John's Gospel* (ii. 13, 20): a *terminus ad quem* for the Baptism is the synchronism of the first Passover mentioned after it with the forty-sixth year of the building of Herod's Temple. Herod began the Temple in the eighteenth year of his reign, probably 20-19 B.C., and the Passover of the forty-sixth year is probably that of A.D. 27. While too much stress must not be laid on a chain of reasoning open to some uncertainty at several points, it is difficult to suppose with Loisy, *Revue d'histoire et de littérature religieuses*, 1900, p. 536, that the number was intended by the evangelist as purely figurative, and is therefore destitute of all historical meaning.

On the whole, the Baptism of Christ should probably be placed in A.D. 26-27; and as the Nativity was placed in 7-6 B.C. (at latest), this would make the age of Christ at His Baptism to be about thirty-two, which tallies well enough with St Luke's general estimate.

4. The interval between the Baptism and the Crucifixion, or, in other words, the duration of the public ministry of Christ.

(*a*) *Evidence of the Synoptic Tradition and of St Mark's Gospel* (ii. 23, vi. 39, xiv. 1). The order of events in the primitive synoptic tradition appears to be faithfully reproduced in St Mark; and if this order is chronological, Christ's ministry lasted at least two years, since the plucking of the ears of corn (April-June) marks a first spring; the feeding of the five thousand when the grass was fresh green (χλωρός: about March), a second; and the Passover of the Crucifixion a third: and these three points are so far removed from one another in the narrative that the conclusion would hold, even if the general arrangement in St Mark were only roughly, and not minutely, chronological. On the other hand, it may be true that an impression of a briefer period of ministry naturally results, and in early generations did actually result, from the synoptic account considered as a whole.

(*b*) *Evidence of St Luke's Gospel* (ix. 51-xix. 28 compared with iv. 14-ix. 50; iv. 19). Still stronger is the impression of brevity suggested by St Luke. The second and larger half of the narrative of the ministry is introduced at ix. 51 with the words, "It came to pass as the days of His assumption were coming to the full, He set His face firmly to go to Jerusalem," under which phrase the evangelist cannot have meant to include more than a few months, perhaps not more than a few weeks; so that even if the earlier and shorter half of the account, which describes a purely Galilean ministry ("Judæa" in iv. 44, if it is the true reading, means Judæa in the sense of Palestine), is to be spread over a longer period of time, the combined narrative can hardly have been planned on the scale of more than a single year. St Luke himself may have understood literally, like so many of his readers in ancient times, the reference which he records to the

"acceptable year of the Lord" (iv. 19 = Isaiah lxi. 2): see, too, above, 3 (*a*) *ad fin.*

(*c*) *Evidence of St John's Gospel* (ii. 13, "the Passover of the Jews was near," and 23, "He was in Jerusalem at the Passover at the feast"; v. 1, "after these things was a feast [or, 'the feast'] of the Jews"; vi. 4, "and the Passover, the feast of the Jews, was near"; vii. 2, "and the feast of the Jews, the Tabernacles, was near"; x. 22, "at that time the feast of dedication took place at Jerusalem"; xi. 55, "and the Passover of the Jews was near": besides iv. 35, "say ye not that there is yet a period of four months and harvest cometh? behold, I tell you, lift up your eyes and see the fields that they are white to harvest"). This catena of time-references is of course unique in the Gospels as a basis for a chronology of the ministry; and it is not reasonable to doubt (with Loisy, *loc. cit.*, who suggests that the aim was to produce an artificial correspondence of a three and a half years' ministry with the half-week of Daniel; but many and diverse as are the early interpretations of Daniel's seventy weeks, no one before Eusebius thought of connecting the half-week with the ministry), that the evangelist intended these notices as definite historical *data*, possibly for the correction of the looser synoptic narratives and of the erroneous impressions to which they had given rise. Unfortunately, difficulties, either (i.) of reading, or (ii.) of interpretation, or (iii.) of arrangement, have been raised with regard to nearly all of them; and these difficulties must be briefly noticed here.

(i.) *Readings* (α) v. 1, ἑορτή A B D, Origen, Epiphanius, Chrysostom, *Paschal Chronicle*; ἡ ἑορτή ℵCLΔ 1-118, 33, the Egyptian versions, Eusebius, Cyril-Alex. (Irenæus?). The balance of internal evidence—copyists being more likely to accentuate than to diminish the precision of a note of time—inclines, like the balance of external evidence, against the article. (β) vi. 4, τὸ πάσχα is read by all known MSS. and versions; but it has been argued by Hort (in Westcott's and Hort's *New Testament in Greek*, appendix, pp. 77-81) that four ancient authorities omitted the words, and that their omission simplifies the whole chronology, since "the feast" which was "near" in vi. 4 would then be identical with the feast of Tabernacles mentioned in vii. 2, and all the time-notices of the Gospel could be arranged to fall within the space of a single year, between the Passover of ii. 13 and the Passover of xi. 55. But of the four authorities alleged, Irenæus (II. xxii. 3 [xxxiii. 1]) and the Alogi (*ap.* Epiphanius, *Hær.* li. 22) were giving catalogues of Passovers "observed" by Christ (at Jerusalem), and therefore naturally omitted a mere chronological reference like vi. 4: Cyril of Alexandria, in so far as his evidence is adverse to the words, appears to be incorporating a passage from the *Commentary* of Origen, not extant *in loc.*; and the only writer who perhaps really did omit the words—with the view, no doubt, of reconciling the witness of the fourth Gospel with the then widely-spread tradition of the single-year ministry—is Origen himself.

(ii.) *Interpretation* (α) iv. 35: which is to be taken literally, the "four months to harvest" (about January), or the "fields white to harvest" (about May)? It does not seem possible to rule out either interpretation; the choice between them will follow from the view taken of the general chronological arrangement of the Gospel. (β) v. 1: if "the feast" is read, a choice remains between Passover and Tabernacles (the definite article would not be very definite after all); if the more probable "a feast," the greater feasts are presumably excluded, but a choice remains between, at any rate, Pentecost (May), Trumpets (September), Dedication (December), and Purim (February). Here again the decision will follow on the general chronological arrangement which may be adopted.

(iii.) *Arrangement.*—So far the amount of possible latitude left is not so great as to obscure the main outline of the chronology. For a first (ii. 13, 20), second (vi. 4), and third (xi. 55) Passover are established, with two indeterminate notices (iv. 35, v. 1) between the first and second, and two determinate notices (vii. 2 Tabernacles in October, x. 22 Dedication in December) between the second and third. But of late years an increasing desire has been manifested, especially in Germany and America, to manipulate the fourth Gospel on grounds of internal evidence, at first only in the way of particular transpositions of more or less attractiveness, but latterly also by schemes of thoroughgoing rearrangement. The former class of proposals will, however, as a rule hardly affect the chronology of the Gospel; the latter will affect it vitally. The distinction here drawn may be illustrated from the earliest instance of the former and the latest of the latter. In 1871 Archdeacon J. P. Norris (*Journal of Philology*) wished to transpose chapters v. and vi.—ch. vi. was, like ch. xxi., a Galilean appendix, and was inserted by mistake at somewhat too late a point in the body of the Gospel—and to read "the feast" in v. 1, identifying it with the Passover which was near in vi. 4: in any case, whether "the feast" = Passover, or "a feast" = Pentecost, were read in v. 1, the transposition would not affect the two years' ministry. In 1900 Prof. B. W. Bacon (*American Journal of Theology*, p. 770) proposed a rearrangement of the whole Gospel, according to which the time-notices would occur in the following order: vi. 4, Passover is near; iv. 35, the fields white to harvest = May; v. 1, "a feast" = Pentecost; vii. 2, Tabernacles; x. 22, Dedication; xi. 55, Passover is near; xii. 1, Jesus at Bethany six days before Passover; ii. 13, Passover is near and Jesus goes up to Jerusalem (ii. 23, an interpolation) for the Passover of the Crucifixion; and the ministry would thus be reduced to a single year. Such a scheme does not lend itself to discussion here; but as far as evidence is at present obtainable, the conclusion that St John drew up his narrative on the basis of a two years' rather than a one year's ministry appears to be irrefragable.

Not only do the fourth and second Gospels thus agree in indications of a two years' ministry, but the notes of the middle spring of the three (John vi. 4, Mark vi. 39) both belong to the feeding of the 5000, one of the few points of actual contact between the two Gospels.

The question, however, may still be raised, whether these time-indications of the two Gospels are exhaustive, whether (that is) two years, and two years only, are to be allotted to the ministry. Irenæus (II. xxii. 3-6 [xxxiii. 1-4]), in favour of a ministry of not less than ten years, appeals (i.) to the tradition of Asia Minor; (ii.) to the record in St John that Christ, who was thirty years old at the time of His baptism, was addressed by the Jews as "not yet [*i.e.* nearly] fifty years old": but both his arguments are probably derived from a single source, Papias's interpretation of John viii. 57. With this exception, however, all ancient writers, whether they enumerated two or three or four Passovers in the Gospel history, believed that the enumeration was exhaustive; and their belief appears correctly to represent the mind of St John, whose notes of time were probably in intentional contrast to the looser synoptic accounts. Moreover, the wide currency in early times of the tradition of the single-year ministry (Ptolemæus, *ap.* Iren. *loc. cit.*; *Clementine Homilies*, xvii. 19; Clem. Alex. *Strom.* i. 145, vi. 279; Julius Africanus, *ap.* Routh, *Rell. Sacr.* ii. 240, 306; Hippolytus, *Paschal Cycle* and *Chronicle*; Origen *in Levit. Hom.* ix. 5, *de Principiis*, iv. 5) becomes more difficult to account for the farther it is removed from the actual facts.

5. The date of the Crucifixion.

(*a*) *The Roman Governor.*—Pontius Pilate was on his way back to Rome, after ten years of office, when Tiberius died on 16th March A.D. 37 (Josephus, *Ant.* XVIII. ii. 2, iv. 2). Luke xiii. 1, xxiii. 12, show that he was not a newcomer at the time of the Crucifixion. For the Crucifixion "under Pontius Pilate" the Passover of A.D. 28 is therefore the earliest possible and the Passover of A.D. 36 the latest.

(*b*) *The Jewish High-Priest.*—Caiaphas was appointed before Pilate's arrival, and was deposed at a Passover apparently not later than that of the year of Herod Philip's death, A.D. 34 (*Ant.* XVIII. ii. 2, iv. 3-v. 3). The Crucifixion at some previous Passover would then fall not later than A.D. 33.

(*c*) *The Day of the Week.*—The Resurrection on "the first day of the week" (Sunday) was "on the third day" after the Crucifixion; and that "the third day" implies an interval of only two days hardly needed to be shown, but has been shown to demonstration in Field's *Notes on the Translation of the New Testament* (on Matt. xvi. 21). The Crucifixion was therefore on a Friday in some year between A.D. 28 and 33 inclusive.

(*d*) *The Day of the Jewish Month Nisan.*—The Passover was kept at the full moon of the lunar month Nisan, the first of the Jewish year; the Paschal lambs were slain on the afternoon of the 14th, and the Passover was eaten after sunset the same day—which, however, as the Jewish day began at sunset, was by their reckoning the 15th; the first fruits (of the barley harvest) were solemnly offered on the 16th. The synoptic Gospels appear to place the Crucifixion on the 15th, since they speak of the Last Supper as a Passover; St John's Gospel, on the other hand (xiii. 1, 29, xviii. 28), distinctly implies that the feast had not yet taken place, and thus makes the Crucifixion fall on the 14th. Early Christian tradition is unanimous on this side; either the 14th is mentioned, or the Crucifixion is made the antitype of the slaughter of the Paschal Lamb (and the resurrection of the first fruits), in the following authorities anterior to A.D. 235: St Paul, 1 Cor. v. 7, xv. 20; Quartodecimans of Asia Minor, who observed the Crucifixion on the "14th," no matter on what day of the week it fell; Claudius Apollinaris, Clement of Alexandria, Hippolytus, all three quoted in the *Paschal Chronicle;* Irenæus (apparently) IV. x. 1 [xx. 1]; [Tertullian] *adv. Judæos*, 8; Africanus, in Routh, *Rell. Sacr.* ii. 297. The Crucifixion, then, should be placed rather on the 14th than on the 15th of Nisan.

These four lines of inquiry have shown that the Crucifixion fell on Friday, Nisan 14 (less probably 15), in one of the six years 28-33 A.D.; and therefore, if it is possible to discover (i.) exactly which moon or month was reckoned each year as the moon or month of Nisan, and (ii.) exactly on what day that particular moon or month was reckoned as beginning, it will, of course, be possible to tell in which of these years Nisan 14 (or 15) fell on a Friday. To neither question can an answer be given in terms so precise as to exclude some latitude, but to both with sufficient exactness to rule out at once three of the six years. (i.) The difficulty with regard to the month is to know how the commencement of the Jewish year was fixed —in what years an extra month was intercalated before Nisan. If the Paschal full moon was, as in later Christian times, the first after the spring equinox, the difficulty would be reduced to the question on what day the equinox was reckoned. If, on the other hand, it was, as in ancient Jewish times, the first after the earliest ears of the barley harvest would be ripe, it would have varied with the forwardness or backwardness of the season from year to year. (ii.) The difficulty with regard to the day is, quite similarly, to know what precise relation the first day of the Jewish month bore to the astronomical new moon. In later Christian times the Paschal month was calculated from the astronomical new moon; in earlier Jewish times all months were reckoned to begin at the first sunset when the new moon was visible, which in the most favourable circumstances would be some thirty-six hours later than the astronomical new moon.

Direct material for answering the question when and how far astronomical calculations replaced simple observations as the basis of the Jewish kalendar is not forthcoming. Jewish traditions represented the Sanhedrim as retaining to the end its plenary power over the kalendar, and as still fixing the first day of every month and the first month of every year. But as it is quite inconceivable that the Jews of the Dispersion should not have known beforehand at what full moon they were to present themselves at Jerusalem for the Passover, it must be assumed as true in fact, whether or no it was true in theory, that the old empirical methods must have been qualified by permanent, that is in effect by astronomical, rules for the commencement of years and months. The first of each month was within a certain limit from the astronomical new moon. Nisan was fixed with reference to the equinox, though with regard to the day of the equinox it must be remembered (i.) that even of Christian calculations, while the Alexandrine reckoning in the 4th century adopted 21st March, Anatolius in A.D. 277 had employed 19th March, and Hippolytus in A.D. 221 18th March; (ii.) that Christian controversialists from Anatolius onwards accused the Jews of disregarding the (Christian) equinoctial limit, and of sometimes placing the Paschal full moon before it; the Jewish equinox may therefore have gone back even as far as 17th March. In the following table the first column gives the *terminus paschalis*, or 14th of the Paschal moon, according to the present Christian kalendar; the second gives the 14th, reckoned from the time of the astronomical new moon of Nisan; the third the 14th, reckoned from the first appearance of the new moon at sunset. Alternative moons are given for A.D. 29, according as the full moon falling about 18th March is or is not reckoned after the equinox.

| | | | |
|---|---|---|---|
| A.D. 28 | Sat. Mar. 27 | Mar. 28 | Mar. (29–) 30 |
| ,, 29 | Th. Mar. 17 | Mar. 17 | Mar. (18–) 19 |
| | F. Ap. 15 | Ap. 16 | Ap. (17–) 18 |
| ,, 30 | Tu. Ap. 4 | Ap. 5 | Ap. (6–) 7 |
| ,, 31 | Sat. Mar. 24 | Mar. 25 | Mar. (26–) 27 |
| ,, 32 | Sat. Ap. 12 | Ap. 12 | Ap. (13–) 14 |
| ,, 33 | W. Ap. 1 | Ap. 1-2 | Ap. (2–) 3 or (3–) 4 |

The first and third columns may safely be taken to represent the possible extremes for Nisan 14, so that it will be seen at once that Friday cannot have fallen on Nisan 14th or 15th in any of the three years A.D. 28, 31, and 32. The choice is narrowed down to A.D. 29, Friday 18th March (Friday 15th April would probably be too early even for Nisan 14); A.D. 30, Friday 7th April; and A.D. 33, Friday 3rd April.

(*e*) *The Civil Year* (consuls, or regnal years of Tiberius) in early Christian tradition. It is not *à priori* improbable that the year of the central event from which the Christian Church dated her own existence should have been noted in the apostolic age and handed down to the memory of succeeding generations; and the evidence does go some way to suggest that we have in favour of A.D. 29, the consulate of the two Gemini (15th or 16th year of Tiberius), a body of tradition independent of the Gospels and ancient, if not primitive, in origin.

The earliest witness, indeed, who supplies material for a definite date for the Crucifixion gave not 29, but 33 A.D. The pagan chronicler, Phlegon, writing in the reign of Hadrian, noted under Olympiad 202·4 (= A.D. 32-33), besides a great earthquake in Bithynia, an eclipse so phenomenal that it became night "at the sixth hour of the day." The eclipse meant is, of course, that of the Crucifixion (so Origen, *contra Celsum*, ii. 33 [but see *in Matt.* 134, Delarne iii. 922], Eusebius's *Chronicle* Tib. 19 [= A.D. 33], Anon. in Cramer's *Catena in Matt.* p. 237), but as the notice of it was clearly derived by Phlegon, pagan as he was, directly or indirectly from the Gospel narrative, there is no reason at all to ascribe any independent value to the date. Phlegon may have had grounds for dating the Bithynian earthquake in that year, and have brought the dateless portent into connexion with the dated one. Eusebius adopted and popularized this date, which fell in with his own system of Gospel chronology, but of the year 33 as the date of the Passion there is no vestige in Christian tradition before the 4th century.

The only date, in fact, which has any real claim to represent Christian tradition independent of the Gospels, is the year 29. Tiberius 15 is given by Clem. Alex. *Strom.* i. 147; Origen, *Hom. in Jerem.* xiv. 13; cf. *c. Cels.* iv. 22. Tiberius 16 by Julius Africanus (Routh, *Rell. Sacr.* ii. 301-304), and pseudo-Cyprian *de pascha*

*computus* (A.D. 243), § 20. The consulship of the two Gemini by Lactantius *Div. Inst.* IV. x. 18, and (Lactantius?) *de morte pers.* § 2; the consulship of the two Gemini = Tiberius 18 by Hippolytus *Comm. in Danielem*, iv. (ed. Bonwetsch, p. 242); the consulship of the two Gemini = Tiberius 15 by [Tertullian] *adv. Judæos*, § 8; the consulship of the two Gemini = Tiberius 15 (*al.* 18 or 19) = Ol. 202. 4 [this last is a later interpolation from Eusebius] in the *Acts of Pilate*. Other methods of expressing the year 29 appear in Hippolytus's *Paschal Cycle* and *Chronicle*, and in the Abgar legend (*ap.* Eusebius, *H. E.* i. 13). No doubt it would be possible to explain Tiberius 16 as a combination of Luke iii. 1 with a one year ministry, and even to treat Tiberius 15 as an unintelligent repetition from St Luke—though the omission to allow a single year for the ministry would be so strange as to be almost unintelligible—but the date by the consuls has an independent look about it, and of its extreme antiquity the evidence gives two indications: (i.) Hippolytus's Commentary on Daniel (now generally dated *c.* A.D. 200) combines it with an apparently inconsistent date, Tiberius 18; the latter is clearly his own combination of the length of the ministry (he says in the same passage that Christ suffered in His 33rd year) with Luke iii. 1—the consulship must have been taken from tradition without regard to consistency; (ii.) the names of the Gemini are divergently given in our oldest authorities; in [Tert.] *adv. Judæos* correctly as Rubellius Geminus and Fufius (or Rufius) Geminus, but in Hippolytus and the *Acts of Pilate* as Rufus and Rubellio. But if the tradition of the consulships was thus, it would seem, already an old one about the year 200, there is at least some reason to conclude that trustworthy information in early Christian circles pointed, independently of the Gospels, to the year 29 as that of the Crucifixion.

(*f*) *The Civil Month and Day.*—The earliest known calculations, by Basilidian Gnostics, quoted in Clem. Alex. *Strom.* i. 147, gave alternative dates, Thamenoth 25, Pharmuthi 25, Pharmuthi 19; that is, according to the fixed Alexandrine kalendar of B.C. 26, 21st March, 20th April, 14th April; in the older, not wholly superseded, Egyptian kalendar the equivalents with Roman days varied from year to year. But in all probability these dates were only one development of those speculations in the region of numbers to which Gnosticism was so prone; and in any case to look for genuine traditions among Egyptian Gnostics, or even in the church of Alexandria, would be to misread the history of Christianity in the 2nd century. Such traditions must be found, if anywhere, in Palestine and Syria, in Asia Minor, in Rome, not in Egypt; within the church, not among the Gnostics. The date which makes the most obvious claim to satisfy these conditions would be 25th March, as given by Hippolytus, [Tert.] *adv. Judæos*, and the *Acts of Pilate* (according to all extant MSS. and versions, but see below), *locc. citt.*—the same three authorities who bear the earliest witness for the consuls of the year of the Crucifixion—and by many later writers. It cannot be correct, since no full moon occurs near it in any of the possible years; yet it must be very early, too early to be explained with Dr Salmon (*Dictionary of Christian Biography*, iii. 92*b*), as originated by Hippolytus's Paschal cycle of A.D. 221. Now Epiphanius (*Hær.* l. 1) had seen copies of the *Acts of Pilate* in which the day given was not 25th March, but *a.d. xv. kal. Apr.* (= 18th March); and if this was the primitive form of the tradition, it is easy to see how 25th March could have grown out of it, since the 18th would from comparatively early times have been thought impossible as falling before the equinox (see above, 5 *d*), and no substitution would be so natural as that of the day week, Friday, 25th March. But Friday, 18th March A.D. 29, was one of the three alternative dates for the Crucifixion which on astronomical and kalendar grounds were found (see above, 5*d*) to be possible.

Thus A.D. 29 is the year, 18th March is the day, to which Christian tradition (whatever value, whether much or little, be ascribed to it) appears to point. Further, the Baptism was tentatively placed in A.D. 26-27; the length of the ministry was fixed, with great preponderance of probability, at something over two years; and here too the resultant date for the Crucifixion would be the Passover of A.D. 29.

To sum up: the various dates and intervals, to the approximate determination of which this article has been devoted, do not claim separately more than a tentative and probable value. But it is submitted that their harmony and convergence give them some additional claim to acceptance, and at any rate do something to secure each one of them singly—the Nativity in 7-6 B.C., the Baptism in A.D. 26-27, the Crucifixion in A.D. 29—from being widely or even appreciably in error.

*The Chronology of the Apostolic Age.*

The chronology of the New Testament outside the Gospels may be defined for the purposes of this article as that of the period between the Crucifixion in A.D. 29 (30) on the one hand, and on the other the persecution of Nero in A.D. 64 and the fall of Jerusalem in A.D. 70. Of the events in Christian history which fall between these limits it must be admitted that there are many which with our present information we cannot date with exactness. But the book of Acts, our only continuous authority for the period, contains two synchronisms with secular history which can be dated with some approach to certainty and constitute fixed points by help of which a more or less complete chronology can be constructed for at least the latter half of the apostolic age. These are the death of Herod Agrippa I. (xii. 23) and the replacement of Felix by Festus (xxiv. 27).

1. The death of Herod Agrippa I. This prince, son of Aristobulus and grandson of Herod the Great, was made (i.) king over the tetrarchy which had been Herod Philip's, "not many days" after the accession of Gaius, 16th March A.D. 37; (ii.) ruler of the tetrarchy of Antipas, in A.D. 39-40; (iii.) ruler of the whole of Palestine (with Abilene), on the accession of Claudius at the beginning of A.D. 41. Josephus's *Jewish Wars* and *Antiquities* differ by one in the number of years they allot to his reign over the tetrarchies (the former work says three years, the latter four), but agree in the more important *datum* that he reigned three years more after the grant from Claudius, which would make the latest limit of his death the spring of A.D. 44. The *Antiquities* also reckon it in the seventh year of his reign, which would suggest A.D. 43-44. On the other hand, coins whose genuineness there is no apparent reason to doubt are extant of Agrippa's ninth year; and this can only be reconciled even with A.D. 44 by supposing that he commenced reckoning a second year of his reign on Nisan 1, A.D. 37, so that his ninth would run from Nisan 1, A.D. 44. On the balance of evidence the only year which can possibly reconcile all the data appears to be A.D. 44 after Nisan, so that it will have been at the Passover of that year that St Peter's arrest and deliverance took place.

After Agrippa's death Judæa was once more governed by procurators, of whom Cuspius Fadus and Tiberius Alexander ruled from A.D. 44 to 48; the third, Cumanus, was appointed in A.D. 48; and the fourth, Felix, in A.D. 52. Under Tiberius Alexander, *i.e.*, in A.D. 46 or 47, occurred the great famine which Agabus had foretold, and in which the Antiochene church sent help to that of Jerusalem by the

ministry of Barnabas and Saul (Acts xi. 30, xii. 25). Thus the earliest date at which the commencement of the first missionary journey (Acts xiii. 4) can be placed is the spring of A.D. 47. The journey extended from Salamis "throughout the whole island" of Cyprus as far as Paphos, and on the mainland from Pamphylia to Pisidian Antioch, Iconium, Lystra, and Derbe, at each of which places indications are given of a prolonged visit (xiii. 49, xiv. 3, 6, 7, 21). The same places were visited in reverse order on the return journey, as far as Perga on the Pamphylian coast; but instead of revisiting Cyprus the voyage to Syria was this time made direct. In estimating the length of time occupied by this first missionary journey, it must be remembered that a sea voyage could never have been undertaken, and land travel only rarely, during the winter months, say November to March; and as the amount of the work accomplished is obviously more than could fall within the travelling season of a single year, the winter of 47-48 must have been spent in the interior, and return to the coast and to Syria made only some time before the end of autumn A.D. 48. The succeeding winter, at least, was spent again at Antioch of Syria (xiv. 28). The council at Jerusalem of Acts xv. will fall at earliest in the spring of A.D. 49, and as only "certain days" were spent at Antioch after it (xv. 36), the start on the second missionary journey might have been made in the (late) summer of the same year. The "confirmation" of the existing churches of Syria and Cilicia, and of those of the first journey beginning with Derbe (xv. 41, xvi. 5), cannot have been completed under several months, nor would the Apostle have commenced the strictly missionary part of the journey, in districts not previously visited, before the opening of the travelling season of A.D. 50. No delay was then made on the Asiatic side: it may still have been in spring when St Paul crossed to Europe and began the course of preaching at Philippi, Thessalonica, Berœa, and Athens which finally brought him to Corinth. The stay of eighteen months at the last-named place (xviii. 11) will naturally begin at the end of one travelling season and end at the beginning of another, *i.e.*, from the autumn of A.D. 50 to the spring of A.D. 52. From Corinth the Apostle went to Jerusalem to "salute the church," and then again to Antioch in Syria, where he stayed only for "a time" (xviii. 22), and soon left—on the third missionary journey, as conventionally reckoned—proceeding "in order" through the churches of the interior of Asia Minor. These journeys and the intervening halts must have occupied seven or eight months, and it must have been about the end of the year when St Paul established his new head-quarters at Ephesus. The stay there lasted between two and three years (xix. 8, 10, xx. 31), and cannot have terminated before the spring of A.D. 55. From Ephesus he went into Europe, and after "much teaching" given to the churches of Macedonia (xx. 2), spent the three winter months at Corinth, returning to Philippi in time for the Passover (xx. 3, 6) of A.D. 56. Pentecost of the same year was spent at Jerusalem, and there St Paul was arrested, and kept in prison at Cæsarea for two full years, until Festus succeeded Felix as governor (xx. 16, xxiv. 27), an event which, on this arrangement of the chronology of the missionary journeys, would therefore fall in A.D. 58.

Care, however, must be taken to remember exactly what this line of argument amounts to—what it can fairly be said to have proved, and what it still leaves open. It has been shown, firstly, that the missionary journeys cannot have commenced before the spring of A.D. 47, and, secondly, that between their commencement and the end of the two years' imprisonment at Cæsarea not less than eleven full years must have elapsed. Consequently A.D. 58 appears to be the earliest date possible for the arrival of Festus. On the other hand, a later date for Festus is not absolutely excluded. It is possible that the first missionary journey should be placed in A.D. 48 instead of A.D. 47; and it is possible, though not probable, that the missionary journeys should be spread over one year more than has been suggested above. At any rate, then, the alternative is open that every date given above, from A.D. 47 to A.D. 58, should be moved on one year, with the result of placing Festus's arrival in A.D. 59.

It is now time to turn to the direct evidence for the date of Festus's arrival as procurator, in order to test by it the result already tentatively obtained.

2. The replacement of Felix by Festus. This is the pivot date of St Paul's later life, but unfortunately two schools of critics date it as differently as A.D. 55 and A.D. 60 (or 61). The former are represented by Harnack, the latter by Wieseler, whom Lightfoot follows. It can be said confidently that the truth is between these two extremes (though in what exact year it is not easy to say), as will be evident from a consideration of the arguments urged, which in each case appear less to prove one extreme than to disprove its opposite.

*Arguments for the Later Date, A.D. 60 or 61.*—(α) St Paul, at the time of his arrest, two years before Felix's recall, addresses him as "for many years past a judge for this nation" (Acts xxiv. 10, 27). It is certain that Felix succeeded Cumanus in A.D. 52, for Tacitus mentions Cumanus's recall under that year; Josephus immediately before the notice of the completion of Claudius's twelfth year [January, A.D. 53]; Eusebius probably under Claudius 11, that is, between September 51 and September 52 (for the meaning of the regnal years in the *Chronicle* of Eusebius see the present writer's article in *Journal of Theological Studies*, January 1900, pp. 188-192). It is argued that "many years" cannot mean less than six or seven, so that St Paul must have been speaking at earliest in 58 or 59, and Felix will have left Judæa at earliest in 60 or 61. But this argument overlooks the fact that Felix had been in some position which might properly be described as that of "judge for this nation" before he became governor of all Palestine in A.D. 52. In the words of Tacitus, Felix was at the time of that appointment *iampridem Iudaeae impositus* (*Annals*, xii. 54); he certainly supposes Felix to have been already governor of Samaria, and apparently of Judæa too, and only recognizes Cumanus as governor of Galilee; and Josephus, though he says nothing of this, and treats Cumanus as the sole procurator down to A.D. 52, implies that Felix had been in some position where the Jewish authorities could judge of his fitness when he tells us that the high priest Jonathan used to press on Felix, as a reason for urging him to govern well, the fact that he had asked for his appointment to the procuratorship (*Ant.* XX. viii. 5). If Felix had acted in some position of responsibility in Palestine before 52 (perhaps for some time before), St Paul could well have spoken of "many years" at least as early as 56 or 57.

(β) Josephus enumerates after the accession of Nero (October 54) a long catalogue of events which all took place under the procuratorship of Felix, including the revolt of "the Egyptian" which was already "before these days" at the time of St Paul's arrest, two years from the end of Felix's tenure. This suggests, no doubt, that the Egyptian rebelled at earliest in 54-55, and makes it probable that St Paul's arrest did not take place before (the Pentecost of) A.D. 56; and it implies certainly that the main or most important part of Felix's governorship fell, in Josephus's view, under Nero. But as two years only of Felix's rule (52-54) fell under Claudius, this procedure would be quite natural on Josephus's part if his recall were dated in 58 or 59, so that four or five years fell under Nero. And there is no need at all to suppose that all the incidents which the historian masses under his account of Felix were successive: events in Emesa, Chalcis, Cæsarea, and Jerusalem may easily have been synchronous.

The arguments, then, brought forward in favour of A.D. 60 or 61 do not do more than bring the rule of Felix down to 58 or 59.

*Arguments for an Early Date, A.D. 55 or 56.*—(α) Eusebius's *Chronicle* places the arrival of Festus in Nero 2, October 55-56, and Eusebius's chronology of the procurators goes back probably through Julius Africanus (himself a Palestinian) to contemporary authorities like the *Jewish kings* of Justus of Tiberias. But (i.) Nero 2 is really September 56-September 57; (ii.) it is doubtful whether Eusebius had any authority to depend on here other than Josephus, who gives no precise year for Festus—Julius Africanus is hardly probable, since we know that his chronicle

was very jejune for the Christian period—and if so, Eusebius had to find a year as best he could.[1]

(3) Felix, on his return to Rome, was prosecuted by the Jews for misgovernment, but was acquitted through the influence of his brother Pallas. Pallas had been minister and favourite of Claudius, but was removed from office in the winter following Nero's accession, 54-55. Felix must therefore have been tried at the very beginning of Nero's reign. But this argument would make Felix's recall—if Festus came in summer, as Acts xxv. 1, xxvii. 1, 9, seem to prove—fall actually under Claudius. And, in fact, it would be a mistake to look upon Pallas's retirement as a disgrace. He stipulated that no inquiry should be made into his conduct in office, and was left for another seven years unmolested in the enjoyment of the fortune he had amassed. There is, therefore, every likelihood that he retained for some years enough influence to shield his brother.

Of these arguments, then, the first, so far as it is valid, is an argument for the summer, not of A.D. 55 or 56, but of A.D. 57 as that of the recall, while the second will apply to any of the earlier years of Nero's reign.

In the result, then, the arguments brought forward in favour of each extreme fail to prove their case, but at the same time prove something against the opposite view. Thus the point that Josephus catalogues the events of Felix's procuratorship under Nero cannot be pressed to bring down Felix's tenure as far as 60 or 61, but it does seem to exclude as early a termination as 56, or even 57. Conversely, the influence of Pallas at court need not be terminated by his ceasing to be minister early in 55; but it would have been overshadowed not later than the year 60 by the influence of Poppæa, who in the summer of that year[2] enabled the Jews to win their cause in the matter of the Temple wall, and would certainly have supported them against Felix. Thus the choice again appears to lie between the years 58 and 59 for the recall of Felix and arrival of Festus.

Identical results follow from another line of argument which, though somewhat precarious, was unduly neglected before Ramsay recalled attention to it, namely, the data of St Paul's stay at Philippi and Troas in Acts xx. 6, 7. Being anxious to arrive at Jerusalem for Pentecost, the apostle left Philippi, it may be presumed, on the first day after the days of unleavened bread, took four days, according to our method of reckoning, on the voyage to Troas, and stayed there six days, leaving on a Monday. He arrived, therefore, at Troas on a Tuesday, and left Philippi on the preceding Friday, Nisan 22. Nisan 14, therefore, fell on Thursday This would be possible in A.D. 56 (Thursday, 18th March) or A.D. 57 (Thursday, 7th April), but hardly in either A.D. 55 or 58. As this journey of St Paul immediately preceded his arrest, and his imprisonment under Felix lasted two years, 58 and 59 again appear as the possible alternatives for Felix's recall.

If St Paul was arrested in 56 or 57, and appealed to Cæsar on the arrival of Festus in 58 or 59, then, as he reached Rome in the early part of the year following, and remained there a prisoner for two full years, we are brought down to the early spring of either 61 or 62 for the close of the period recorded in the Acts. That after these two years he was released and visited Spain in the west, and in the east Ephesus, Macedonia, Crete, Troas, Miletus, and perhaps Achaia and Epirus, is probable, in the one case, from the evidence of Romans xv. 28, Clem. *ad Cor.* v., and the Muratorian canon, and, in the other, from the Pastoral Epistles. These journeys certainly cannot have occupied less than two years, and it is more natural to allow three for them, which takes us down to 64-65.

Early evidence is unanimous in pointing to St Peter and St Paul as victims of the persecution of Nero (Clem. *ad Cor.* v. vi., Dionysius of Corinth *ap.* Eus. *H. E.* ii. 25, &c., combined with what we know from Tacitus of the course of the persecution, and from Gaius of Rome, *ap.* Eus. ii. 25, of the burial-places of the two apostles); and tradition clearly distinguished the fierce outbreak at Rome that followed on the fire of the city in July 64 from any permanent disabilities of the Christians in the eye of the law which the persecution may have initiated. There is therefore no reason at all to doubt that both apostles were martyred in 64-65, and the date serves as a confirmation of the chronology adopted above of the imprisonment, release, and subsequent journeys of St Paul.

Investigation, then, of that part of the book of Acts which follows the death of Agrippa, recorded in chap. xii.—*i.e.*, of that part of the apostolic age which follows the year 44—has shown that apparent difficulties can be to a large extent set aside, and that there is nowhere room between A.D. 44 and 64 for doubt extending to more than a single year. The first missionary journey may have begun in 47 or 48; the arrival of Festus may have taken place in the summer of 58 or of 59; the two years of the Roman imprisonment recorded in the last chapter of Acts may have ended in the spring of 61 or 62; and the dates which fall in between these extremes are liable to the same variation. The present writer leans to the earlier alternative in each case, 47, 58, 61, but he willingly concedes that the evidence, as he understands it, is not inconsistent with the later alternative.

But if the events of A.D. 44-64 can thus be fixed with a fair approximation to certainty, it is unfortunately otherwise with the events of A.D. 29-44. Here we are dependent (i.) on general indications given in the Acts; (ii.) on the evidence of the Epistle to the Galatians, which, though in appearance more precise, can be and is interpreted in very different ways.

(i.) The book of Acts is divided, by general summaries from time to time inserted in the narrative, into six periods: i. 1-vi. 7; vi. 8-ix. 31; ix. 32-xii. 24; xii. 25-xvi. 5; xvi. 6-xix. 20; xix. 21-xxviii. 31. Of these the three last extend respectively from the death of Herod to the start for Europe in the second missionary journey (A.D. 44 to the spring of 50 [51]), from the start for Europe to the end of the long stay at Ephesus (A.D. 50 [51] to the spring of A.D. 55 [56]), and from the departure from Ephesus to the end of the two years' captivity at Rome (A.D. 55 [56] to the beginning of A.D. 61 [62]). It will be seen that these periods are of more or less the same length, namely, six (or seven) years, five years, six years. There is therefore some slight presumption that the three earlier periods, which together cover about fifteen years, were intended by so artistic a writer as St Luke to mark each some similar lapse of time. If that were so, the preaching of the apostles at Jerusalem and organization of the Church at the capital—the preaching of the seven and the extension of the Church all over Palestine—the extension of the Church to Antioch, and the commencement of St Paul's work—might each occupy five years more or less, that is to say, roughly, A.D. 29-34, 34-39, 39-44. The conversion of St Paul, which falls within the second period, would on this arrangement fall somewhere between five and ten years after the Crucifixion. Such conclusions are, however, of course general in the extreme.

(ii.) A nearer attempt to date at least the chronology of

[1] Dr C. Erbes (*Texte und Untersuchungen*, new series, iv. 1) attempts to interpret the evidence of Eusebius in favour of the *later* date for Festus as follows: Eusebius's date for Festus is to be found in Nero 1, by striking a mean between the Armenian, Claudius 12, and the Latin, Nero 2; it is really to be understood as reckoned, not by years of Nero, but by years of Agrippa; and as Eusebius erroneously antedated Agrippa's reign by five years, commencing it with A.D. 45 instead of A.D. 50, his date for Festus is five years too early also, and should be moved to Nero 6, A.D. 59-60. The whole of this theory appears to the present writer to be a gigantic mare's nest: see *Journal of Theological Studies*, October 1901, pp. 120-23.

[2] This date appears to be satisfactorily established by Ramsay, "A Second Fixed Point in the Pauline Chronology," *Expositor*, August 1900.

St Paul's earlier years as a Christian could be made by the help of the Galatian Epistle, if we could be sure from what point and to what point its reckonings are made. The apostle tells us that on his conversion he retired from Damascus into Arabia, and thence returned to Damascus; then after three years (from his conversion) he went up to Jerusalem, but stayed only a fortnight, and went to the regions of Syria and Cilicia. Then after fourteen years (from his conversion? or from his last visit?) he went up to Jerusalem again to confer with the elder apostles. Now, if either of these visits to Jerusalem could be identified with any of the visits whose dates have been approximately settled in the chronology of A.D. 44-64, we should have a fixed point from which to argue back. Unfortunately, even less agreement exists on this head than on the question whether the fourteen years of the last-mentioned visit are to be reckoned from the conversion or from the previous visit. Most critics, indeed, are now agreed that the fourteen years are to be calculated from the conversion; and most of them still hold that the visit of Galatians ii. is the same as the council of Acts xv., partly, no doubt, on the ground that the latter visit was too important and decisive for St Paul to have omitted in giving even the most summary description of his relations with the twelve. This ground would, however, be cut away from their feet if it were possible to hold (with J. V. Bartlet, *Apostolic Age*, 1900, and V. Weber, *Die Abfassung des Galaterbriefs vor dem Apostelkonzil*, Ravensburg, 1900) that the epistle was actually written just before the council, *i.e.*, in the winter of 48-49 [49-50]. In that case, of course, the two visits of Galatians i. and ii. would be those of Acts ix. 26 and xi. 30. The fourteen years reckoned back from the latter (*c.* A.D. 46) would bring us to A.D. 32-33 as the latest possible date for the conversion. With the older view, on the other hand, the fourteen years reckoned from the council in A.D. 49 [50] would allow us to bring down the conversion to A.D. 36. The new view clears away some manifest difficulties in the reconciliation of the Epistle and the Acts, and the early date for Galatians in relation to the other Pauline Epistles is not so improbable as it may seem; but the chronology still appears more satisfactory on the older view, which enables the conversion to be placed at least three years later than on the alternative theory. But it is clear that the last word has not been said, and that definite results for this period cannot yet be looked for.

To sum up: an attempt has been made, it is hoped with some success, to provide a framework of history equipped with dates from the time of St Peter's arrest by Herod Agrippa I. at the Passover of A.D. 44 down to the martyrdom of St Peter and St Paul in the persecution of Nero, A.D. 64-65. For the previous period, on the other hand, from A.D. 29 to A.D. 44, it appeared impossible in our present state of knowledge to state conclusions other than in the most general form.

AUTHORITIES.—The views stated in this article are in general (though with some modifications) the same as those which the present writer worked out with more fulness of detail in HASTINGS'S *Dictionary of the Bible*, i. (1898) 403-424. Of older books should be mentioned:—IDELER. *Handbuch der mathematischen und technischen Chronologie*, 2 vols. (1825).—WIESELER. *Chronologie des apostolischen Zeitalters* (1848).—LEWIN'S *Fasti Sacri* (1865).—The most important modern contributions are to be found in Prof. W. M. RAMSAY'S various works, and in HARNACK'S *Chronologie der altchristlichen Litteratur bis Eusebius*, i. 233-244. (C. H. T.)

**Chrudim,** a town in Bohemia, Austria. It has an important horse market, besides manufactures of sugar, spirits, beer, soda-water, and agricultural machinery. There are also steam corn-mills and saw-mills. Chrudim is the birthplace of Joseph Ressel (1793-1857), who is honoured in Austria as the inventor of the screw propeller. Population, 13,017.

**Chubut,** a territory of the Argentine Republic, Patagonia, bounded on the N. by Rio Negro, on the S. by Santa Cruz, on the E. by the Atlantic, and on the W. by Chile. Its official area at the census of 1895 was 93,427 square miles; and in 1895 its population was 3748, as compared with 153 in 1869. The capital, Rawson, is situated 3 miles from the mouth of the Chubut. The territory is divided into three departments. In 1895 there were 29,944 head of cattle, 47,306 sheep, 12,907 horses, 310 farms, and 12,355 acres planted in cereals.

**Chulalongkorn, Phra Paramindr Maha** (1853-——), king of Siam, eldest son of King Maha Mongkut, was born 21st September 1853. His full signature, used in all important state documents, consists of twenty-seven names, but it is by the first four that he is usually known. Educated in his childhood by English teachers, especially by Captain John Bush, he acquired a good knowledge of the English language and a due appreciation of Western culture. But his surroundings were purely Oriental, and as his boyhood was spent, according to custom, in a Buddhist monastery, he remained in sympathy with his people. He succeeded to the throne on the death of his father, 1st October 1868, and was crowned on 11th November following, when Europeans were present for the first time at such a ceremony. Until his majority in 1873 the government was carried on by a regent, the young king retiring to a Buddhist monastery, and then making a long tour through India and the Dutch East Indies, an event hitherto unheard of among the potentates of Eastern Asia. But he had no sooner taken the reins of power than he gave evidence of his recognition of the importance of modern culture by abolishing slavery, which existed in Siam in its most extended form. He also did away with the custom of approaching the king on all fours. Still more important, in view of the numerous races and creeds included among his subjects, was the proclamation of liberty of conscience. This was followed by the erection of schools and hospitals, the construction of roads and railways, and the further development of the army and fleet which his father had commenced. To him Siam is indebted for its standard coinage, its postal and telegraph service, and for the police, sanitation, and electric-lighting of Bangkok. Two of the king's sons were sent to school in England, and in the summer of 1897 King Chulalongkorn paid a visit to Europe, arriving at Portsmouth in his yacht on the 29th July. On the 4th August he was received by Queen Victoria at Osborne. After a tour in Great Britain he proceeded to Berlin, Brussels, and The Hague, and arrived in Paris on 11th September, and after spending some weeks in the French capital, returned to Siam late in the year.

**Chumla.** See SHUMLA.

**Chungking,** a city in the province of Szechuen, China, on the left bank of the Yangtse, at its point of junction with the Kialing, in 29° 33′ N. lat. and 107° 2′ E. long. It is the commercial centre for the trade, not only of Szechuen, but of all south-western China. The one highway between Szechuen and the eastern provinces is the Yangtse river route, as owing to the mountainous nature of the intervening country land transit is almost impracticable. The import trade brought up by large junks from Ichang, and consisting of cotton cloth, yarn, metals, and foreign manufactures, centres here, and is distributed by a class of smaller vessels up the various rivers of the provinces. Native produce, such as

yellow silk, white wax, hides, rhubarb, musk, and opium, is here collected and repacked for conveyance to Hankow, Shanghai, or other parts of the empire. The city was opened to foreign trade by convention with the British Government in 1891, with the proviso, however, that foreign steamers should not be at liberty to trade there until Chinese-owned steamers had succeeded in ascending the river. This restriction was abolished by the Japanese treaty of 1895, which declared Chungking open on the same terms as other ports. Since that date the problem of steam navigation on the section of the river between Ichang and Chungking has been occupying the attention of practical men. A small steamer has been navigated up the rapids, but it is a question how far steam navigation can be made a practical success. At present the trade is carried by native craft, which are hauled up against the strength of the current in the worst places by a line of trackers on the bank. Another difficulty is the great rise in the river during the summer months. At Chungking this rise is ordinarily 70 feet, and occasionally it is as much as 96 feet. The population of Chungking, including the city of Kiangpeh on the opposite bank of the Kialing river, is about 300,000. The foreign residents are very few. In 1898 the value of the trade passing through the maritime customs was H. taels 17,426,000 (£2,614,000), and in 1899 H. taels 25,792,000 (£3,868,000), of which imports, chiefly Manchester goods, counted for £1,961,000.

**Chuquisaca,** a department of Bolivia, bounded on the N. by the departments of Cochabamba and Santa Cruz, on the S. by that of Tarija, on the E. by the Rio Paraguay, and on the W. by the department of Potosi. It has an area of 39,850 square miles, and had a population in 1893 of 286,710. Its capital is Sucre (26,000). The department is divided into four provinces, Yamparaez, Cinti, Tomina, and Azero, and has 29 schools with about 2000 pupils.

**Church, Richard William** (1815-1890), Dean of St Paul's, was the son of John Dearman Church, an Irish merchant of Quaker ancestry. He was born at Lisbon, 25th April 1815, his early years being mostly spent at Florence. After his father's death in 1828 he was sent to a school of a pronounced evangelical type at Redlands, Bristol, and went in 1833 to Wadham College, Oxford, an evangelical college. He took first-class honours in 1836, much to his own surprise, and in 1838 was elected fellow of Oriel. One of his contemporaries, Richard Michell, commenting on this election, said: "There is such a moral beauty about Church that they could not help taking him." He was appointed tutor of Oriel in 1839, and was ordained the same year. He was an intimate friend of Newman's at this period, and closely allied to the Tractarian party. In 1841 No. 90 of *Tracts for the Times* appeared, and Church resigned his tutorship. In 1844-1845 he was junior proctor, and in that capacity, in concert with his senior colleague, vetoed a proposal to censure Tract 90 publicly. In 1846 Church, with others, started the *Guardian* newspaper. In 1850 he became engaged to Miss H. F. Bennett, of a Somersetshire family, a niece of Bishop Moberly. After again holding the tutorship of Oriel, he accepted in 1852 the small living of Whatley in Somersetshire, near Frome, and was married in the following year. He was a diligent parish priest and a serious student, and contributed largely to current literature. In 1869 he refused a canonry at Worcester, but in 1871 he accepted, most reluctantly (calling it "a sacrifice *en pure perte*"), the deanery of St Paul's, to which he was nominated by Mr Gladstone. His task as dean was a complicated one. It was (1) the restoration of the cathedral, (2) the adjustment of the question of the cathedral revenues with the Ecclesiastical Commissioners, (3) the reorganization of a conservative cathedral staff with anomalous vested rights. He described the intention of his appointment to be "that St Paul's should waken up from its long slumber." The first year that he spent at St Paul's was, writes one of his friends, one of "misery" for a man who loved study and quiet and the country, and hated official pomp and financial business and ceremonious appearances. But he performed his difficult and uncongenial task with almost incredible success, and is said never to have made an enemy or a mistake. The dean was distinguished for uniting in a singular degree the virtues of austerity and sympathy. He was pre-eminently endowed with the faculty of judgment, characterized by Canon Scott Holland as the faculty of "high and fine and sane and robust decision." Though of unimpressive stature, he had a strong magnetic influence over all brought into contact with him, and though of a naturally gentle temperament, he never hesitated to express censure if he was convinced it was deserved. In the pulpit the voice of the dean was deliberately monotonous, and he employed no adventitious gesture. He may be described as a High Churchman, but of an essentially rational type, and with an enthusiasm for religious liberty that made it impossible for him to sympathize with any unbalanced or inconsiderate demands for deference to authority. He said of the Church of England that there was "no more glorious church in Christendom than this inconsistent English Church." The dean often meditated resigning his office, though his reputation as an ecclesiastical statesman stood so high that he was regarded in 1882 as a possible successor to Archbishop Tait. But his health and mode of life made it out of the question. In 1888 his only son died; his own health declined, and he appeared for the last time in public at the funeral of Canon Liddon in 1890, dying on 9th December 1890, at Dover. He was buried at Whatley. The dean's chief published works are a *Life of St Anselm* (1870), the lives of *Spenser* (1879) and *Bacon* (1884) in Macmillan's "Men of Letters" series, an *Essay on Dante* (1878), *The Oxford Movement* (1891), together with many other volumes of essays and sermons. In these writings he exhibits a great grasp of principles, an accurate mastery of detail, and the same fusion of intelligent sympathy and dispassionate judgment that appeared in his handling of business. His style is lucid, and has the charm of austerity. He stated that he had never studied style *per se*, but that he had acquired it by the exercise of translation from classical languages; that he watched against the temptation of using unreal and fine words; that he employed care in his choice of verbs rather than in his use of adjectives, and that he fought against self-indulgence in writing just as he did in daily life. His sermons have the same quality of self-restraint. His private letters are fresh and simple, and contain many unaffected epigrams; in writing of religious subjects he resolutely avoided dogmatism without ever sacrificing precision. The dean was a man of genius, whose moral stainlessness and instinctive fire were indicated rather than revealed by his writings. (A. C. Bᴇ.)

**Church Army.**—The Church Army is an English religious organization, which was founded in 1882 by the Rev. Wilson Carlile, who banded together in an orderly army of "soldiers" and "officers" a few working men and women, whom he and others trained to act as "Church of England evangelists" among the outcasts and criminals of the Westminster slums. Previous experience had convinced him that wickedness and irreligion among the lowest classes of the people could best be overcome by new and aggressive action on the part

of the Church, and that this work was most effectively done by zealous laymen and women of the same class as those whom it was desired to touch. "Evangelistic zeal with Church order" is the principle of the Church Army, and it is essentially a working men's and women's mission to working people. As the work grew, a training institution for evangelists was started in Oxford, but soon moved (1886) to 130 Edgware Road, London, W., where the headquarters of the Army are established. Working men are trained as evangelists, and working women as mission nurses, and are supplied to the clergy whenever asked for. The men evangelists have to pass an examination by the archdeacon of Middlesex, and are then (since 1896) admitted by the bishop of London as "lay evangelists in the Church"; the mission nurses must likewise pass an examination by the diocesan inspector of schools. All Church Army workers (of whom there are over 1200 of one kind and another) are entirely under the control of the incumbent of the parish to which they are sent. They never go to a parish unless invited, nor stay when asked to go by the parish priest. Officers and nurses are paid a limited sum for their services by the vicar or by voluntary local contributions. Church Army mission and colportage vans circulate throughout the country parishes, if desired, with itinerant evangelists, who hold simple missions, without charge, and spread wholesome literature. Each van missioner has a clerical "adviser." Missions are also held in prisons and workhouses, at the invitation of the authorities. In 1888 (before the similar work of the Salvation Army was inaugurated) the Church Army established labour homes in London and elsewhere, with the object of giving a "fresh start in life" to the outcast and destitute. The Church Army homes deal with the outcast and destitute in a plain, simple, straightforward way. They demand that the persons should show a desire for amendment; they subject them to firm discipline; they give them hard work; they give them decent clothes; and they strive to win them to a Christian life. The inmates earn their board and lodging by piece-work, for which they are paid at the current trade rates, while by a gradually lessening scale of work and pay they are stimulated to obtain situations for themselves and given time to seek for them. There are about 103 homes in London and the provinces, and 56 per cent. of the 26,000 cases helped in 1900 made the successful beginning of an honest, self-supporting life. Selected and tested cases are enabled to emigrate. The Church Army has lodging homes, an employment bureau, cheap food depot, old clothes department, dispensary, and other social works, and an inebriates' reformatory under the Act of 1898. The whole of the work is done in loyal subordination to the diocesan and parochial organization of the Church of England. (M. B. S.)

**Churchill,** MISSINNIPPI, or ENGLISH, a river of Athabasca and Keewatin districts, Canada. It rises in La Loche—a small lake in 56° 30′ N. lat. and 109° 30′ W. long., at an altitude of 1577 feet above the sea—and flows in a north-easterly direction to Hudson Bay, passing through a number of lake expansions. Its principal tributaries are the Beaver—350 miles long, Sandy, Montreal, Reindeer, and Little Churchill rivers. Between Frog and Methy portages—480 miles—it formed part of the old *voyageur* route to the Peace, Athabasca, and Mackenzie. Its largest affluent, Reindeer river, discharges the waters of Reindeer lake (with an area of 2490 square miles and 1150 feet above the sea) and Wollaston lake (altitude, 1300 feet). The Churchill is 925 miles long. Port Churchill, at its mouth, is the best harbour in the southern portion of Hudson Bay.

**Churchill, Lord Randolph Henry Spencer** (1849–1895), English statesman, third son of John, seventh duke of Marlborough, by Frances, daughter of the third marquis of Londonderry, was born at Blenheim Palace, on 13th February 1849. His early education was conducted at home, and at Mr Tabor's preparatory school at Cheam. In January 1863 he went to Eton, where he remained till July 1865. He was not specially distinguished either in school work or games while at Eton; his contemporaries describe him as a vivacious and rather unruly lad. In October 1867 he matriculated at Merton College, Oxford. He was fond of amusement, and had carried to Oxford an early taste for sport which he retained throughout life. But he read with some industry, and obtained a second class in jurisprudence and modern history in 1870. In 1874 he was elected to Parliament in the Conservative interest for Woodstock, defeating Mr George Brodrick, a fellow, and afterwards Warden, of Merton College. His maiden speech, delivered in his first session, made no impression on the House, nor did he become in any way conspicuous till 1878. In that year he forced himself into public notice as the exponent of a species of independent Conservatism. He directed a series of furious attacks against some of the occupants of the front ministerial bench, and especially that "old gang" who were distinguished rather for the respectability of their private characters, and the unblemished purity of their Toryism, than for striking talent. Mr Sclater Booth, president of the Local Government Board, was the especial object of his ire, and that minister's County Government Bill was fiercely denounced as the "crowning dishonour to Tory principles," and the "supreme violation of political honesty." The audacity of Lord Randolph's attitude, and the vituperative fluency of his invective, made him a parliamentary figure of some importance before the dissolution of the 1874 Parliament, though he was not as yet taken quite seriously. In the new Parliament of 1880 he speedily began to play a more notable rôle. With the assistance of his devoted adherents, Sir Henry Drummond Wolff, Mr John Gorst, and occasionally of Mr Arthur Balfour, and one or two others, he constituted himself at once the audacious opponent of the Liberal administration and the unsparing critic of the Conservative front bench. The "fourth party," as it was nicknamed, was effective at first not so much in damaging the Government as in awakening the Opposition from the apathy which had fallen upon it after its defeat at the polls. Churchill roused the Conservatives and gave them a fighting issue, by putting himself at the head of the resistance to Mr Bradlaugh, the member for Northampton, who, though an avowed atheist or agnostic, was prepared to take the parliamentary oath. Sir Stafford Northcote, the Conservative leader in the Lower House, was forced to take a strong line on this difficult question by the energy of the fourth party, who in this case clearly expressed the views of the bulk of the Opposition. The long and acrimonious controversy over Mr Bradlaugh's seat, if it added little to the reputation of the English legislature, at least showed that Lord Randolph Churchill was a parliamentary champion who added to his audacity much tactical skill and shrewdness. He continued to play a conspicuous part throughout the Parliament of 1880–85, dealing his blows with almost equal vigour at Mr Gladstone and at the Conservative front bench, some of whose members, and particularly Sir Richard Cross and Mr W. H. Smith, he assailed with extreme virulence. From the beginning of the Egyptian imbroglio Lord Randolph was emphatically opposed to almost every step taken by the Government. He declared that the suppression of Arabi Pasha's rebellion

was an error, and the restoration of the Khedive's authority a crime. He called Mr Gladstone the "Moloch of Midlothian," for whom torrents of blood had been shed in Africa. He was equally severe on the domestic policy of the administration, and was particularly bitter in his criticism of the Kilmainham Treaty and the *rapprochement* between the Gladstonians and the Parnellites. It is true that for some time before the fall of the Liberals in 1885, he had considerably modified his attitude towards the Irish question, and was himself cultivating friendly relations with the Home Rule members, and even obtained from them the assistance of the Irish vote in the English constituencies in the general election. By this time he had definitely formulated the policy of progressive Conservatism which was known as "Tory democracy." He declared that the Conservatives ought to adopt, rather

LORD RANDOLPH CHURCHILL.
(*From a photograph by Elliot & Fry, London.*)

than oppose, reforms of a popular character, and to challenge the claims of the Liberals to pose as the champions of the masses. His views were to a large extent accepted by the official Conservative leaders in the treatment of the Gladstonian Franchise Bill of 1884. Lord Randolph insisted that the principle of the Bill should be accepted by the Opposition, and that resistance should be focussed upon the refusal of the Government to combine with it a scheme of redistribution. The prominent, and on the whole judicious and successful, part he played in the debates on these questions, still further increased his influence with the rank and file of the Conservatives in the constituencies. At the same time he was actively spreading the gospel of democratic Toryism in a series of platform campaigns. In 1883 and 1884 he invaded the Radical stronghold of Birmingham itself, and in the latter year took part in a Conservative garden party at Aston Manor, at which his opponents paid him the compliment of raising a serious riot. He gave constant attention to the party organization, which had fallen into considerable disorder after 1880, and was an active promoter of the Primrose League, which owed its origin to the happy inspiration of one of his own "fourth party" colleagues. In 1884 the struggle between stationary and progressive Toryism came to a head, and terminated in favour of the latter. At the conference of the Central Union of Conservative Associations, Lord Randolph was nominated chairman, notwithstanding the strenuous opposition of the parliamentary leaders of the party. The split was averted by Lord Randolph's voluntary resignation; but the episode had confirmed his title to a leading place in the Tory ranks. It was further strengthened by the prominent part he played in the events immediately preceding the fall of the Liberal Government in 1885; and when Mr Childers's budget resolutions were defeated by the Conservatives, aided by about half the Parnellites, Lord Randolph Churchill's admirers were justified in proclaiming him to have been the "organizer of victory." His services were, at any rate, far too important to be refused recognition; and in Lord Salisbury's Cabinet of 1885 he was appointed to no less an office than that of secretary of state for India. During the few months of his tenure of this great post the young free-lance of Tory democracy surprised the permanent officials and his own friends by the assiduity with which he attended to his departmental duties and the rapidity with which he mastered the complicated questions of Indian administration. In the autumn election of 1885 he contested Central Birmingham against Mr Bright, and though defeated here, was at the same time returned by a very large majority for South Paddington. In the contest which arose over Mr Gladstone's Home Rule scheme, both in and out of Parliament, Lord Randolph again bore a conspicuous part, and in the electioneering campaign his activity was only second to that of some of the Liberal Unionists, the marquis of Hartington, Mr Goschen, and Mr Chamberlain. He was now the recognized Conservative champion in the Lower Chamber, and when the second Salisbury administration was formed after the general election of 1886 he became chancellor of the exchequer and leader of the House of Commons. His management of the House was on the whole successful, and was marked by tact, discretion, and temper. But he had never really reconciled himself with some of his colleagues, and there was a good deal of friction in his relations with them, which ended with his sudden resignation on 20th December 1886. Various motives influenced him in taking this surprising step; but the only ostensible cause was that put forward in his letter to Lord Salisbury, which was read in the House of Commons on 27th January. In this document he stated that his resignation was due to his inability, as chancellor of the exchequer, to concur in the demands made on the treasury by the ministers at the head of the naval and military establishments. It was commonly supposed that he expected his resignation to be followed by the unconditional surrender of the Cabinet, and his restoration to office on his own terms. The sequel, however, was entirely different. The Cabinet was reconstructed with Mr Goschen as chancellor of the exchequer, and Lord Randolph's own career as a Conservative chief was practically closed. He continued, for some years longer, to take a considerable share in the proceedings of Parliament, giving a general, though decidedly independent, support to the Unionist administration. On the Irish question he was a very candid critic of Mr Balfour's measures, and one of his later speeches, which recalled the acrimonious violence of his earlier period, was that which he delivered in 1890 on the report of the Parnell Commission. He also fulfilled the promise made on his resignation by occasionally advocating the principles of economy and retrenchment in the debates on the naval and military estimates.

In April 1889, on the death of Mr Bright, he was asked to come forward as a candidate for the vacant seat in Birmingham, and the result was a rather angry controversy with Mr Chamberlain, terminating in the so-called "Birmingham compact" for the division of representation of the Midland capital between Liberal Unionists and Conservatives. But his health was already precarious, and this, combined with the anomaly of his position, induced him to relax his devotion to Parliament during the later years of the Salisbury administration. He bestowed much attention on society, travel, and sport. He was an ardent supporter of the turf, and in 1889 he won the Oaks with a mare named the Abbesse de Jouarre. In 1891 he went to South Africa, in search both of health and relaxation. He travelled for some months through Cape Colony, the Transvaal, and Rhodesia, making notes on the politics and economics of the countries, shooting lions, and recording his impressions in letters to a London newspaper, which were afterwards republished under the title of *Men, Mines, and Animals in South Africa*. He returned with renewed energy, and in the general election of 1892 once more flung himself, with his old vigour, into the strife of parties. His seat at South Paddington was uncontested; but he was active on the platform, and when Parliament met he returned to the Opposition front bench, and again took a leading part in debate, attacking Mr Gladstone's second Home Rule Bill with especial energy. But it was soon apparent that his powers were undermined by the inroads of disease. As the session of 1893 wore on his speeches lost their old effectiveness, and in 1894 he was listened to not so much with interest as with pity. His last speech in the House was delivered in the debate on Uganda in June 1894, and was a painful failure. He was, in fact, dying of general paralysis. A journey round the world was undertaken as a forlorn hope. Lord Randolph started in the autumn of 1894, accompanied by his wife, but the malady made so much progress that he was brought back in haste from Cairo. He reached England shortly before Christmas, and died at 50 Grosvenor Square on 24th January 1895.

Lord Randolph Churchill married, in January 1874, Jennie, daughter of Mr Leonard Jerome of New York, U.S.A., who survived him. He left two sons, Winston and John, the former of whom, after serving for some time in the 4th Hussars and acting as a special correspondent in the South African war, was elected member of Parliament for Oldham in October 1900.

The earlier speeches of Lord Randolph Churchill have been edited, with an introduction and notes, by Louis Jennings; two vols., London, 1889. See also T. H. S. Escott, *Randolph Spencer Churchill*, 1895; and H. W. Lucy, *Diary of Two Parliaments*, 1892. (S. J. L.)

**Chust,** a town of Russian Turkestan, province of Fergana, district of Namangan, 110 miles north-east of Kokan, on Narym river. Population, 13,686.

**Cialdini, Enrico** (1811–1892), Italian soldier and politician, was born at Castelvetro, in Modena, Italy, 10th August 1811. In 1831 he took part in the insurrection at Modena, fleeing afterwards to Paris, whence he proceeded to Spain to fight against the Carlists. Returning to Italy in 1848, he commanded a regiment at the battle of Novara. In 1859 he organized the Alpine Brigade, fought at Palestro at the head of the 4th Division, and in the following year invaded the Marches, won the battle of Castelfidardo, took Ancona, and subsequently directed the siege of Gaeta. For these services he was created duke of Gaeta by the king, and was assigned a pension of 10,000 lire by Parliament. In 1861 his intervention envenomed the Cavour-Garibaldi disputé, royal mediation alone preventing a duel between him and Garibaldi. Placed in command of the troops sent to oppose the Garibaldian expedition of 1862, he defeated Garibaldi at Aspromonte. Between 1862 and 1866 he held the position of Lieutenant-Royal at Naples, and in 1864 was created Senator. On the outbreak of the war of 1866 he resumed command of an army corps, but dissensions between him and Lamarmora prejudiced the issue of the campaign and contributed to the defeat of Custoza. After the war he refused the command of the General Staff, which he wished to render independent of the War Office. In 1867 he attempted unsuccessfully to form a Cabinet sufficiently strong to prevent the threatened Garibaldian incursion into the Papal States, and two years later failed in a similar attempt, through disagreement with Lanza concerning the army estimates. On 3rd August 1870 he pleaded in favour of Italian intervention in aid of France, a circumstance which enhanced his influence when in July 1876 he replaced Nigra as ambassador to the French Republic. This position he held until 1882, when he resigned on account of the publication by Mancini of a despatch in which he had complained of arrogant treatment by M. Waddington. He died at Leghorn, 8th September 1892. (H. W. S.)

**Cider.**—The recent development of the cider-making industry, coupled with certain changes in the mode of manufacture, render it necessary to supplement the two articles on Cider and Perry in the ninth edition of the *Encyclopædia Britannica* with additional information.

Cider and perry are liquors containing from as little as 2 per cent. of alcohol to 7 or 8 per cent., seldom more, and rarely as much, produced by the vinous fermentation of the expressed juice of apples and pears; but cider and perry of prime quality can only be obtained from vintage fruit, that is, apples and pears grown for the purpose and unsuited for the most part for table use. A few table apples make good cider, but the best perry is only to be procured from pears too harsh and astringent for consumption in any other form. The making of perry is in England confined, in the main, to the counties of Hereford, Worcester, and Gloucester. These three counties, together with Somerset and Devon, constitute, too, the principal cider-making district of the country; but the industry, which was once more widely spread, still survives in Norfolk, and has lately been revived in Kent, though, in both these counties, much of the fruit used in cider-making is imported from the west country and some from the Continent. Speaking generally, the cider of Herefordshire is distinguished for its lightness and briskness, that of Somerset for its strength, and that of Devonshire for its lusciousness.

Inasmuch as English orchards are crowded with innumerable varieties of cider apples, many of them worthless, a committee composed of members of the Herefordshire Fruit-Growers' Association and of the Fruit and Chrysanthemum Society was appointed in 1899 to make a selection of vintage apples and pears best suited to Herefordshire and the districts adjoining. The following is the list drawn up by the committee:—

*Apples.*—Old Foxwhelp, Cherry Pearmain, Cowarne Red, Dymock Red, Eggleton Styre, Kingston Black or Black Taunton, Skyrme's Kernel, Spreading Redstreak, Carrion apple, Cherry Norman, Cummy Norman, Royal Wilding, Handsome Norman, Strawberry Norman, White Bache or Norman, Broad-leaved Norman, Argile Grise, Bramtôt, De Boutville, Fréquin Audièvre, Medaille d'Or, the last five being French sorts introduced from Normandy about twenty years ago, and now established in the orchards of Herefordshire.

*Pears.*—Taynton Squash, Barland, Oldfield, Moorcroft or Malvern Hill, Red-pear, Thurston's Red, Longland, Pine pear.

No equally authoritative selection has been made for the Somerset and Devon districts, but the following varieties of cider apples are held in good repute in those parts:—Kingston Black, Jersey Chisel, Hangdowns, Fair Maid of Devon, Woodbine, Duck's Bill, Slack-my-Girdle, Bottle Stopper, Golden Ball, Sugar-loaf, Red Cluster, Royal Somerset, and Cadbury (believed to be identical with the Royal Wilding of Herefordshire). As a rule the best cider apples are of small size. "Petites pommes, gros cidre," say the French.

Cider and perry not being taxable liquors in England, it is impossible to estimate with even an approach to accuracy the amount of the annual production of them. In 1896 Mr Sampson, the then secretary of the National Association of English Cider-makers, in his evidence before the Royal Commission on Agriculture, put it at 55½ million gallons. Since that date the increased demand for these native wines has given such an impetus to the industry that this figure might with safety be doubled. In France official statistics are available, and these show not only that that country is the largest producer of cider (including perry) in the world, but that the output is yearly increasing. In the ten years ending 1888 the annual average production amounted to 14 million hectolitres. This average was, however, largely exceeded in 1899 and 1900, the production in 1899 reaching 21 million, and in 1900 nearly 30 million hectolitres, or within 5 million hectolitres of the output of wine in the last-mentioned year. Although some cider is made in sixty-five departments, by far the largest amount comes from the provinces of Normandy and Brittany. In Germany cider-making is a considerable and growing industry. Manufactories on a small scale exist in North Germany, as at Guben and Grünberg, but the centre of the industry is at Frankfort-on-Main, Sachsenhausen, and the neighbourhood, where there are five large and twenty-five small factories employing upwards of 1000 hands. Of late years the production of cider in Wurtemberg has greatly increased, and large quantities of fruit are imported from foreign countries, especially from Switzerland, where there are numerous orchards of cider apples. Stuttgart is the principal depot for foreign fruit. Out of 2857 truckloads brought in by rail in 1898, 1973 came from Switzerland and 561 from Austria. In Baden, Hesse, Wurtemberg, and the Palatinate the highways have within the last twenty-five years been extensively planted with cider fruit. The trees belong to the respective states, which derive an increasing revenue from the sale of the fruit. Speaking generally, however, the native-grown fruit used in Germany for cider-making consists of inferior and undersized table apples not worth marketing. The cider thus made is of poor quality, but, as it is chiefly used for "bowle"—a kind of cider cup flavoured with "Mai-kraut" (the common woodruff)—the quality is not of consequence. The bottled cider for export is treated much like champagne and is usually fortified and flavoured until, in the words of an acknowledged French authority, M. Truelle, it becomes a hybrid between cider and white wine rather than pure cider.

The practice which formerly prevailed in England of making cider on the farm from the produce of the home orchards has within the last few years been to a large extent given up, and, as in Germany and many parts of France, farmers now sell their fruit to owners of factories where the making of cider and perry is carried on as a business of itself. In these hand or horse power is superseded by steam and sometimes by electricity, as in the factory of E. Seigel in Grünberg, and the old-fashioned appliances of the farm by modern mills and presses capable of turning out large quantities of liquor. The clearing of the juice, too, which used to be effected by running it through bags, is in the factories accomplished more quickly by forcing it through layers of compressed cotton in a machine of German origin known as Lumley's filter. The actual process of cider and perry making is a simple one, and is as described in the ninth edition of this work, but, owing in the main to the investigations of German scientists, it is now possible to trace the causes of those changes, familiar to all practical cider-makers, which occur in both cider and perry during fermentation, and thereby to impart to the manufacture of these liquors a degree of exactitude unattainable hitherto. Cider made from a judicious mixture of several varieties of apples is to be preferred to cider made from one variety only, inasmuch as it is less difficult to find the requisite degrees of richness, astringency, and flavour in several varieties than in one; but the contrary is the case with pears, of which the most noted sorts, such as the Barland, the Taynton Squash, and the Oldfield, produce the best perry when unmixed with other varieties. It is not now considered advisable to crush the seeds or pips in making cider from the best fruit, as their aromatic taste would mask or destroy the delicate flavour of the juice; but where the latter is of poor quality the crushing of the pips is admissible in order to supplement its deficiency in flavour.

Some fining of an albuminous nature is generally requisite in order to clear the juice and facilitate its passage through the filter, but the less used the better. The simplest and cleanest is skim milk whipped to a froth and blended gradually with the cider as it is pumped into the mixing vat. Many nostrums are sold for the clearing of cider, but none are necessary and most are harmful.

Of late years the practice has largely obtained of using preservatives for the purpose of checking fermentation. The principal preservatives employed are salicylic and boracic acid and formalin. The two former are ineffective except in quantities likely to prove hurtful to health, while formalin, in itself a powerful and deleterious drug, though it stops fermentation, renders the liquor cloudy and undrinkable. Other foreign ingredients, such as saccharin and porcherine, both coal-tar derivatives—the latter a recent discovery of a French chemist, after whom it is named—are used by many makers, chiefly for the purpose of rendering bad and therefore unwholesome cider palatable and saleable. Provided that cider and perry be properly filtered and attention paid to perfect cleanliness of vessels and appliances, there is no need of preservatives or sweeteners, and their use ought to be forbidden by law in England, as it is in most continental states in the case of liquors to be consumed within their borders, though not, it is significant to note, in the case of liquors intended for exportation.

Within the last few years the wholesome properties of cider and perry when pure and unadulterated have been recognized by medical men, who recommend them as pleasant and efficacious remedies in affections of a gouty or rheumatic nature, maladies which, strange to say, these very liquors were once supposed to foster, if not actually to originate. Under a similar false impression the notion is general that hard rough cider is apt to cause diarrhœa, colic, and kindred complaints, whereas, as a fact, disorders of this kind are conspicuous by their absence in those parts of the country where rough cider and perry constitute the staple drinks of the working-classes. This is especially the case in Herefordshire, which is said also to be the only county in England whence no instance of the occurrence of Asiatic cholera has ever been reported.

Now that the increasing demand for cider and perry has drawn attention to its importance to agriculturists, the cider-making industry has received a certain amount of assistance and encouragement from public or quasi-public sources. Many agricultural societies, including the Royal and the Bath and West, offer prizes for cider and perry in cask and bottle, and the latter society gives a grant of £100 a year towards the cost of some interesting experiments at Butleigh in Somersetshire. The county councils in the cider-producing districts have included cider-making among the subjects in which they give gratuitous instruction, though as yet these bodies are hampered by the difficulty of procuring competent teachers. The Herefordshire county council has, through the co-operation of certain landowners, obtained the use of six pomological stations in different parts of the county, consisting of small fruit plantations, where demonstrations are given in various branches of fruit culture. In addition to these the council has established a central pomological and experimental garden close to Hereford, where, as one of the principal aims of the council is to promote the cider industry, a branch of agriculture of special importance to Herefordshire, a large number of cider apples and perry pears have been planted. Included among these is a nice collection of approved French sorts obtained from Normandy; and as the varieties introduced thence, as already mentioned, about 1880, have turned out to be valuable additions to the orchards of the county, it is probable that some of these still newer importations will prove to be well suited to English soil and climate.

Fruit-growers who look to cider-making "as a means of utilizing windfalls and small and inferior apples of cooking and dessert varieties not worth sending to market" (to quote from a paper lately read by a fruit-grower before a learned society) should be warned that it is as important to the cider industry that good cider only should be on sale as it is to the fruit-growing industry that good fruit only should be sent to market. Bad cider of English make brings discredit on the beverage and lets in the foreigner, just as inferior fruit does. The juice of the apple is naturally affected by the condition of the fruit itself, and if this be unripe, unsound, or worm-eaten the cider made from it will be inferior to that made from full-grown, ripe, and sound fruit. If such fruit be not good enough to send to market, neither will the cider made from it be good enough to place before the public. Nevertheless, it may furnish a sufficiently palatable drink for home consumption, and may therefore be so utilized. But when, as happens from time to time in fruit-growing districts, there is a glut, and even the best table fruit is not saleable at a profit, then, indeed, cider-making is a means of storing in a liquid form what would otherwise be left to rot on the ground; whilst if a proportion of vintage fruit were mixed therewith, a drink would be produced which would not discredit the cider trade, and would bring a fair return to the maker. (C. W. R. C.)

**Ciechanow,** a district town of Russian Poland, government Plock, on the Prussian frontier, 105 miles north-west of Warsaw. Population, 10,670.

**Cienfuegos,** one of the principal cities of Cuba, near the central portion of the south coast. It lies on a land-locked harbour known as the bay of Jagua, which Columbus visited on his second voyage, and which Father Las Casas described as the most magnificent port in the world. It was settled in 1819 by refugees from Santo Domingo. Since 1880 its trade has increased enormously. A circular railway leads to the wharves and large warehouses, thereby facilitating the loading and unloading of vessels. Many local steamers connect the town with Batabano, Trinidad, Santiago, and the Isle of Pines. The streets are regularly laid out; the houses are well built, and there are beautiful shade trees and plazas, one of which is the largest in Cuba. There is a handsome main avenue, at the end of which are statues. It is lighted by gas and electricity, has abundant water-supply, excellent clubs, and a theatre. It has also an imposing governor's house, military and government hospitals, market-place, and railway station. Some of the largest and finest sugar estates in the world are situated in the vicinity, including the Soledad and others. Probably no place on the island offers greater advantages for seeing sugar-making in its most favourable aspects. Population (1899), 30,038.

**Cieza,** a town of Murcia, Spain, on the railway and high road from Madrid to Cartagena, and on the river Sigura. Population (1897), 11,717. Its environs are very fertile, and produce cereals, raisins, oranges, olive, spart grass. In the town itself are flour and paper mills, sawmills, distilleries. The streets are broad, and have fine private residences, a modern town hall on the principal square, a large renaissance parish church, and a promenade styled La Glorieta.

**Cilicia,** the Roman Province, extended along the south coast of Asia Minor from the *Alara Su*, which separated it from Pamphylia, to the *Giaour Dagh*, M. Amanus, which parted it from Syria. Its northern limit was the crest of M. Taurus; its southern the sea. It was naturally divided into Cilicia Trachea, west of the *Lamas Su*, and Cilicia Pedias, east of that river. Cilicia Trachea is a rugged mountain district formed by the spurs of Taurus, which run southwards to the sea, and often terminate in rocky headlands with small sheltered harbours,—a feature which, in classical times, made the coast a favourite resort of pirates, and, in the Middle Ages, led to its occupation by Genoese and Venetian traders. The district is watered by the *Geuk Su* (Calycadnus and its tributaries), and is covered to a large extent by forests which still, as of old, supply timber to Egypt and Syria. There were several towns but no large trade centres. In the interior were Koropissus (*Da Bazár*), Olba (*Uzunjaburj*), and, in the valley of the Calycadnus, Claudiopolis (*Mút*), and Germanicopolis (*Ermenek*). On, or near the coast were Coracesium (*Alaya*), Selinus-Trajanopolis (*Selinti*), Anemeurium, Kelenderis (*Kilindria*), Seleucia (*Selefke*), Korykus (*Korghoz*), and Elæusa-Sebaste (*Ayash*). Roads connected Laranda, north of the Taurus, with Kelenderis and Seleuceia.

Cilicia Pedias included the rugged spurs of Taurus and a large plain which consists, in great part, of a rich stoneless loam. Its eastern half is studded with isolated rocky crags, which are crowned with the ruins of ancient strongholds, and broken by the low hills that border the plain of Issus. The plain is watered by the Cydnus (*Tersus Chai*), the Sarus (*Sihún*), and the Pyramus (*Jihún*), each of which brings down much silt. The Sarus now enters the sea almost due south of Tarsus, but there are clear indications that at one period it joined the Pyramus, and that the united rivers ran to the sea west of *Kara-tash*. Such appears to have been the case when Alexander's army crossed Cilicia. The plain is extremely productive, though now little cultivated (see ADANA). Through it ran the great highway, between the east and the west, on which stood Tarsus on the Cydnus, Adana on the Sarus, and Mopsuestia (*Missis*), on the Pyramus. North of the road between the two last places were Sision-Flaviopolis (*Sis*), Anazarbus (*Anazarba*), and Hieropolis-Kastabala (*Budrúm*); and on the coast were Soli-Pompeiopolis, Mallus (*Kara-tash*), Ægæ (*Ayash*), Issus, Baiæ (*Piyas*), and Alexandria ad Issum (*Alexandretta*). The great highway from the west, on its long rough descent from the Anatolian plateau to Tarsus, ran through a narrow pass between walls of rock called the Cilician Gate, *Ghulek Boghaz*. After crossing the low hills east of the Pyramus it passed through a masonry (Cilician) gate, *Demir Kapu*, and entered the plain of Issus. From that plain one road ran southward through a

masonry (Syrian) gate to Alexandretta and thence crossed M. Amanus by the Syrian Gate, *Beilan Pass*, to Antioch and Syria; and another ran northwards through a masonry (Amanian) gate, south of *Toprak Kaleh*, and crossed M. Amanus by the Amanian Gate, *Baghche Pass*, to North Syria and the Euphrates. By the last pass, which was apparently unknown to Alexander, Darius crossed the mountains prior to the battle of Issus. Both passes are short and easy, and connect Cilicia Pedias geographically and politically with Syria rather than with Asia Minor. Another important road connected Sision with Kokusos and Melitene. In Roman times Cilicia exported the goats'-hair cloth, Cilicium, of which tents were made.

Cilicia has been identified by some authorities with the Kuah and Helak of the emended texts of 1 Kings x. 28, and Ezek. xxvii. 11, and by Maspero with the Keti of the Egyptian inscriptions. The Cilicians appear to have belonged to that great family of non-Aryan tribes which included the Syro-Cappadocians, or Hittites, and the Proto-Armenians. Under the Persian Empire, Cilicia was apparently governed by tributary native kings who bore the name Syennesis. After Alexander's death it was loosely held by the Seleucid kings, and Cilicia Trachea became the haunt of pirates who were subdued by Pompey. Cilicia Pedias became Roman territory in 103 B.C., and the whole was organized by Pompey, 64 B.C., into a province which extended to and included part of Phrygia. It was reorganized by Cæsar, 47 B.C., and about 27 B.C. became part of the province Syria-Cilicia-Phœnice. At first the western district was left independent under native kings or priest-dynasts, and a small kingdom, under Tarkondimotus, was left in the east; but these were finally united to the province by Vespasian, A.D. 74. Under Diocletian, *circ.* 297, Cilicia, with the Syrian and Egyptian provinces, formed the Diocesis Orientis. In the 7th century it was invaded by the Arabs, who held the country until it was re-occupied by Nicephorus II. in 965.

The Seljúk invasion of Armenia was followed by an exodus of Armenians southwards, and in 1080 Rhupen, a relative of the last king of Ani, founded in the heart of the Cilician Taurus a small principality which gradually expanded into the kingdom of Lesser Armenia. This Christian kingdom—situated in the midst of Moslem states, hostile to the Byzantines, giving valuable support to the leaders of the Crusades, and trading with the great commercial cities of Italy—had a stormy existence of about 300 years. Gosdantin I. (1095–1100) assisted the Crusaders on their march to Antioch, and was created knight and marquis. Thoros I. (1100–1123), in alliance with the Christian princes of Syria, waged successful war against Byzantines and Seljúks. Levond II., "the Great" (1185–1219), extended the kingdom beyond Mount Taurus and established the capital at Sis. He assisted the Crusaders, and was crowned king by the archbishop of Mayence, and married one of the Lusignans of Cyprus. Haithon I. (1224–69) made an alliance with the Mongols, who, before their adoption of Islám, protected his kingdom from the Memlúks of Egypt. When Levond V. died (1342), John of Lusignan was crowned king as Gosdantin IV.; but he and his successors alienated the Armenians by attempting to make them conform to the Roman Church, and by giving all posts of honour to Latins, and at last the kingdom, a prey to internal dissensions, succumbed (1375) to the attacks of the Egyptians. Cilicia Trachea was occupied by the Osmanlis in the 15th century, but C. Pedias was only added to the empire in 1515. From 1833 to 1840 Cilicia formed part of the dominion of Mahommed Ali, who was compelled to evacuate it by the Allied Powers.

RAMSAY. *Historical Geography of Asia Minor*, 1890.—BENT and HICKS in *Journal of Hellenic Studies*, 1890.—STERRETT in *Journal Archæolog. Inst. of America*, 1884–85.—MARQUARDT. *Römische Staatsverwaltung*. (C. W. W.)

**Cilli** (*Slovene*, CELJE), an old and picturesque town with special charter and seat of a district administration in Styria (Austria). It is situated on the left bank of the Sann river, and is a station on the Southern Railway from Vienna to Trieste. Apart from the parish church, dating from the 14th century, Cilli furnishes some interesting specimens of mediæval architecture, such as the beautiful Gothic chapel and the so-called German church in the Romanesque style. Remains of the old walls and towers with which the town was once surrounded are yet visible, and memorials of a still earlier period of its history—Roman antiquities—are to be seen in the municipal museum. Cilli owes a good deal of its recent prosperity to the growing popularity of its river baths, which have converted it into a favourite summer resort. During the bathing season the water has a temperature of 75° to 85° Fahr. It has also a considerable trade in timber, iron, leather, corn, and coal, while its industries include zinc smelting and metal works, and the manufacture of chemicals, explosives, veneers, leather, brick and tiles, flour and beer. The town has latterly taken a somewhat prominent part in the nationality struggle; it was an educational concession to the Slovene element of the population which brought about the fall of the German, Clerical, and Polish coalition in June 1895. Population (1890), 6264; (1900), 6743 (about 75 per cent. German, and 25 per cent. Slovene; 99 per cent. Roman Catholic, and 1 per cent. Protestant).

Cilli, which is mentioned by the Elder Pliny, and whose origin was attributed to the Celts, was taken possession of by the Romans (15 B.C.) under the Emperor Claudius and received the name of Claudia Celeja. It was incorporated with Aquileia, under Constantine; and towards the end of the 6th century was destroyed by the invading Slavs. It had a period of exceptional prosperity from the middle of the 14th to the latter half of the 15th century under the Counts of Cilli, on the extinction of which family it fell to Austria. In the 16th century it suffered greatly both from revolts of the peasantry and from the Counter-Reformation, Protestantism having made many converts in the district, particularly among the nobles. (Æ. O'N.)

**Cincinnati**, the capital of Hamilton county, Ohio, U.S.A., situated on the north bank of the Ohio river, N. lat. 39° 6′, W. long. 84° 26′, the tenth city in population in the Union. The population in 1890 was 296,908, 71,408 being foreign-born, chiefly German, Irish, British, and Russian; in 1900 it was 325,902, of whom 57,961 were foreign-born and 14,482 were negroes. These figures do not include suburbs, with an estimated population of 60,000; nor the cities of Covington and Newport and adjoining towns on the south bank of the Ohio, with a population of 71,329. Five bridges connect Cincinnati with these cities, over three of which trolley cars run. There are forty-four lines of street cars extending many miles in all directions from a common central point in the city. These have pushed the area of residence and manufacture far beyond the surrounding hills on which are the original suburbs. The hill-tops are also reached by four inclined-plane cable railways. The climate is salubrious; the mean temperature in summer is 75·5° F., in winter 38·1°, and for the year 55·9°. The mean relative humidity is 71 per cent. According to the U.S. census, the death-rate of Cincinnati in 1890 was 21·0; in 1900 it was 19·2, showing a considerable decrease. There are 376 miles of improved streets largely paved with granite, asphalt, and brick. The adjoining parts of Ohio, Indiana, and Kentucky are thickly settled, and Cincinnati is the commercial centre of a rich, fertile, and populous region comprising parts of ten states. Sixteen lines of railway enter it from all directions, one of which—that to Chattanooga, 334 miles long—was built and is owned by the city. It cost $18,000,000, and is run by a lessee, at an annual rental of $1,000,000. Steam river navigation has declined as railways have increased, there being, in 1899, ninety vessels registered with a tonnage of 16,827. The National Government has improved and lighted the channel, and large quantities of coal, ore, iron, lumber, and salt float down in flatboats. Cincinnati is a growing seat of education. Besides the university of Cincinnati, with law, medical, and other departments, it contains St Xavier and other colleges and schools for general and special instruction, a college of music, an art school, a technical school, a mechanics' institute, a college of pharmacy, and a Hebrew union college for the education of rabbis, which is the only one of the kind in the United States. Scientific, social, historical, political, and other societies are numerous, many having buildings and libraries. There are 246 churches of 25

sects. There are 1 city, 1 United States, 4 private and 11 charity hospitals. A fresh-air home and farm for poor children has been established by private subscriptions. The art museum in Eden Park with galleries, &c. (cost of building, $350,000; endowment, $580,000), and separate buildings for art school and library, are the gift of citizens; as are also the music hall, with a seating capacity of 5000, where musical festivals occur biennially; and the library and two other buildings of the university in Burnet Woods Park. A large, well-appointed zoological garden is privately maintained, but not for profit. Among other new buildings are the United States building, which cost $5,000,000; the city hall, which cost $1,500,000; the court house, which replaces that burned by a mob in 1884; Chamber of Commerce, Armoury, Turner's hall, Odd Fellows' temple, Young Men's Christian Association, Union Trust Co., 17 storeys high; Queen City, Phœnix, and Cincinnati clubs. In the parks are statues of Presidents W. H. Harrison, Garfield, and Lincoln, and of Captain Desmond, killed in defending the court house. There are 11 daily newspapers and 214 other regular publications. The central situation of the city and its accessibility make it a common meeting-place for general bodies. The government is by a mayor, a board of legislation, and a general administrative board of public service of five members, all elective. The rate of taxation is 2·574 per cent; the public debt $25,546,456.43 (including the cost of the railway to Chattanooga); the city's credit is high, 3 per cent. bonds commanding a premium. The greatest recent growth of Cincinnati has been industrial. There are over 200 industries.

| Year. | Establishments. | Cash Capital and Property occupied. | Hands employed. | Products. |
|---|---|---|---|---|
| 1880 | 5493 | $108,635,220 | 74,798 | $148,957,280 |
| 1890 | 7832 | 136,419,558 | 96,689 | 196,063,983 |
| 1898 | 8667 | 171,581,264 | 115,944 | 236,162,060 |

Cincinnati ranks first in the United States in the manufacture of vehicles, harness, leather, hardwood lumber, wood-working machinery, machine tools, printing ink, soap, pig-iron, tobacco, and whisky, second in that of shoes, and fourth in that of clothing, cooperage, and pianos. The statistics for 1899 were :—

| | |
|---|---|
| Clothing | $25,457,000 |
| Cooperage | 3,288,500 |
| Harness | 5,250,000 |
| Hardwood lumber | 24,000,000 |
| Leather | 4,664,000 |
| Machine tools | 3,340,000 |
| Pianos | 2,500,000 |
| Pig-iron | 38,375,000 |
| Printing ink | 1,000,000 |
| Shoes | 9,619,838 |
| Soap | 9,826,500 |
| Tobacco | 9,256,414 |
| Vehicles | 9,750,000 |
| Whisky | 38,603,000 |
| Wood-working machinery | 1,550,000 |

There are 19 banks—other than Savings and Building and Loan Associations, which are numerous—with a capital of $8,415,000, and total clearings in 1899 of $748,490,350. (J. HA.)

**Cinematograph.**—The cinematograph is an application of photography to the zoëtrope. This apparatus shows in rapid sequence a series of views representing closely successive phases of a moving object, and persistence of vision creates the illusion that the object is in motion. The cinematograph, invented by Edison in 1894, is the result of the introduction of the flexible film into photography in place of glass. A long sensitized film is moved across the focal plane of a camera and exposed intermittently to moving objects. A series of images results, which when passed in rapid and intermittent succession before the eye gives the appearance of a photograph in motion. The original apparatus showed the film to a single observer, but in its perfected form it throws the successive images on a screen by means of a lantern so that an entire audience can see them. In one apparatus for making the exposures a cam jerks the film across the field once for each picture, the slack being gathered in on a drum at a constant rate. In another four lenses are rotated so as to give four images for each rotation, the film travelling so as to present a new portion in the field as each lens comes in place. Twenty-five to fifty pictures may be taken per second. At the slower rate it is found in practice that during the operation the film should be stationary about $\frac{1}{1}\frac{1}{2}$ths of the time. The films are developed on large drums, within which a ruby electric light may be fixed to enable the process to be watched. In the magic lantern an electric lamp or limelight of high power projects, through an objective lens, the successive images of the film upon a distant screen. Such subjects as an army on the march, or an express train at full speed, are presented with marvellous distinctness and completeness of detail. To regulate the feed in the lantern a hole is punched in the film for each picture. These holes must be extremely accurate in position. As they wear the feed becomes irregular, and the picture dances or vibrates in an unpleasant manner. For an hour's exhibition 50,000 to 165,000 pictures are needed, and they are fed at the rate of 26 miles an hour. A very simple system of exhibiting the views consists in attaching them by their lower edge transversely to a band which moves over two rollers. A detent at the top holds back the top edges so that they fly across, as the band rotates, like the leaves of a book. By looking at them at this point the effect of motion is produced. This method has been so simplified that little books of cinetoscopic views are sold, from which the moving effect is obtained by simply letting the leaves escape rapidly from the thumb as the book is bent backwards. (T. O'C. S.)

**Cintra,** a picturesque town of Portugal, district Lisbon, 16 miles north-west from Lisbon, in great repute as a summer resort owing to its salubrious climate. Many new villas have recently been built. Population, 4928.

**Ciotat, La,** a coast town and railway station, France, department of Bouches-du-Rhône, arrondissement of Marseilles, 20 miles south-east of that town. The port, easily accessible for vessels drawing 19 feet, is well sheltered, and defended by a battery. Large shipbuilding yards and repairing docks give employment to about 3000 workmen. Other important industries are the fisheries and the coral fishery. Coasting trade is actively carried on; the town is frequented for sea-bathing. Population (1881), 8045; (1901), 11,311.

**Circleville,** capital of Pickaway county, Ohio, U.S.A., on the east bank of Scioto river, which here is not navigable. It is on the Cincinnati and Muskingum Valley, and the Norfolk and Western Railways, at an altitude of 707 feet. Its manufactures consist in large part of furniture and agricultural implements. It occupies the site of ancient earthworks of the mound-builders, from one of which, a circle, it derives its name. Population (1880), 6046; (1900), 6991.

**Circulation of the blood.** See under PHYSIOLOGY (*Vascular System*) and PATHOLOGY (*Circulation*).

**Cittadella,** a town of Italy, Venetia, province of Padua, 23 miles north by west from Padua. It is still

surrounded with mediæval walls and towers, and possessed of a fine parish church, theatre, and botanical garden. It was founded in 1220 as a border defence of the people of Padua against Treviso. It has a technical school. Population, about 9500.

**Cittanova,** a town of Calabria, Italy, province of Reggio, 31 miles north-east from Reggio. It was built up out of the ruins of the former Casalnuovo (destroyed by an earthquake in 1783), and took its present name in 1852. It has olive-oil presses. Population, about 11,400.

**Ciudad Bolivar,** capital of the state of Bolivar in Venezuela, on the right bank of the Orinoco river, about 240 miles from the mouth, at an elevation of 187 feet above the sea. Up to 1846 it was known as Angostura. Its population numbers over 15,000. It is a great commercial centre for the whole Guiana region; the port through which all the gold is exported; maintains steamship communication with Trinidad; and is the starting-point for the steamers furnishing the mail, passenger, and freight service to all points on the upper Orinoco and between Apure and Nutrias. The market, cathedral, masonic temple, custom-house, university, and theatre are the most important buildings. The customs receipts for the year ending 30th June 1896 were 3,285,371 bolivars. The returns of shipping for 1898 were—entered 70 ships of 22,326 tons, cleared 59 ships of 21,762 tons. The value of the exports in 1897 was £339,197, and in 1898 it was £354,008. In 1897 the imports were valued at £243,845, and in 1898 at £233,800.

**Ciudad Real,** a province of South Central Spain divided into 10 administrative districts and 96 parishes, with an area of 7840 square miles. The population was 292,291 in 1887 and 305,002 in 1897. Only about 8000 acres are properly irrigated, 670,000 acres are covered with forests, and about 1200 square miles are covered with sparse vegetation and meagre brushwood. It is the grazing ground of large flocks, but the locust plague often destroys vast extents of pasture. Some of the rivers of Ciudad Real, like the Yavalon and Azuel, curiously rise from chalky soil, and from their very sources give abundant supplies of water to many mills. Almost the whole province is in the upper basin of the Guadiana, except the southernmost part, where several tributaries of the Guadalquivir water some districts. The means of communication, except the railways, are in a very bad condition. In 1897, out of 53,944 boys and girls between the ages of 4 and 14, there were 32,338 on the school registers, but only 22,601 really attended classes. The province has 280 miles of railways, and one will connect the important coal-mines of Puertollano with Cordova. One quicksilver, one zinc, 6 coal, and 18 lead mines were worked in 1898. The province produced 19,945 tons of quicksilver ore, 201,097 of coal, 4261 of lead, and 23,514 of argentiferous lead. The net increase of coal was 70,550 tons in 1898, being 54 per cent. over the figures of 1897. The mines employed in all 5257 men, 679 lads, 177 women. The live stock includes 12,001 horses, 36,051 mules, 33,380 asses, 21,680 cattle, 337,892 sheep, 196,501 goats, and 57,790 pigs. 288,437 acres are devoted to wheat crops, 136,037 to barley, 15,042 to rye, 7607 to oats, 3688 to pod fruit, 150,744 to vines, 80,045 to olives.

**Ciudad Real,** the capital of the above province, had a population of 14,700 in 1887, and 14,547 in 1897. It has fine modern schools, an institute, a training school for teachers, and some good public buildings, town hall, barracks, casinos, prison. The chief commerce of the town is in agricultural products and live stock at the weekly fairs.

**Civil List.**—The civil list is the account in which are contained all the expenses immediately applicable to the support of the British sovereign's household and the honour and dignity of the crown. An annual sum is settled by Parliament at the beginning of the reign on the sovereign, and is charged on the Consolidated Fund. But it is only from the reign of William IV. that the sum thus voted has been restricted solely to the personal expenses of the crown. Before his accession many charges properly belonging to the ordinary expenses of Government had been placed on the civil list. The history of the civil list dates from the reign of William and Mary. Before the Revolution no distinction had been made between the expenses of Government in time of peace and the expenses relating to the personal dignity and support of the sovereign. The ordinary revenues derived from the hereditary revenues of the crown, and from certain taxes voted for life to the king at the beginning of each reign, were supposed to provide for the support of the sovereign's dignity and the civil Government, as well as for the public defence in time of peace. Any saving made by the king in the expenditure touching the government of the country or its defence would go to swell his privy purse. But with the Revolution a step forward was made towards the establishment of the principle that the expenses relating to the support of the crown should be separated from the ordinary expenses of the State. The evils of the old system under which no appropriation was made of the ordinary revenue granted to the crown for life had been made manifest in the reign of Charles II. and James II.; it was their control of these large revenues that made them so independent of Parliament. Moreover, while the civil Government and the defences suffered, the king could use these revenues as he liked. The Parliament of William and Mary fixed the revenue of the crown in time of peace at £1,200,000 per annum; of this sum about £700,000 was appropriated towards the "civil list." But from this the sovereign was to defray the expenses of the civil service and the payment of pensions, as well as the cost of the support of the royal household and his own personal expenses. It was from this that the term "civil list" arose, to distinguish it from the statement of military and naval charges. The revenue voted to meet the civil list consisted of the hereditary revenues of the crown and a part of the excise duties. Certain changes and additions were made in the sources of revenue thus appropriated between the reign of William and Mary and the accession of George III., when a different system was adopted. Generally speaking, however, the sources of revenue remained as settled at the Revolution.

*History.*

Anne had the same civil list, estimated to produce an annual income of £700,000. During her reign a debt of £1,200,000 was incurred. This debt was paid by Parliament and charged on the civil list itself. George I. enjoyed the same revenue by parliamentary grant, in addition to an annual sum of £120,000 on the Aggregate Fund. A debt of £1,000,000 was incurred, and discharged by Parliament in the same manner as Anne's debt had been. To George II. a civil list of £800,000 as a minimum was granted, Parliament undertaking to make up any deficiency if the sources of income appropriated to its service fell short of that sum. Thus in 1746 a debt of £456,000 was paid by Parliament on the civil list. On the accession of George III. a change was made in the system of the civil list. Hitherto the sources of revenue appropriated to the service of the civil list had been settled on the crown. If these revenues exceeded the sum they were computed to produce annually, the surplus went to the king. George III., however, surrendered the life-interest in the hereditary

*Anne, George I., and George II.*

*George III.*

revenues and the excise duties hitherto voted to defray the civil list expenditure, and any claim to a surplus for a fixed amount. The king still retained other large sources of revenue which were not included in the civil list, and were free from the control of Parliament. The revenues from which the civil list had been defrayed were henceforward to be carried into, and made part of, the Aggregate Fund. In their place a fixed civil list was granted—at first of £723,000 per annum, to be increased to £800,000 on the falling in of certain annuities to members of the royal family. From this £800,000 the king's household and the honour and dignity of the crown were to be supported, as well as the Civil Service offices, pensions, and other charges still laid on the list.

During the reign of George III. the civil list played an important part in the history of the struggle on the part of the king to establish the royal ascendancy. From the revenue appropriated to its service came a large portion of the money employed by the king in creating places and pensions for his supporters in Parliament, and, under the colour of the royal bounty, bribery was practised on a large scale. No limit was set to the amount applicable to the pensions charged on the civil list, so long as the sum granted could meet the demand; and there was no principle on which the grant was regulated. Secret pensions at the king's pleasure were paid out of it, and in every way the independence of Parliament was menaced; and though the more legitimate expenses of the royal household were diminished by the king's penurious style of living, and though many charges not directly connected with the king's personal expenditure were removed, the amount was constantly exceeded, and applications were made from time to time to Parliament to pay off debts incurred; and thus opportunity was given for criticism. In 1769 a debt of £513,511 was paid off in arrears; and in spite of the demand for accounts and for an inquiry into the cause of the debt, the ministry succeeded in securing this vote without granting such information. All attempts to investigate the civil list were successfully resisted, though Lord Chatham went so far as to declare himself convinced that the funds were expended in corrupting members of Parliament. Again, in 1777, an application was made to Parliament to pay off £618,340 of debts; and in view of the growing discontent Lord North no longer dared to withhold accounts. Yet, in spite of strong opposition and free criticism, not only was the amount voted, but also a further £100,000 per annum, thus raising the civil list to an annual sum of £900,000.

*Indebtedness of civil list.*

In 1779, at a time when the expenditure of the country and the national debt had been enormously increased by the American war, the general dissatisfaction found voice in Parliament, and the abuses of the civil list were specially singled out for attack. Many petitions were presented to the House of Commons praying for its reduction, and a motion was made in the House of Lords in the same sense, though it was rejected. In 1780 Burke brought forward his scheme of economic reform, but his name was already associated with the growing desire to remedy the evils of the civil list by the publication in 1769 of his pamphlet on "The Causes of the Present Discontent." In this scheme Burke freely animadverts on the profusion and abuse of the civil list, criticizing the useless and obsolete offices and the offices performed by deputy. In every department he discovers jobbery, waste, and peculation. His proposal was that the many offices should be reduced and consolidated, that the pension list should be brought down to a fixed sum of £60,000 per annum, and that pensions should be conferred only to reward merit or fulfil real public charity. All pensions were to be paid at the Exchequer. He proposed also that the civil list should be divided into classes, an arrangement which later was carried into effect. In 1780 Burke succeeded in bringing in his Establishment Bill; but though at first it met with considerable support, and was even read a second time, Lord North's Government defeated it in committee. The next year the Bill was again introduced into the House of Commons, and Pitt made his first speech in its favour. The Bill was, however, lost on the second reading.

In 1782 the Rockingham Ministry, pledged to economic reform, came into power; and the Civil List Act, 1782, was introduced and carried with the express object of limiting the patronage and influence of ministers, or, in other words, the ascendancy of the crown over Parliament. Not only did the Act effect the abolition of a number of useless offices, but it also imposed restraints on the issue of secret service money, and made provision for a more effectual supervision of the royal expenditure. As to the pension list, the annual amount was to be limited to £95,000; no pension to any one person was to exceed £1200, and all pensions were to be paid at the Exchequer, thus putting a stop to the secret pensions payable during pleasure. Moreover, pensions were only to be bestowed in the way of royal bounty for persons in distress or as a reward for merit. Another very important change was made by this Act: the civil list was divided into classes, and a fixed amount was to be appropriated to each class. The following were the classes:—

*Civil List Act, 1782.*

1. Pensions and allowances of the royal family.
2. Payment of salaries of Lord Chancellor, Speaker, and judges.
3. Salaries of ministers to foreign courts resident at the same.
4. Approved bills of tradesmen, artificers, and labourers for any article supplied and work done for His Majesty's service.
5. Menial servants of the household.
6. Pension list.
7. Salaries of all other places payable out of the civil list revenues.
8. Salaries and pensions of treasurer or commissioners of the treasury and of the Chancellor of the Exchequer.

Yet debt was still the condition of the civil list down to the end of the reign, in spite of the reforms established by the Rockingham Ministry, and notwithstanding the removal from the list of many charges unconnected with the king's personal expenses. The debts discharged by Parliament between 1782, the date of the passing of the Civil List Act, and the end of George III.'s reign, amounted to £2,300,000. In all, during his reign £3,398,061 of debt owing by the civil list was paid off.

With the regency the civil list was increased by £70,000 per annum, and a special grant of £100,000 was settled on the Prince Regent. In 1816 the annual amount was settled at £1,083,727, including the establishment of the king, now insane; though the civil list was relieved from some annuities payable to the royal family. Nevertheless, the fund still continued charged with such civil expenses as the salaries of judges, ambassadors, and officers of state, and with pensions granted for public services. Other reforms were made as regards the definition of the several classes of expenditure, while the expenses of the royal household were henceforth to be audited by a Treasury official—the auditor of the civil list. On the accession of George IV. the civil list, freed from the expenses of the late king, was settled at £845,727. On William IV. coming to the throne a sum of £510,000 per annum was fixed for the service of the civil list. The king at the same time surrendered all the sources of revenue enjoyed by his predecessors, apart from the civil list, represented by the hereditary revenues of Scotland—the Irish civil list, the droits of the crown and admiralty, the 4½ per cent. duties, the West India duties, and other

casual revenues hitherto vested in the crown, and independent of Parliament. The revenues of the duchy of Lancaster were still retained by the crown. In return for this surrender and the diminished sum voted, the civil list was relieved from all the charges relating rather to the civil Government than to the support of the dignity of the crown and the royal household. The future expenditure was divided into five classes, and a fixed annual sum was appropriated to each class. The pension list was reduced to £75,000. The king resisted an attempt on the part of the select committee to reduce the salaries of the officers of state on the grounds that this touched his prerogative, and the ministry of Earl Grey yielded to his remonstrance.

The civil list of Queen Victoria was settled on the same principles as that of William IV. A considerable reduction was made in the aggregate annual sum voted, from £510,000 to £385,000, and the pension list was separated from the ordinary civil list. The civil list proper was divided into the following five classes, with a fixed sum appropriated to each:—

*Queen Victoria's civil list.*

| | |
|---|---|
| Privy purse | £60,000 |
| Salaries of household | 131,260 |
| Expenses of household | 172,500 |
| Royal bounty, &c. | 13,200 |
| Unappropriated | 8,040 |

In addition the Queen might, on the advice of her ministers, grant pensions up to £1200 per annum, in accordance with a resolution of the House of Commons of 18th February 1834, "to such persons as have just claims on the royal beneficence, or who, by their personal services to the crown, by the performance of duties to the public, or by their useful discoveries in science and attainments in literature and art, have merited the gracious consideration of the sovereign and the gratitude of their country." The service of these pensions increased the annual sum devoted to support the dignity of the crown and the expenses of the household to about £409,000. The list of pensions must be laid before Parliament within thirty days of 20th June. Thus the civil list was reduced in amount, and relieved from the very charges which gave it its name as distinct from the statement of military and naval charges. It now really only dealt with the support of the dignity and honour of the crown and the royal household. The arrangement was most successful, and during the last three reigns there was no application to Parliament for the discharge of debts incurred on the civil list.

The death of Queen Victoria rendered it necessary that a renewed provision should be made for the civil list; and King Edward VII., following former precedents, placed unreservedly at the disposal of Parliament his hereditary revenues. A select committee of the House of Commons was appointed to consider the provisions of the civil list for the crown, and to report also on the question of grants for the honourable support and maintenance of Her Majesty the Queen and the members of the royal family. The committee in their conclusions were guided to a considerable extent by the actual civil list expenditure during the last ten years of the last reign, and made certain recommendations which, without undue interference with the sovereign's personal arrangements, tended towards increased efficiency and economy in the support of the sovereign's household and the honour and dignity of the crown. On their report was based the Civil List Act, 1901, which established the new civil list. The system that the hereditary revenues should as before be paid into the exchequer and be part of the consolidated fund was maintained. The amount payable for the civil list was increased from £385,000 to £470,000. In the application of this sum the number of classes of expenditure to which separate amounts are to be appropriated is increased from five to six. The following is the new arrangement of classes:—1st class, Their Majesties' privy purse, £110,000; 2nd class, salaries of His Majesty's household and retired allowances, £125,800; 3rd class, expenses of His Majesty's household, £193,000; 4th class, works (the interior repair and decoration of Buckingham Palace and Windsor Castle), £20,000; 5th class, royal bounty, alms, and special services, £13,200; 6th class, unappropriated, £8000. The system relating to civil list pensions, established by the Civil List Act, 1837, continues to apply, but the pensions are not to be regarded as chargeable on the sum paid for the civil list. The committee also advised that the mastership of the Buckhounds should not be continued; and His Majesty, on the advice of his ministers, agreed to accept their recommendation. The maintenance of the royal hunt thus ceases to be a charge on the civil list. The annuities of £20,000 to the prince of Wales, of £10,000 to the princess of Wales, and of £18,000 to His Majesty's three daughters, are not included in the civil list, though they are conferred by the same Act. Other grants made by special Acts of Parliament to members of the royal family are also excluded from it. (H. S. S.)

*Civil List Act, 1901.*

**Civil Service.** — *British Empire.* — The civil service is the generic name given to all public servants. It is the machinery by which the executive, through the various administrations, carries on the central government of the country. The cost of the civil services has increased of late years. The net total of the estimates for the civil services for 1901–2 was £23,630,120, as opposed to £22,838,808 for 1900–1. The increase (after the adjustment of certain items) was £783,812, as opposed to the increase of £659,143 in 1900–1.

The appointments to the civil service until the year 1855 were made by nomination, with an examination not sufficient to form an intellectual or even a physical test. It was only after much consideration and almost years of discussion that the nomination system was abandoned. Various commissions reported on the civil service, and Orders in Council were issued. Finally in 1855 a qualifying examination of a stringent character was instituted, and in 1870 the principle of open competition was adopted as a general rule. On the report of the Playfair Commission (1876), an Order in Council was issued dividing the civil service into an upper and lower division. The Order in Council directed that a lower division should be constituted, and men and boy clerks holding permanent positions replaced the temporary assistants and writers. The "temporary" assistant was not found to be advantageous to the service. In December 1886 a new class of assistant clerks was formed to replace the men copyists. In 1887 the Ridley Commission reported on the civil service establishment. In 1890 two Orders in Council were issued based on the reports of the Ridley Commission, which sat from 1886 to 1890. The first Order constituted what is now known as the second division of the civil service. The second Order in Council concerns the officers of the 1st class, and provision was made for the possible promotion of the second division clerks to the first division after eight years' service.

The whole system is under the administration of the Civil Service Commissioners, and power is given to them, with the approval of the Treasury, to prescribe the subjects of examination, limits of age, &c. The age is fixed for compulsory retirement at sixty-five. In exceptional cases a prolongation of five years is within the powers of the Civil

Service Commissioners. The examination for 1st class clerkships is held concurrently with that of the civil service of India and Eastern cadetships in the colonial service. Candidates can compete for all three or for two. In addition to the intellectual test the candidate must fulfil the conditions of age (22 to 24), must present recommendations as to character, pass a medical examination, and must also pay a fee of £6. The subjects include the language and literature of England, France, Germany, ancient Greece and Rome, Sanscrit and Arabic, mathematics (pure and applied), natural science, history (English, Greek, Roman, and general modern), political economy and economic history, mental and moral philosophy, Roman and English law and political science. The candidate is obliged to reach a certain standard of knowledge in each subject before any marks at all are allowed him. This rule was made to prevent success by mere cramming, and to ensure competent knowledge on the basis of real study. Clerks of Class I. are employed in the following departments and offices :—

Admiralty, Head Office and Outposts.
Agriculture, Board of.
Chief Secretary's Office, Ireland.
Civil Service Commission.
Colonial Office.
Constabulary, Ireland (Inspector-General's Office).
Customs.
Exchequer and Audit Departments.
Home Office.
India Office (Correspondence, Political, Accountant-General's Store and Audit Departments).
Inland Revenue.
Local Government Board, England and Ireland.
Lunacy Commission.
Patent Office.
Post Office.
Privy Council Office.
Record Offices, England and Ireland.
Science and Art Department.
Scottish Office.
Supreme Court Pay Office, England.
Trade, Board of.
Treasury.
War Office.

The maximum scale of the salaries of clerks of Class I. is as follows :—3rd class, £200 a year, increasing by £20 a year to £500; 2nd class, £600, increasing by £25 a year to £800; 1st class, £850, increasing by £50 a year to £1000. Their pensions are fixed by the Superannuation Act 1859, 22 Vict. c. 26 :—

"To any person who shall have served ten years and upwards, and under eleven years, an annual allowance of ten-sixtieths of the annual salary and emoluments of his office :

"For eleven years and under twelve years, an annual allowance of eleven-sixtieths of such salary and emoluments :

"And in like manner a further addition to the annual allowance of one-sixtieth in respect of each additional year of such service, until the completion of a period of service of forty years, when the annual allowance of forty-sixtieths may be granted ; and no additions shall be made in respect of any service beyond forty years."

The "ordinary annual holidays allowed to officers" (1st class) "shall not exceed thirty-six week-days during each of their first ten years of service and forty-eight week-days thereafter." Order in Council, 15th August 1890.

"Within that maximum heads of departments have now, as they have hitherto had, an absolute discretion in fixing the annual leave."

Sick leave can be granted on full salary for not more than six months, on half salary for another six months.

The scale of salary for 2nd division clerks begins at £70 a year, increasing by £5 to £100; then £100 a year, increasing by £7, 10s. to £190; and then £190 a year, increasing by £10 to £250. The highest is £300 to £500. Advancement in the 2nd division to the higher ranks depends on merit, not seniority. The ordinary annual holiday of the 2nd division clerks is 14 working days for the first five years, and 21 working days afterwards. They can be allowed sick leave for six months on full pay and six months on half pay. The subjects of their examination are :—(1) handwriting and orthography, including copying MS. ; (2) arithmetic ; (3) English composition ; (4) précis, including indexing and digest of returns ; (5) book-keeping and shorthand writing ; (6) geography and English history ; (7) Latin or French or German ; (8) elementary mathematics ; (9) inorganic chemistry with elements of physics. Not more than four of the subjects, (4) to (9), are to be taken. The candidate must be between the ages of 17 and 20. The fee is £2. A certain number of the places in the 2nd division were reserved for the candidates from the boy clerks appointed under the old system. The severity of the competition is shown by the fact that in February 1900 there were 932 candidates for 120 places. Candidates are allowed a choice of departments subject to the exigencies of the services. The departments are as follows :—

Agriculture, Board of.
Admiralty.
British Museum.
Chancery Department (Edinburgh).
Charity Commission.
Chelsea Hospital.
Chief Secretary's Office (Dublin).
Chief Secretary's Office, Veterinary Department.
Civil Service Commission.
Colonial Office.
Constabulary (Ireland), Inspector-General's Office.
Customs (London, Liverpool, and Outposts).
Deeds, Registry of (Dublin).
Dublin Metropolitan Police Office.
Education Department.
Exchequer and Audit Office.
Exchequer Office (Scotland).
Fisheries Office (Dublin).
Fishery Board (Scotland).
Foreign Office.
Friendly Societies Registry.
Home Office.
Inland Revenue—
  Offices in London.
  Offices in Edinburgh.
  Offices in Dublin.
Local Government Board (London).
Local Government Board (Edinburgh).
Local Government Board (Dublin).
Lunacy Commission.
Mint.
National Debt Office.
National Education Office (Dublin).
Paymaster-General's Office (London and Dublin).
Pay Office of the Supreme Court.
Post Office (London).
Post Office (Edinburgh).
Post Office (Dublin).
Prisons Board (Dublin).
Prisons Department (Edinburgh).
Privy Council Office.
Public Works Loan Office.
Public Works Office (Dublin).
Reformatories Office.
Registrar-General's Office (London).
Registrar-General's Office (Edinburgh).
Registrar-General's Office (Dublin).
Science and Art Department (London).
Science and Art Department (Dublin).
Scotland, Office of Secretary for.
Scottish Education Department.
Stationery Office.
Supreme Court of Judicature (Ireland) Accounting Office.
Teachers' Pension Office (Dublin).
Trade, Board of.
Trade, Board of ; Bankruptcy Department.
Trade, Board of ; Commercial, Labour, and Statistical Department.
Trade, Board of ; Patents Office.
Seamen's Registry Office.
Treasury.
Treasury, Remembrancer's Office (Dublin).
Valuation Office (Dublin).
War Office.
War Office, Royal Army Clothing Depot.
Works, Office of.

The total number of 2nd division clerks employed is 2945.

A new class of assistant clerks or abstractors was formed in 1886. The appointments are made from the ranks of the men copyists. The maximum salary is about £150. Now only 93 men copyists remain, so this source for candidates is practically exhausted, but open competition has not yet been instituted for the assistant clerkships. The subjects of the examination that is held are — handwriting, orthography, arithmetic, English composition, digesting returns into summaries, and geography. A competent amount of general proficiency is insisted upon. This new class has been introduced into the following offices :—Admiralty, Board of Agriculture, Census Office, Charity Commission, Customs, Education Department, General Registrar Office, Home Office, Irish Land Commission, Inland Revenue, Local Government Board (England and Ireland), General Post Office (Savings Bank Department, London and Dublin), Prisons Commission (England and Scotland), Public Works Loan Board, General Prisons Board (Ireland), Registrar-General's Office (Dublin), Science and Art Department, Seamen's Registry Office, Board of Trade, Treasury, War Office, and Office of Woods (Quit Rent Office, Dublin).

A new class of boy copyists has also been established. They are almost entirely employed in London, a few in Dublin and Edinburgh, and, very seldom, in some provincial towns. The subjects of their examination are : *Obligatory*—handwriting and orthography, arithmetic, and English composition. *Optional*—(any two of the following) : (1) copying MS. ; (2) geography ; (3)

English history; (4) translation from one of the following languages—Latin, French, or German; (5) Euclid, bk. i. and ii., and algebra, up to and including simple equations; (6) rudiments of chemistry and physics. Candidates must be between the ages of fifteen and eighteen. They have no claims to superannuation or compensation allowance. Boy copyists will not be retained after the age of twenty.

Candidates for the *Civil Service of India* take the same examination as for 1st class clerkships. Candidates successful in the examination must subsequently spend one year in England. They receive for that year £100 if they elect to live at one of the universities or colleges approved by the Secretary of State for India. At the close of this year they will be submitted to a final examination in the following subjects—Indian Penal Code and the Code of Criminal Procedure, the principal vernacular language of the province to which they are assigned, the Indian Evidence Act (these three subjects are compulsory), the Code of Civil Procedure and the Indian Contract Act, Hindu and Mahommedan Law, Sanscrit, Arabic, Persian, the history of British India, Chinese (for Burma only). Of these seven two are to be selected, but a candidate may not take Arabic or Sanscrit both in the first examination and in the final. They must also pass a thorough examination in riding, which is conducted at the Royal Artillery Riding School at Woolwich. On reaching India their salary begins at 400 rupees a month. In 1899 the value of the rupee was permanently fixed by Government at 1s. 4d. They may take, as leave, one-fourth of the time on active service in periods strictly limited by regulation. After twenty-five years' service (of which twenty-one must be active service) they can retire on a pension of £1000 a year. The unit of administration is the district. At the head of the district is an executive officer called either collector-magistrate or deputy-commissioner. In most provinces he is responsible to the commissioner, who corresponds directly with the provincial government. The Indian civilian after four years' probation in both branches of the service is called upon to elect whether he will enter the revenue or judicial department, and this choice as a rule is held to be final for his future work.

Candidates for the Indian Forest Service have to pass a competitive examination, one of the compulsory subjects being German. They have also to pass a severe medical examination, especially in their powers of vision and hearing. They must be between the ages of seventeen and twenty. Successful candidates are required to pass a three years' course, with a final examination, seven terms of the course at Cooper's Hill, the rest of the time receiving practical instruction in Continental forests. The obligatory expenses at Cooper's Hill are £61 a term, and £150 is charged for the time abroad. On reaching India they start as assistant conservators at 250 rupees a month. The highest salary, that of inspector-general of forests, in the India Forest Service is 2000 rupees a month.

The Indian Police Service is entered by a competitive examination of very much the same kind as for the Forests, except that special subjects such as German and botany are not included. The candidates are limited in age to nineteen and twenty-one. They must pass a riding examination. A free passage out is given them. They are allotted as probationers, their wishes being consulted as far as possible as to their province. A probationer receives 250 rupees a month. A district superintendent can rise to 1000 rupees a month, while there are a few posts with a salary of 2500 rupees a month in the Police Service. The leave and pension in both these departments follow the general rules for Indian services.

The Civil Service also includes student interpreterships for China, Japan, and Siam, and for the Ottoman dominions, Persia, Greece, and Morocco. Both these classes of student interpreters are selected by open competition. Their object is to supply the consular service in the above-named countries with persons having a thorough knowledge of the language of the country in which they serve.

In the first case, China, Japan, &c., they learn their language in the country itself, receiving £200 as probationers. Then they become assistants in a consulate. The highest post is that of consul-general. In the case of student interpreters for the Ottoman dominions, Persia, Greece, and Morocco, the successful candidates learn their languages at Oxford. Turkish is taught gratuitously, but they pay the usual fees for other languages. At Oxford they receive £200 a year for two years. On leaving Oxford they become assistants under the embassy at Constantinople, the legations at Teheran, Athens, or Morocco, or at one of H.B.M. consulates. As assistants they receive £300 a year. The consuls, the highest post to which they can reach, receive in the Levant from £500 to £1600 a year. The civil services of Ceylon, Hong-Kong, the Straits Settlements, and the Malay Peninsula are supplied by the Eastern cadetships. The limits of age for the examination are twenty-one and twenty-four. The cadets are required to learn the native language of the colony or dependency to which they are assigned. In the case of the Straits Settlements and Malay cadets they may have to learn Chinese or Tamil, as well as the native language. The salaries are: passed cadets, 3500 rupees per annum, gradually increasing until first-class officers receive from 12,000 to 18,000 rupees per annum. They are allowed three months' vacation on full pay in two years, and leave of absence on half pay after six years' service, or before that if urgently needed. They can retire for ill-health after ten years with fifteen-sixtieths of their annual salary. Otherwise they can add one-sixtieth of their annual salary to their pension for every additional year's service up to thirty-five years' service.

In spite of the general rule of open competition, there are still a few departments where the system of *nomination* obtains, accompanied by a severe test of knowledge. In the following offices it is so for some of the appointments.

Foreign Office (all the following posts):—8 ambassadors, 16 ministers plenipotentiary, 10 ministers resident, 2 agents and consuls-general, 8 secretaries of embassy, 15 secretaries of legation, 6 commercial attachés, 34 2nd secretaries, 23 3rd secretaries (attachés): Metropolitan police courts; mines; naval service, assistant clerks; post office secretary's office, supplementary, office of the controller of stores; British Museum; clerks of the two Houses of Parliament; Royal Irish Constabulary; Board of Education; Education Office for Ireland; Inspectors of Factories.

The employment of *women* in the Civil Service has not yet been much developed except in the Post Office. Women are employed in the Post Office as female clerks, counter clerks, telegraphists, returners, sorters, and post-mistresses all over the United Kingdom. In 1881 the Postmaster-General took a decided step in favour of female employment, and with the consent of the Treasury instituted *female clerkships*. Female clerks do not come in contact with the public. Their duties are purely clerical, and entirely in the accountant-general's department at the Savings Bank.

Their *leave* is one month per annum, their *pension* is on the ordinary Civil Service scale. The *examination* is competitive, the subjects are handwriting and spelling, arithmetic, English composition, geography, English history, French or German. Candidates must be between the ages of 18–20. Whether unmarried or widows they must resign on marriage. The class of *girl clerks* take the same subjects in a competitive examination. They must be between the ages of 16–18; they serve only in the Savings Bank department. If competent they can pass on later to female clerkships. The salaries of the female clerkships range from £200 to £500 in the higher grade, £55 to £190 in the 2nd class, whilst girl clerks are paid from £35 to £40, with the chance of advancement to higher posts. The total of women employed by the Post Office and telegraphs is not to be found in official returns, but women are now so largely employed not only in the higher grades, but as sorters, counter clerks, telegraphists in London and throughout the country that the aggregate number is very considerable. For instance, there are 778 sorters, counter clerks, and telegraphists in the Metropolitan district alone.

In other departments there is a notable increase in female employment. The Board of Agriculture, the Customs, and the India Office employ women. The Department of Agriculture, Technical Education, the Board of Education generally, the Local Government Board, all to a certain extent employ women, whilst in the Home Office there are seven women inspectors of Workshops and Factories. (JNO. S.)

*United States.*—Civil Service Reform, like other great administrative reforms, began in America in the latter half of the 19th century. Personal and partisan government, with

all the entailed evils of the patronage system, culminated in Great Britain during the reign of George III., and was one of the efficient causes of the American revolution. Trevelyan characterizes the use of patronage to influence legislation, and the giving of colonial positions as sinecures to the privileged classes and personal favourites of the administration, by saying, "It was a system which, as its one achievement of the first order, brought about the American war, and made England sick, once and for all, of the very name of personal Government." It was natural that the founders of the new Government in America, after breaking away from the mother-country, should strive to avoid the evils which had in a measure brought about the revolution. Their intention that the administrative officers of the Government should hold office during good behaviour is manifest, and was given thorough and practical effect by every administration during the first forty years of the life of the Government. The constitution fixed no term of office in the executive branch of the Government except those of president and vice-president; and Madison, the expounder of the constitution, held that the wanton removal of a meritorious officer was an impeachable offence. Not until nine years after the passage of the Four Years' Tenure of Office Act in 1820 was there any material departure from this traditional policy of the Government. This Act (suggested by an appointing officer who wished to use the power it gave in order to secure his own nomination for the presidency, and passed without debate and apparently without any adequate conception of its full effect) opened the doors of the service to all the evils of the "spoils system." The foremost statesmen of the time were not slow to perceive the baleful possibilities of this legislation, Jefferson,[1] Webster, Clay, Calhoun, Benton, and many others being recorded as condemning and deploring it in the strongest terms. The transition to the "spoils system" was not, however, immediate, and for the next nine years the practice of reappointing all meritorious officers was practically universal; but in 1829 this practice ceased and the Act of 1820 lent the sanction of law to the system of proscriptions which followed, which was a practical application of the theory that "to the victor belong the spoils of the enemy." In 1836 the provisions of this law, which had at first been confined mainly to officers connected with the collection of revenue, were extended to include also all postmasters receiving a compensation of $1000 per annum or more. It rapidly became the practice to regard all these four years' tenure offices as agencies not so much for the transaction of the public business as for the advancement of political ends. The revenue service from being used for political purposes merely came to be used for corrupt purposes as well, with the result that in one administration frauds were practised upon the Government to the extent of $75,000,000. The corrupting influences permeated the whole body politic. Political retainers were selected for appointment not on account of their ability to do certain work but because they were followers of certain politicians; these "public servants" acknowledged no obligation except to those politicians, and their public duties, if not entirely disregarded, were negligently and inefficiently performed. Thus grew a saturnalia of spoils and corruption which culminated in the assassination of a president.

*The "spoils" system.*

Acute conditions, not theories, give rise to reforms. In the congressional election of November 1882, following the assassination of President Garfield as an incident in the operation of the spoils system, the voice of the people commanding reform was unmistakable. Congress assembled in December 1882, and during the same month a bill looking to the improvement of the civil service, which had been pending in the Senate for nearly two years, was finally taken up and considered by that body. In the debate upon this bill its advocates declared that it would "vastly improve the whole civil service of the country," which they characterized as being at that time "inefficient, expensive, and extravagant, and in many instances corrupt."[2] This bill passed the Senate on 27th December 1882, and the House on 4th January 1883, and was signed by the president on 16th January 1883, coming into full operation on 16th July 1883. It is now the national civil service law. The fundamental principles of this law are:—(1) selection by competitive examination for all appointments to the "classified service," with a period of probationary service before absolute appointment; (2) apportionment among the states and territories, according to population, of all appointments in the departmental service at Washington; (3) freedom of all the employees of the Government from any necessity to contribute to political campaign funds or to render political services. For putting these principles into effect the Civil Service Commission was created, and penalties were imposed for the solicitation or collection from government employees of contributions for political purposes, and for the use of official positions in coercing political action. The commission, in addition to its regular duties of aiding in the preparation of civil service rules, of regulating and holding examinations, and certifying the results thereof for use in making appointments, and of keeping records of all changes in the service, was given authority to investigate and report upon any violations of the Act or rules. The "classified" service to which the Act applies has grown, by the action of successive presidents in progressively including various branches of the service within it, from 13,924 positions in 1883 to some 80,000 (in round numbers) in 1900, constituting now about 40 per cent. of the entire civil service of the Government and including practically all positions above the grade of mere labourer or workman to which appointment is *not* made directly by the president with the consent of the Senate.[3] A very large class to which the Act is expressly applicable, and which has not been brought within its provisions by executive action, is that of fourth-class postmasters, of whom there are between 70,000 and 80,000.

*Law of 1883.*

In order to provide registers of eligibles for the various grades of positions in the classified service, the United States Civil Service Commission now holds annually throughout the country about 300 different kinds of examinations. In the work of preparing these examinations and of marking the papers of competitors in them, the commission is authorized by law to avail itself, in addition to its own corps of trained men, of the services of the scientific and other experts in the various executive departments. In the work of holding the examinations it is aided by about 1300 local boards of examiners, which are its local representatives throughout the country and are located at the principal post offices, custom houses, and other government offices, being composed of three or more Federal employees in those offices. About 50,000 persons

[1] See letter to Monroe, 29th November 1820, Jefferson's *Writings*, vii. p. 190. A quotation from this letter is given at p. 454 of the *Fifteenth Report of the U.S. Civil Service Commission.*

[2] See *Senate Report No. 576*, 47th Congress, 1st session; also *U.S. Civil Service Commission's Third Report*, p. 16 *et seq.*, *Tenth Report*, pp. 136, 137, and *Fifteenth Report*, pp. 483, 484.

[3] The progressive classification of the executive civil service, showing the growth of the merit system, is discussed, with statistics, in the *U.S. Civil Service Commission's Sixteenth Report*, pp. 129–37. A revision of this discussion, with important additions, appears in the *Seventeenth Report.*

annually compete in these examinations, and about 10,000 of those who are successful receive appointments through regular certification. Persons thus appointed, however, must serve six months "on probation" before their appointment can be made absolute. At the end of this probation, if his service has not been satisfactory, the appointee is simply dropped; and the fact that less than 1 per cent. of those appointed prove thus deficient on trial is high testimony to the practical nature of the examinations held by the commission, and to their aptness for securing persons qualified for all classes of positions.

The effects of the Civil Service Act within the scope of its actual operation have amply justified the hopes and promises of its advocates. After its passage, absentee holders of lucrative appointments were required to report for duty or to sever their connexion with the service. Improved methods were adopted in the departments, and superfluous and useless work was no longer devised in order to provide a show of employment and a *locus standi* for the parasites upon the public service. Individual clerks were required, and by reason of the new conditions were enabled, to do more and better work; and this, coupled with the increase in efficiency in the service on account of new blood coming in through the examinations, made possible an actual decrease in the force required in many offices, notwithstanding the natural growth in the amount of work to be done.[1] Experience proves that the desire to create new and unnecessary positions was in direct proportion to the power to control them, for where the Act has taken away this power of control the desire had disappeared naturally. There is no longer any desire on the part of heads of departments to increase the number or salaries of classified positions which would fall by law within the Civil Service rules and be subject to competitive examinations. Thus the promises of improvement and economy in the service have been fulfilled.

The chief drawback to the full success of the Act within its intended scope of operation has been the withholding of certain positions in the service from the application of the vital principle of competition. The Civil Service Act contemplated no exceptions, within the limits to which it was made applicable, to the general principle of competition upon merit for entrance to the service. In framing the first Civil Service rules, however, in 1883, the president, yielding to the pressure of the heads of some of the departments, and against the urgent protest of the Civil Service Commission, excepted from the requirement of examination large numbers of positions in the higher grades of the service, chiefly fiduciary and administrative positions such as cashiers, chief clerks, and chiefs of division. These positions being thus continued under the absolute control of the appointing officer, the effect of their exception from examination was to retain just that much of the old or "spoils" system within the nominal jurisdiction of the new or "merit" system. Even more: under the old system, while appointments from the outside had been made regardless of fitness, still those appointments had been made in the lower grades, the higher positions being filled by promotion within the service, usually of the most competent, but under the new system with its exceptions, while appointments to the lower grades were filled on the basis of merit, the pressure for spoils at each change of administration forced inexperienced, political, or personal favourites in at the top. This blocked promotions and demoralized the service. Thus, while the general effect of the Act was to limit very greatly the number of vicious appointments, at the same time the effect of these exceptions was to confine them to the upper grades, where the demoralizing effect of each upon the service would be a maximum. By constant efforts the Civil Service Commission succeeded in having position after position withdrawn from this excepted class, until by the action of the president, on 6th May 1896, it was finally reduced almost to a minimum. By subsequent presidential action, however, on 29th May 1899, the excepted class was again greatly extended.[2]

A further obstacle to the complete success of the merit system, and one which prevents the carrying forward of the reform to the extent to which it has been carried in Great Britain, is inherent in the Civil Service Act itself. All postmasters who receive compensation of $1000 or more per annum, and all collectors of customs and collectors of internal revenue, are appointed by the president and confirmed by the Senate, and are therefore, by express provision of the Act, not "required to be classified." The universal practice of treating these offices as political agencies, instead of as administrative business offices, is therefore not limited by the Act. Such officers are active in political work throughout the country, and their official position adds greatly to their power to affect the political prospects of the leaders in their districts. Accordingly the Senate, from being, as originally intended, merely a confirming body as to these officers, has become in a large measure, actually if not formally, a nominating body, and holds with tenacity to the power thus acquired by the individual senators. Thorough Civil Service reform requires that these positions also, as well as those of fourth-class postmasters (which are already classifiable under the Act), be made subject to the merit system, for in them is the real remaining stronghold of the spoils system. Even though all their subordinates be appointed through examination, it will be impossible to carry the reform to ultimate and complete success so long as the officers in charge are appointed mainly for political reasons and are changed with every change of administration.

The purpose of the Act to protect the individual employees in the service from the rapacity of the "political barons" has been measurably, if not completely, successful. The power given the Civil Service Commission, to investigate and report upon violations of the law, has been used to bring to light such abuses as the levying of political contributions, and to set the machinery of the law in motion against them. While comparatively few actual prosecutions have been brought about, and although the penalties imposed by the Act for this offence have been but seldom inflicted, still the publicity given to all such cases by the commission's investigations has had a wholesome deterrent effect. Before the passage of the Act, positions were as a general rule held upon a well-understood lease-tenure, the political contributions for them being as securely and as certainly collected as any rent. Now, however, it can be said that these forced contributions have almost entirely disappeared. The efforts which are still made to collect political funds from government employees in evasion of the law are limited in the main to persuasion to make "voluntary" contributions, and it has been possible so to limit and obstruct these efforts that their practical effect upon the character of the service is now very small.

**State examinations.**

The same evils that the Federal Civil Service Act was designed to remedy exist to a large degree in many of the state governments, and are especially aggravated in the administration of the local governments of some of the larger cities. The chief, if not the only, test of fitness for office in many cases has been party loyalty, honesty and capacity being seldom

[1] For details justifying these statements, see *U.S. Civil Service Commission's Fourteenth Report*, pp. 12–14.

[2] For the scope of these exceptions, see Civil Service Rule VI., at p. 57 of the *U.S. Civil Service Commission's Fifteenth and Sixteenth Reports*. A statement of the number of positions actually affected by this action of the president appears in the *Seventeenth Report*.

more than secondary considerations. The result has been the fostering of dishonesty and extravagance, which have brought weakness and gross corruption into the administration of the local governments. In consequence of this there has been a constantly growing tendency, among the more intelligent class of citizens, to demand that honest business methods be applied to local public service, and that appointments be made on the basis of intelligence and capacity, rather than of party allegiance. The movement for the reform of the civil service of cities is going hand in hand with the movement for general municipal reform, those reformers regarding the merit system of appointments as not merely the necessary and only safe bulwark to preserve the results of their labours, but also as the most efficient means for bringing about other reforms. Hence Civil Service Reform has been given a leading position in all programmes for the reform of state and municipal governments in recent years. This has undoubtedly been due, in the first instance, at least, to the success which attended the application of the merit system to the Federal service, municipal and state legislation following in the wake of the national civil service law. In New York an Act similar to the Federal Civil Service Act was passed on 4th May 1883, and in 1894 the principles of the merit system were introduced by an amendment into the State Constitution, and made applicable to cities and villages as well. In Massachusetts an Act was passed on 3rd June 1884, which in its general features was based upon the Federal Act and the New York Act. Similar laws were passed in Illinois and Wisconsin in 1895, applying both to the state governments and to the city governments of Chicago, Milwaukee, and several other cities. In New Orleans, La., and in Seattle, Wash., the merit system was introduced by an amendment to the city charter in 1896. The same result was accomplished by New Haven, Conn., in 1897, and by San Francisco, Cal., in 1899. In still other cities the principles of the merit system have been enacted into law, in some cases applying to the entire service and in others to only a part of it.

The application of the merit system to state and municipal governments has proved successful wherever it has been given a fair trial.[1] As experience has fostered public confidence in the system, and at the same time shown those features of the law which are most vulnerable, and the best means for fortifying them, numerous and important improvements upon the pioneer Act applying to the Federal service have been introduced in the more recent legislation. This is particularly true of the Acts now in force in New York (passed in 1899) and in Chicago. The power of the commission to enforce these Acts is materially greater than the power possessed by the Federal Commission. In making investigations they are not confined to taking the testimony of voluntary witnesses, but may administer oaths, and compel testimony and the production of books and papers where necessary; and in taking action they are not confined to the making of a report of the findings in their investigations, but may themselves, in many cases, take final judicial action. Further than this, the payment of salaries is made dependent upon the certificate of the commission that the appointments of the recipients were made in accordance with the civil service law and rules. Thus these commissions have absolute power to prevent irregular or illegal appointments by refractory appointing officers. Their powers being so much greater than those of the national commission, their action can be much more drastic in most cases, and they can go more directly to the heart of an existing abuse, and apply more quickly and effectually the needed remedy.

Upon the termination of the Spanish-American war, the necessity for the extension of the principles of the merit system to the new territories, the responsibility for whose government the results of this war had thrown upon the United States, was realized.[2] By the acts providing for civil government in Porto Rico (12th April 1900) and Hawaii (30th April 1900), the provisions of the Civil Service Act and Rules were applied to those islands. Under this legislation the classification applies to all positions which are analogous to positions in the Federal service, those which correspond to positions in the municipal and state governments being considered as local in character, and not included in the classification.

On 19th September 1900 the United States Philippine Commission passed an Act "for the establishment and maintenance of an efficient and honest civil service in the Philippine Islands." This Act, in its general features, is based upon the national civil service law, but includes also a number of the stronger points to be found in the state and municipal laws mentioned above. Among these are the power given the Civil Service Board to administer oaths, summon witnesses, and require the production of official records; and the power to stop payment of salaries to persons illegally appointed. Promotions are to be determined by competitive examinations, and are to be made throughout the service, as there are no excepted positions. A just right of preference in local appointments is given to natives. The president of the Philippine Commission in introducing this bill said: "The purpose of the United States Government . . . in these islands is to secure for the Filipino people as honest and as efficient a government as may be possible. . . . It is the hope of the commission to make it possible for one entering the lowest ranks to reach the highest, under a tenure based solely upon merit." It is too early as yet to give positive testimony as to its actual operation, but judging by past experience it is believed that this law is well adapted to accomplish the purpose above stated.

For fuller information upon the details of the present workings of the merit system in the Federal service, recourse should be had to the publications of the U.S. Civil Service Commission, which are to be found in the public libraries in all the principal cities in the United States, or which may be had free of charge upon application to the commission. The *Manual of Examinations*, published semi-annually, gives full information as to the character of the examinations held by the commission, together with the schedule of dates and places for the holding of those examinations. The *Annual Reports* of the commission contain full statistics of the results of its work, together with comprehensive statements as to the difficulties encountered in enforcing the law, and the means used to overcome them. In the *Fifteenth Report*, pp. 443–485, will be found a very valuable historical compilation from original sources, upon the "practice of the presidents in appointments and removals in the Executive Civil Service, from 1789 to 1883." In the same report, pp. 511–517, is a somewhat comprehensive bibliography of "civil service" in periodical literature in the 19th century, brought down to the end of 1898. (J. R. P.)

**Civita Castellana,** a town and episcopal see of Italy, province of Rome, 49 miles north from Rome by rail. In 1887 remains of an Etruscan temple, and also the remains of a temple attributed to Juno Quiritis, were

[1] In the *U.S. Civil Service Commission's Fifteenth Report*, pp. 489–502, the "growth of the civil service reform in states and cities" is historically treated, briefly, but with some thoroughness.

[2] See *U.S. Civil Service Commission's Fifteenth Report*, p. 37 and pp. 521–559, in which the application of civil service reform principles to colonial governments was discussed in connexion with a review of the experience of Great Britain and Holland in this regard.

discovered here. Six miles to the south-east is the Mount Soracte of Horace (*Carm.* i. 9) and Virgil (*Æn.* xi. 785). Population, about 4500.

**Civitavecchia,** a seaport town and episcopal see of Italy, province of Rome, on the west coast, 50 miles north-west from Rome by rail. It is the port of Rome; the harbour has been deepened, though only in part, to 21 feet; the northern entrance was deepened to 26¼ feet in 1899–1900. A new quay was completed in 1895, a new breakwater begun in 1900, and other improvements have been effected since 1887. There are shipbuilding yards, blast furnaces, cement and patent fuel factories, and an arsenal, a cathedral, a theatre, and on the south mole a citadel built to the plans of Michel Angelo. The port is cleared by some 1610 vessels of 410,550 tons annually (1233 of 455,000 tons in 1899). Alum is extensively mined. This town supplies Rome with a large portion of its fish. Population, about 14,000.

**Clackmannanshire,** the smallest county in Scotland, bounded on the N. by Perthshire, on the E. by Perth and Fife shires, on the S.W. by the Forth, and on the W. by Stirling and Perth shires.

*Area and Population.*—In 1891 the Stirling part of the parish of Alva was transferred to Clackmannan, and the Clackmannan part of the parishes of Stirling and Logie to Stirling. The area of the county (exclusive of foreshore) as officially estimated is 35,160 acres, or about 55 square miles. The population was in 1881, 25,677; in 1891, 28,432; in 1891, on the above area, 33,140, of whom 15,834 were males and 17,306 females; in 1901 it was 32,019. On the old area, taking land only (30,477 acres, or 47·6 square miles), the number of persons to the square mile in 1891 was 605, and the number of acres to the person 1·1. In the registration county the population increased between 1881 and 1891 by 9·8 per cent. Between 1881 and 1891 the excess of births over deaths was 3495, and the increase of the resident population was 2975. The following table gives particulars of births, deaths, and marriages in 1880, 1890, and 1899:—

| Year. | Deaths. | Marriages. | Births. | Percentage of Illegitimate. |
|---|---|---|---|---|
| 1880 | 417 | 138 | 820 | 8·1 |
| 1890 | 456 | 154 | 784 | 5·10 |
| 1899 | 560 | 178 | 786 | 3·6 |

The birth-rate, death-rate, and marriage-rate are all below the rates for Scotland. The following table gives the birth-rate, death-rate, and marriage-rate per thousand of the population for a series of years:—

| | 1880. | 1881-90. | 1890. | 1891-98. | 1899. |
|---|---|---|---|---|---|
| Birth-rate . . | 34·32 | 30·90 | 29·57 | 26·40 | 22·02 |
| Death-rate . . | 17·45 | 17·12 | 17·20 | 15·17 | 15·69 |
| Marriage-rate . | 5·77 | 5·65 | 5·80 | 5·63 | 4·98 |

In 1891 there were 215 Gaelic-speaking persons in the county, and 89 foreigners. Valuation in 1889–90, £137,084; 1899–1900, £165,706.

*Administration.*—The county unites with Kinross-shire to return a member to parliament. Clackmannan is the county town, but Alloa (11,417), Alva (4624), and Tillicoultry (3337), which are police burghs, take precedence in population and trade. There are 5 parishes, all but one of which belong to the Stirling Combination. In September 1899 the number of paupers and dependants was 556. Clackmannan forms a sheriffdom with Stirling and Dumbarton shires, and a sheriff-substitute sits at Alloa.

*Education.*—Six school boards manage 16 schools, which had an average attendance of 5334 in 1898–99, while 3 voluntary schools (one Episcopal and one Roman Catholic) had 437. There is a famous endowed secondary school, the Institution, at Dollar, and three other schools in the county earned grants in 1898 for giving higher education. A large part of the "residue" grant is spent in subsidizing Dollar Institution and science and art classes in the burghs.

*Agriculture.*—The Ochil hills in the north afford excellent pasturage. Farming is high, and is mixed pastoral and arable. In 1898, 44·5 per cent. of the area was under cultivation, the county ranking thirteenth in this regard in Scotland. In 1895 the average size of the 197 holdings in the county was 80 acres. The percentage under 5 acres was 21·32; between 5 and 50 acres, 34·52; and above 50 acres, 44·16. There were 22 between 50 and 100, 56 between 100 and 300, and 9 between 300 and 500 acres. In 1895, 3026 acres were under wood. Oats are the principal corn crop, and wheat and barley cover about equal acreages. The following table gives the principal acreages at intervals of five years from 1880:—

| Year. | Area under Crops. | Corn Crops. | Green Crops. | Clover. | Permanent Pasture. | Fallow |
|---|---|---|---|---|---|---|
| 1880 | 15,691 | 5772 | 1479 | 3171 | 4926 | 343 |
| 1885 | 15,858 | 5278 | 1358 | 3530 | 5392 | 300 |
| 1890 | 15,857 | 4829 | 1219 | 4459 | 5102 | 234 |
| 1895 | 15,687 | 4703 | 1244 | 3345 | 6149 | 236 |
| 1899 | 16,567 | 4265 | 1146 | 3474 | 6569 | 189 |

The following table gives particulars of the live stock during the same years:—

| Year | Total Horses. | Total Cattle. | Cows or Heifers in Milk or Calf | Sheep. | Pigs. |
|---|---|---|---|---|---|
| 1880 | 694 | 3383 | 1349 | 10,399 | 1473 |
| 1885 | 690 | 3902 | 1499 | 9,749 | 1980 |
| 1890 | 644 | 3930 | 1503 | 10,656 | 1772 |
| 1895 | 687 | 4042 | 1630 | 12,692 | 2985 |
| 1899 | 699 | 3686 | 1522 | 14,446 | 1729 |

*Industries and Trade.*—Paper-making has been added to the industries, of which coal-mining is the most important. 402,733 tons of coal, valued at £140,956, were raised in 1890; 366,697 tons, valued at £137,511, in 1899. 7097 tons of sandstone were obtained in 1895, and 15,605 tons, valued at £5416, in 1899. Alloa is the only fishing port in the county.

AUTHORITIES.—JAMES WALLACE. *The Sheriffdom of Clackmannan: A Sketch of its History.* Edinburgh, 1890.—D. BEVERIDGE. *Between the Ochils and the Forth.* Edinburgh, 1888.—JOHN CRAWFORD. *Memorials of Alloa.* 1885.—JAMES LOTHIAN. *Alloa and its Environs.* 1871.
(W. WA.)

**Clacton-on-Sea,** a seaside town and flourishing watering-place of Essex, England, 16 miles south-east of Colchester by rail, in the Harwich parliamentary division. A Franciscan convent, a higher middle-class day school in connexion with it, a board school, two convalescent homes, a "holiday" home, and a town-hall (£20,000) have been recently erected; and modern improvements include a pier (1873) 1150 feet long, a sea-wall (1880), a promenade 1¼ mile long, and a marine parade (1896). A drainage system was effected in 1894. Area of urban district, 4074 acres; population (1891), 3584; (1901), 7453.

**Clanvowe, Sir Thomas** (14th and 15th centuries), is a name which was first mentioned in the history of English literature by William Morris in 1895, when, in editing the text of *The Cuckoo and the Nightingale* for the Kelmscott Press, he stated that Professor Skeat had discovered that at the end of the best of the MSS. the author was called Clanvowe. In 1897 this information was confirmed and expanded by Professor Skeat himself in the supplementary volume of his Oxford Chaucer (1894–1897). The beautiful romance of *The Cuckoo and the Nightingale* was published by Thynne in 1532, and was attributed by him, and by successive editors down to the days of Henry Bradshaw, to Chaucer. It was due to this error that for three centuries Chaucer was supposed to be identified with the manor of Woodstock, and even painted, in fanciful pictures, as lying

> Under a maple that is fair and green,
> Before the chamber-window of the Queen
> At Wodëstock, upon the greenë lea.

But this queen could only be Joan of Navarre, who arrived in 1403, three years after Chaucer's death, and it is to the spring of that year that Professor Skeat attributes the composition of the poem. Sir Thomas Clanvowe was of a Herefordshire family, settled near Wigmore. He was a prominent figure in the courts of

Richard II. and Henry IV., and was one of those who "had begun to mell of Lollardy, and drink the gall of heresy." The date of his birth is unknown, and his name is last mentioned in 1404. The historic and literary importance of *The Cuckoo and the Nightingale* is great. It is the work of a poet who had studied the prosody of Chaucer with more intelligent care than either Occleve or Lydgate, and who therefore forms an important link between the 14th and 15th centuries in English poetry. Clanvowe writes with a surprising delicacy and sweetness, in a five-line measure almost peculiar to himself. Professor Skeat points out a unique characteristic of Clanvowe's versification, namely, the unprecedented freedom with which he employs the suffix of the final *-e*, and rather avoids than seeks elision. *The Cuckoo and the Nightingale* was imitated by Milton in his sonnet to the Nightingale, and was rewritten in modern English by Wordsworth. It is a poem of so much individual beauty, that we must regret the apparent loss of everything else written by a poet of such unusual talent. (E. G.)

**Clare,** a maritime county of Ireland, province of Munster.

*Population.*—The area of the administrative county in 1900 was 784,956 acres, of which 145,959 were tillage, 478,411 pasture, 243 fallow, 7840 plantation, 28,312 turf-bog, 8098 marsh, 79,432 barren mountain, and 36,661 water, roads, fences, &c. The new administrative county under the Local Government (Ireland) Act, 1898, includes 3 electoral divisions, formerly situated in Galway. The population in 1881 was 141,457, and in 1891, 124,483, of whom 63,138 were males and 61,345 females, divided as follows among the different religions:—Roman Catholics, 122,047; Protestant Episcopalians, 2246; Presbyterians, 106; Methodists, 53; and other denominations, 31. The decrease of population between 1881 and 1891 was 12·00 per cent. The average number of persons to an acre was ·15. Of the total population, 114,928 inhabited the rural districts, being an average of 123 persons to each square mile of crops and pasture. The population in 1901 was 112,129 (Roman Catholics, 109,899; Protestant Episcopalians, 2007; Presbyterians, 151; Methodists, 45; others, 27), being a decrease of 11·2 per cent. The following table gives the degree of education in 1891:—

| | Males. | Females. | Total. | Percentage. | | |
|---|---|---|---|---|---|---|
| | | | | R C. | Pr. Epis. | Presb. |
| Read and write | 42,052 | 38,820 | 80,872 | 71·8 | 93·9 | 92·2 |
| Read only . . | 4,578 | 4,977 | 9,555 | 8 7 | 2·7 | 3·3 |
| Illiterate . . . | 10,083 | 11,391 | 21,474 | 19 5 | 3·4 | 4·5 |

In 1881 the percentage of illiterates among Roman Catholics was 27·8. In 1891 there were 4 superior schools with 253 pupils (all Roman Catholics), and 250 primary schools with 20,549 pupils (Roman Catholics 20,228, and Protestants 321). The number of pupils on the rolls of the national schools on 30th September 1899 was 22,967, of whom 22,693 were Roman Catholics and 274 Protestants. The following table gives the number of births, deaths, and marriages in various years:—

| Year. | Births. | Deaths. | Marriages. |
|---|---|---|---|
| 1881 | 2981 | 1899 | 370 |
| 1891 | 2566 | 1851 | 453 |
| 1899 | 2333 | 1694 | 378 |

In 1899 the birth-rate per 1000 was 18·5, and the death-rate was 13·4; the rate of illegitimacy was 1·6 per cent. of the total births. The total number of emigrants who left the county between 1st May 1851 and 31st December 1899 was 149,084, of whom 72,984 were males and 76,100 females. The following are the chief towns in the county, with their populations in 1891: Ennis, 5460; Kilrush, 4095; Kilkee, 1556.

*Administration.*—The county is divided into two parliamentary divisions, East and West, the number of registered electors in 1900 being respectively 12,028, and 10,683. The rateable value in 1900 was £323,998. By the Local Government (Ireland) Act, 1898, the fiscal and administrative duties of the grand jury and (to a less extent) of other bodies were transferred to a county council, urban and rural district councils were established, and under that Act the county now comprises 2 urban and 9 rural sanitary districts.

*Agriculture.*—The following tables show the acreage under crops, including meadow and clover, and the amount of live stock in 1881, 1891, 1895, and 1900. The figures for 1900 are for the new administrative county:—

| | Wheat | Oats. | Barley, Rye, Beans | Potatoes. | Turnips. | Other Green Crops. | Meadow and Clover | Total |
|---|---|---|---|---|---|---|---|---|
| 1881 | 2597 | 16,215 | 2391 | 25,681 | 5654 | [illegible] | [illegible] | [illegible] |
| 1891 | 2025 | 13,100 | 1652 | 20,665 | 5410 | [illegible] | [illegible] | [illegible] |
| 1895 | 836 | 12,765 | 1633 | 20,547 | 5571 | 5315 | [illegible] | [illegible] |
| 1900 | 1253 | 11,103 | 1541 | 18,504 | 4846 | 5770 | 102,852 | [illegible] |

For 1899 the total value of the cereal and other crops was estimated by the Registrar-General at £968,331. The number of acres under pasture in 1881 was 475,316; in 1891, 463,061, and in 1900, 478,411.

| | Horses and Mules. | Asses | Cattle. | Sheep. | Pigs. | Goats. | Poultry |
|---|---|---|---|---|---|---|---|
| 1881 | 15,960 | 9,596 | 156,153 | 108,121 | 41,847 | 14,994 | 423,072 |
| 1891 | 19,070 | 10,649 | 173,282 | 141,399 | 38,290 | 17,382 | 409,098 |
| 1895 | 20,615 | 11,312 | 171,288 | 118,065 | 41,491 | 17,721 | 429,274 |
| 1900 | 18,057 | 12,092 | 175,756 | 117,864 | 43,439 | 18,038 | 455,867 |

The number of milch cows in 1891 was 45,224, and in 1900, 55,351. It is estimated that the total value of cattle, sheep, and pigs in 1899 was £2,390,014. In 1900 the number of holdings not exceeding 1 acre was 1584; between 1 and 5, 1347; between 5 and 15, [illegible]; between 15 and 30, 4753; between 30 and 50, 3676; between 50 and 100, 2799; between 100 and 200, 939; between 200 and 500, 353; and above 500, 55—total, 18,792. The number of loans issued (the number of loans being the same as the number of tenants) under the Land Purchase Acts, 1885, 1891, and 1896, up to 31st March 1900, was 463, amounting to £127,912. The number of loans sanctioned for agricultural improvements under sect. 31 of the Land Act, 1881, between 1882 and 1900, was 778, and the amount issued was £54,034. The total amount issued on loan for all classes of works under the Land Improvement Acts, from the commencement of operations in 1847 to 31st March 1900, was £177,819. (W. H. Po)

**Claremont,** a town of Sullivan county, New Hampshire, U.S.A. It is situated in the western part of the state, bordering on Connecticut river, and contains several villages, the principal among them being Claremont, Claremont Junction, and West Claremont. It is traversed by the Boston and Maine Railway. Population (1880), 4704; (1900), 6498.

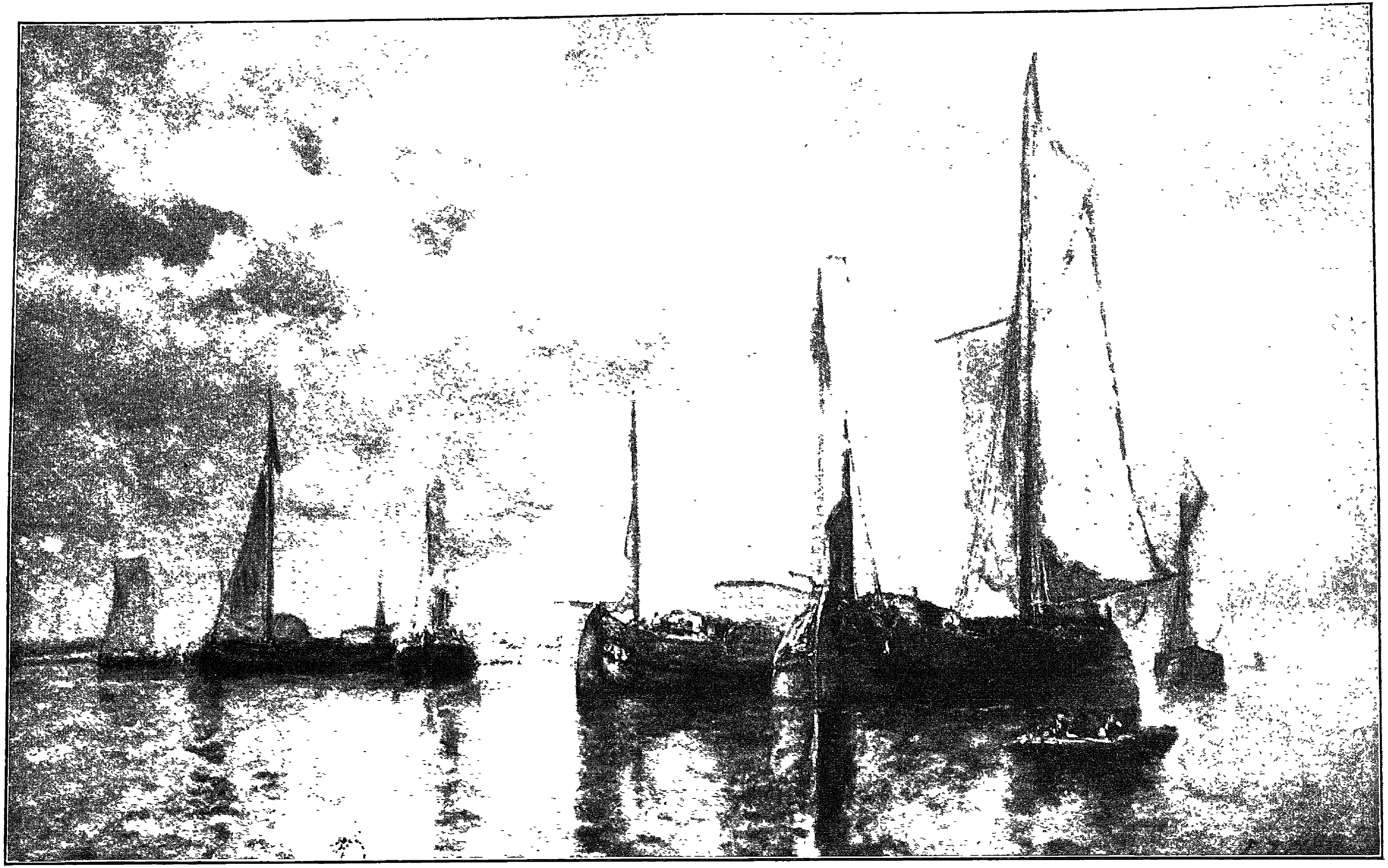
**Clark, Sir Andrew,** 1st Bart. (1826–1893), British physician, was born at Aberdeen on 28th October 1826. His father, who also was a medical man, died when he was only a few years old. After attending school in Aberdeen, he was sent by his guardians to Dundee and apprenticed to a druggist; then returning to Aberdeen he began his medical studies in the university of that city. Soon, however, he went to Edinburgh, where in the extra-academical school he had a student's career of the most brilliant description, ultimately becoming assistant to Dr Hughes Bennett in the Pathological Department of the Royal Infirmary, and assistant demonstrator of anatomy to Dr Robert Knox. But symptoms of pulmonary phthisis brought his academic life to a close, and in the hope that the sea might benefit his health he joined the medical department of the navy in 1848. Next year he became pathologist to the Haslar Hospital, where Huxley was one of his colleagues, and in 1853 he was the successful candidate for the newly-instituted post of curator to the museum of the London Hospital. Here he intended to devote all his energies to pathology, but circumstances brought him into active medical practice. In 1854, the year in which he took his doctor's degree at Aberdeen, the post of assistant physician to the Hospital became vacant and he was prevailed upon to apply for it. He was fond of telling how his phthisical tendencies gained him the appointment. "He is only a poor Scotch doctor," it was said, "with but a few months to live; let him have it." He had it, and two years before his death publicly declared

that of those who were on the staff of the Hospital at the time of his selection he was the only one remaining alive. In 1854 he became a member of the College of Physicians, and in 1858 a fellow, and then went in succession through all the offices of honour the College has to offer, ending in 1888 with the presidency, which he continued to hold till his death. From the time of his selection as assistant physician to the London Hospital, his fame rapidly grew until he became a fashionable doctor with one of the largest practices in London, counting among his patients some of the most distinguished men of the day. The great number of persons who passed through his consulting-room every morning rendered it inevitable that to a large extent his advice should become stereotyped and his prescriptions often reduced to mere stock formulæ, but in really serious cases he was not to be surpassed in the skill and carefulness of his diagnosis and in his attention to detail. In spite of the claims of his practice he found time to produce a good many books, all written in the precise and polished style on which he used to pride himself. Doubtless owing largely to personal reasons, lung diseases and especially fibroid phthisis formed his favourite theme, but he also discussed other subjects, such as renal inadequacy, anæmia, constipation, &c. He died in London on 6th November 1893, after a paralytic stroke which was probably the result of persistent overwork.

**Clarke, Sir Andrew** (1824–1902), British soldier and administrator, son of Colonel Andrew Clarke, of County Donegal, governor of West Australia, was born at Southsea, England, on 27th July 1824, and educated at King's School, Canterbury. He entered the R.M.A., Woolwich, and obtained his commission in the army in 1844 as second lieutenant in the Royal Engineers. He was appointed to his father's staff in West Australia, but was transferred to be A.D.C. and military secretary to the Governor of Tasmania; and in 1847 he went to New Zealand to take part in the Maori war, and for some years served on Sir George Grey's staff. He was then made Surveyor-General in Victoria, took a prominent part in framing its new Constitution, and held the office of Minister of Public Lands during the first administration (1855–57). He returned to England in 1857, and in 1863 was sent on a special mission to the West Coast of Africa. In 1864 he was appointed Director of Works for the Navy, and held this post for nine years, being responsible for great improvements in the naval arsenals at Chatham, Portsmouth, and Plymouth, and for fortifications at Malta, Cork, Bermuda, and elsewhere. In 1873 he was made K.C.M.G., and became Governor of the Straits Settlements, where he did most valuable work in consolidating British rule and ameliorating the condition of the people. From 1875 to 1880 he was Minister of Public Works in India; and on his return to England in 1881, holding then the rank of lieutenant-colonel in the army, he was first appointed commandant at Chatham and then Inspector-General of Fortifications (1882–86). Having attained the rank of lieutenant-general and been created G.C.M.G., he retired from official life, and in 1886 and 1893 unsuccessfully stood for Parliament as a supporter of Mr Gladstone. During his last years he was Agent-General for Victoria. He died 29th March 1902. Both as a technical and strategical engineer, and as an Imperial administrator, Sir Andrew Clarke was one of the ablest and most useful public servants of his time; and his contributions to periodical literature, as well as his official memoranda, contained valuable suggestions on the subjects of Imperial defence and Imperial consolidation, which received too little consideration at a period when the Home Governments were not properly alive to their importance. He is entitled to remembrance as one of those who first inculcated, from a wide practical experience, the views of Imperial administration and its responsibilities which in his last years he saw accepted by the bulk of his countrymen. (H. CH.)

**Clarke, James Freeman** (1810–1888), American preacher and author, was born in Hanover, N.H., on 4th April 1810. He was of a family which runs back, as he supposed, to the captain of the *Mayflower*. He was prepared for college at the Public Latin School of Boston, and after four years in Harvard College took his first degree in 1829. In his class were S. F. Smith, the author of the American National Hymn, and Oliver Wendell Holmes. After three years more of study at Cambridge Clarke was ordained as minister of a Unitarian congregation at Louisville, Kentucky, which was then a slave state. From the beginning, therefore, Clarke watched the institution of slavery, and he threw himself heart and soul into the national movement for its abolition. At the end of seven years he returned to Boston, where he and his friends established the "Church of the Disciples." It brought together a body of men and women active and eager in applying the Christian religion to the social problems of the day; and he would have said that the feature which distinguished it from any other church was that they also were ministers of the highest religious life. Ordination could make no distinction between him and them. For fifty years from the beginning of his active life until his death he wrote freely for the press. With Eliot of St Louis, and James Perkins of Cincinnati, he established and carried on a magazine called the *Western Messenger*. Its business was to carry to readers in the Mississippi valley simple statements of "liberal religion," involving what were then the most radical appeals as to national duty, especially the abolition of slavery. The magazine is now of value to collectors because it contains the earliest printed poems of Ralph Waldo Emerson, who was Clarke's personal friend. Most of Clarke's earlier published writings were addressed to the immediate need of establishing a larger theory of religion than that espoused by people who were still trying to be Calvinists, people who maintained what a good American phrase calls "hard-shelled churches." But it would be wrong to call his work controversial. He was always declaring that the business of the Church is Eirenic and not Polemic. Such books as the *Truth and Errors of Orthodoxy* have been read more largely by members of orthodox churches than by Unitarians. In the great moral questions of the time Clarke was a fearless and practical advocate of the broadest statement of human rights. Without caring much what company he served in, he could always be seen and heard, a leader of unflinching courage in the front rank of the battle. He published but few verses, but at bottom he was a poet. He was a diligent and accurate scholar, and among the books by which he is best known in America is one called *The Ten Great Religions of the World*. Few men in the United States have done more than Clarke to give breadth to the published discussion of the subjects of literature, ethics, and religious philosophy. He died at Jamaica Plain, Mass., on 8th June 1888. His Life—compiled mainly from his autobiography, letters, and diaries—was published in Boston in 1892. (E. E. H.)

**Clarksville**, capital of Montgomery county, Tennessee, U.S.A., situated in the northern part of the state, at an altitude of 394 feet, on Cumberland river, at the mouth of Red river, and on the Louisville and Nashville Railway. The Cumberland is navigable at this point. Clarksville is one of the greatest tobacco markets, being in a region largely devoted to the culture of the plant. It



"Calm on the Scheldt." By P. J. Clays.

is the seat of the South-West Presbyterian University. Population (1880), 3880; (1890), 7924; (1900), 9431.

**Clausius, Rudolf Julius Emmanuel** (1822–1888), German physicist, was born on 2nd January 1822 at Koslin, in Pomerania. After attending the Gymnasium at Stettin, he studied at Berlin University from 1840 to 1844. In 1848 he took his degree at Halle, and in 1850 was appointed professor of physics in the Royal Artillery and Engineering School at Berlin. Late in the same year he delivered his inaugural lecture as *privat docent* in the University. In 1855 he became an ordinary professor at Zürich Polytechnic, accepting at the same time a professorship in the University of Zurich. In 1867 he moved to Würzburg as professor of physics, and two years later was appointed to the same chair at Bonn, where he died on 24th August 1888. During the Franco-German war he was at the head of an ambulance corps composed of Bonn students, and received the Iron Cross for the services he rendered at Vionville and Gravelotte. The work of Clausius, who was a mathematical rather than an experimental physicist, was concerned with many of the most abstruse problems of molecular physics. By his restatement of Carnot's principle he put the theory of heat on a truer and sounder basis, and he deserves the credit of having made thermo-dynamics a science; he enunciated the second law, in a paper contributed to the Berlin Academy in 1850, in the well-known form, "Heat cannot of itself pass from a colder to a hotter body." His results he applied to an exhaustive development of the theory of the steam-engine, laying stress in particular on the conception of entropy. The kinetic theory of gases owes much to his labours, Clerk Maxwell calling him its principal founder. It was he who raised it, on the basis of the dynamical theory of heat, to the level of a theory, and he carried out many numerical determinations in connexion with it, *e.g.*, of the mean free path of a molecule. To Clausius also was due an important advance in the theory of electrolysis, for he put forward the idea that molecules in electrolytes are continually interchanging atoms, the electric force not causing, but merely directing, the interchange. This view found little favour until 1887, when it was taken up by Arrhenius, who adduced additional arguments in its support, and formed from it the hypothesis of electrolytic dissociation now widely accepted.

**Clay, Charles** (1801–1893), English surgeon, was born at Bredbury, near Stockport, on 27th December 1801. He began his medical education as a pupil of Mr Kinder Wood in Manchester (where he used to attend Dalton's lectures on chemistry), and in 1821 went to Edinburgh to continue his studies there. Qualifying in 1823, he began a general practice in Ashton-under-Lyne, but in 1839 removed to Manchester to practise as an operative and consulting surgeon. It was there that, in 1842, he first performed the operation of ovariotomy with which his name is associated. On this occasion it was perfectly successful, and when fifteen years afterwards he published an analysis of his cases he was able to show a mortality only slightly above 25 per cent. Although his merits in this matter have sometimes been denied, his claim to the title "Father of Ovariotomy" is now generally conceded, and it is admitted that he deserves the credit not only of having shown how that operation could be made a success, but also of having played an important part in the advance of abdominal surgery for which last century was conspicuous. In spite of the claims of a heavy practice, Clay found time for the pursuit of geology and archæology. Among the books of which he was the author were a volume of *Geological Sketches of Manchester* and a *History of the Currency of the Isle of Man*, and his collections included over a thousand editions of the Old and New Testaments, and a remarkably complete series of the silver and copper coins of the United States of America. He died at Poulton-le-Fylde, near Preston, on 19th September 1893.

**Clay Cross,** a town in the Chesterfield division of Derbyshire, England, 5 miles south from Chesterfield, with a station on the Midland Railway. Since 1894 it has been governed by an urban district council. The Clay Cross Colliery and Ironworks Company employ a great number of hands. Population (1891), 7727; (1901), 8348.

**Clay, Frederic** (1840–1889), English musical composer, was born in Paris in 1840. He studied music under Molique in Paris, and Hauptmann at Leipzig. With the exception of a few songs and two cantatas, *The Knights of the Cross* (1866) and *Lalla Rookh* (1877), his compositions were all written for the stage; but he will be best remembered as the composer of "I'll sing thee songs of Araby." Clay's first public appearance was made with an opera entitled *Court and Cottage*, the libretto of which was written by Tom Taylor. This was produced at Covent Garden in 1862, and was followed by *Constance* (1865), *Ages Ago* (1869), and *Princess Toto* (1875), to name only three of many works which have long since been forgotten. The last two, which were written to libretti by W. S. Gilbert, are among Clay's most tuneful and most attractive works. He wrote part of the music for *Babil and Bijou* (1872), and *The Black Crook* (1873), both of which were produced at the Alhambra. He also furnished incidental music for a revival of *Twelfth Night*, and for the production of James Albery's *Oriana*. His last works, *The Merry Duchess* (1883), and *The Golden Ring* (1883), the latter written for the reopening of the Alhambra, which had been burned to the ground the year before, showed an advance upon his previous work, and rendered all the more regrettable the stroke of paralysis which crippled his physical and mental energies during the last few years of his life. He died at Great Marlow in 1889. (R. A. S.)

**Clays, Paul Jean** (1819–1900), Belgian artist, was born at Bruges in 1819, and died at Brussels in 1900. He was one of the most esteemed marine painters of his time, and early in his career he substituted a sincere study of nature for the extravagant and artificial conventionality of most of his predecessors. When he began to paint, the sea was considered by Continental artists as worth representing only under its most tempestuous aspects. Artists cared only for the stirring drama of storm and wreck, and they clung still to the old-world tradition of the romantic school. Clays was the first to appreciate the beauty of calm waters reflecting the slow procession of clouds, the glories of sunset illuminating the sails of ships or gilding the tarred sides of heavy fishing-boats. He painted the peaceful life of rivers, the poetry of wide estuaries, the regulated stir of roadsteads and ports. And while he thus broke away from old traditions he also threw off the trammels imposed on him by his master, the marine painter Gudin. Endeavouring only to give truthful expression to the nature that delighted his eyes, he sought to render the limpid salt atmosphere, the weight of waters, the transparence of moist horizons, the gem-like sparkle of the sky. A Fleming in his feeling for colour, he set his palette with clean strong hues, and their powerful harmonies were in striking contrast with the rusty, smoky tones then in favour. If he was not a "luminist" in the modern use of the word, he deserves at any rate to be classed with the founders of the modern naturalistic school. This conscientious and healthy interpretation, to which the artist remained faithful, without any important change,

to the end of an unusually long and laborious career, attracted those minds which aspired to be bold, and won over those which were moderate. Clays soon took his place among the most famous Belgian painters of his generation, and his pictures, sold at high prices, are to be seen in most public and private galleries. We may mention, among others, "The Beach at Ault," "Boats in a Dutch Port," and "Dutch Boats in the Flushing Roads," the last-named in the National Gallery of London. In the Brussels Gallery are "The Port of Antwerp," "Coast near Ostend," and a "Calm on the Scheldt"; in the Antwerp Museum, "The Meuse at Dordrecht"; in the Pinakothek at Munich, "The Open North Sea"; in the New York Gallery, "The Festival of the Freedom of the Scheldt at Antwerp in 1863"; in the palace of the king of the Belgians, "Arrival of Queen Victoria at Ostend in 1857"; in the Bruges Academy, "Port of Feirugudo, Portugal." P. J. Clays was a member of several Academies, Belgian and foreign, and of the Order of Leopold, the Legion of Honour, &c.

See CAMILLE LEMONNIER. *Histoire des Beaux Arts.* Brussels. 1887. (O. M*.)

**Clayton-le-Moors,** a township and parish of Lancashire, England, 2 miles north-north-west of Accrington by rail, in the Accrington parliamentary division. In 1894 the parish was placed under an urban district council of twelve members. Besides the church of All Saints, restored in 1882, the parish has a Roman Catholic church (1819), a Primitive Methodist (1858), a Wesleyan (1862), and a Baptist (1882) chapel; there are also five schools, one of them Roman Catholic. Other buildings are the district council offices, a mechanics' institute, and a fire-station. The industries comprise cotton mills, calico printing, engineering, soap, brick, and tile works. Area of urban district, 1059 acres; population (1881), 6695; (1901), 8153.

**Clearfield,** capital of Clearfield county, Pennsylvania, U.S.A., on the western branch of the Susquehanna river, and on the Pennsylvania, the Beech Creek, and the Buffalo, Rochester, and Pittsburg Railways. Population (1890), 2248; (1900), 5081.

**Cleator Moor,** a town in the Egremont parliamentary division of Cumberland, England, 2½ miles north of Egremont by rail. There are public offices, a market hall, and a free library. The staple industry is the working of coal mines and of iron-ore mines, in connexion with which there are four blast furnaces. Area of urban district, 2947 acres; population (1881), 10,420; (1901), 8121.

**Cleburne,** capital town of Johnson county, Texas, U.S.A., 25 miles south of Fort Worth, at the intersection of two branches of the Gulf, Colorado, and Santa Fé Railway. Population (1890), 3278; (1900), 7493.

**Cleckheaton,** a township and parish in the Spen Valley parliamentary division of the West Riding of Yorkshire, England, 12 miles by rail south-west of Leeds. There are a town hall, a hospital for infectious diseases, a mechanics' institute, and a technical school. A chamber of commerce has held meetings here since 1878. The industries comprise the manufacture of woollens, blankets, flannel, wire-card, and machinery. Area of urban district, 1755 acres; population (1881), 10,653; (1901), 12,523.

**Clémenceau, Georges** (1841——), French politician, was born at Mouilleron-en-Pareds, La Vendée, 28th September 1841. Having adopted medicine as his profession, for which he had been educated at Nantes and Paris, he settled in 1869 in Montmartre; and after the revolution of 1870 he had become sufficiently well known to be nominated mayor of the 18th arrondissement of Paris (Montmartre)—an unruly district over which it was a difficult task to preside. In February 1871 he was elected as a Radical to the National Assembly for the department of the Seine, and voted against the peace preliminaries. The execution, or rather murder, of Generals Lecomte and Clément Thomas by the communists on 18th March, which he vainly tried to prevent, brought him into collision with the Central Committee sitting at the Hôtel de Ville, and they ordered his arrest, but he escaped; he was accused, however, by various witnesses, at the subsequent trial of the murderers (29th November), of not having intervened when he might have done, and though he was cleared of this charge it led to a duel, for his share in which he was prosecuted and sentenced to a fine and a fortnight's imprisonment. Meanwhile, on 20th March 1871, he had introduced in the National Assembly at Versailles, on behalf of his Radical colleagues, the bill establishing a Paris Municipal Council of eighty members; but he was not returned himself at the elections of 26th March. He tried with the other Paris mayors to mediate between Versailles and the Hôtel de Ville, but failed, and accordingly resigned his mayoralty and his seat in the Assembly, and temporarily gave up politics; but he was elected to the Paris Municipal Council on 23rd July 1871 for the Clignancourt *quartier*, and retained his seat till 1876, passing through the offices of secretary and vice-president, and becoming president in 1875. In 1876 he stood again for the Chamber of Deputies, and was elected for the 18th arrondissement. He joined the Extreme Left, and his energy and mordant eloquence speedily made him the leader of the Radical section. In 1877, after the *Seize Mai* (see FRANCE, *History*), he was one of the republican majority who denounced the Broglie ministry, and he took a leading part in resisting the anti-republican policy of which the *Seize Mai* incident was a symptom, his demand in 1879 for the indictment of the Broglie ministry bringing him into particular prominence. In 1880 he started his newspaper, *La Justice*, which became the principal organ of Parisian Radicalism; and from this time onwards throughout M. Grévy's presidency his reputation as a political critic, and as a destroyer of ministries who yet would not take office himself, rapidly grew. He was an active opponent of M. Jules Ferry's colonial policy and of the Opportunist party, and in 1885 it was his use of the Tongking disaster which principally determined the fall of the Ferry Cabinet. At the elections of 1885 he advocated a strong Radical programme, and was returned both for his old seat in Paris and for the Var, selecting the latter. Refusing to form or enter a ministry, he supported the Right in keeping M. Freycinet in power in 1886, and was responsible for the inclusion of General Boulanger in the Freycinet Cabinet as war minister. Boulanger, depending on the Radicals, and supported by them, inaugurated his career by measures congenial to them, but when he began to assert himself and to take advantage of Grévy's unpopularity to pose as a Pretender, with the help of some of the Extreme Left and of the Royalists, Clémenceau withdrew his own support and became a vigorous combatant against the Boulangist movement, though the Radical press and a section of the party continued to patronize the general. By his exposure of the Wilson scandal, and by his personal plain-speaking, M. Clémenceau contributed largely to M. Grévy's resignation of the presidency in 1887, having himself declined Grévy's request to form a Cabinet on the downfall of that of M. Rouvier; and he was primarily responsible, by advising his followers to vote neither for Floquet, Ferry, nor Freycinet, for the election of an "outsider" as president in M. Carnot. He had arrived, however, at the height

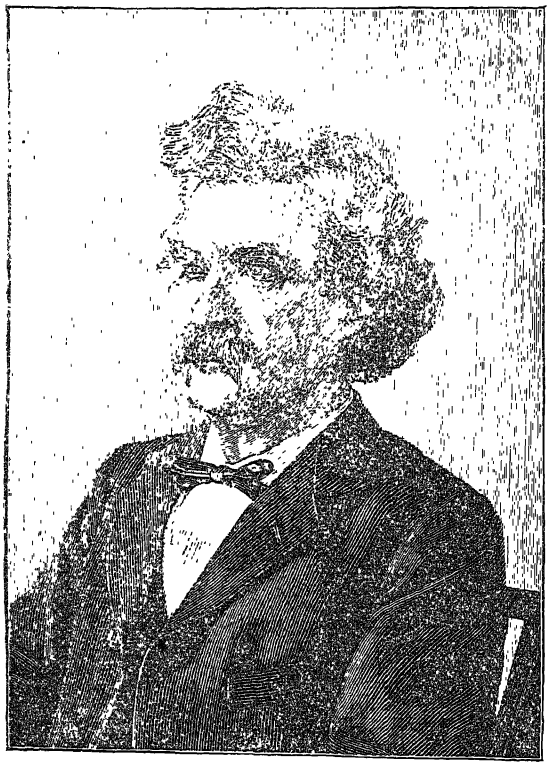
of his influence, and several factors now contributed to his decline. The split in the Radical party over Boulangism weakened his hands, and its collapse made his help unnecessary to the moderate republicans. A further misfortune occurred in the Panama affair, Clémenceau's relations with Cornelius Herz leading to his being involved in the general suspicion; and, though he remained the leading spokesman of French Radicalism, his hostility to the Russian alliance so increased his unpopularity that in the election for 1893 he was defeated for the Chamber, after having sat in it continuously since 1876. After his defeat for the Chamber, M. Clémenceau confined his political activities to journalism, his career being further overclouded—so far as any possibility of regaining his old ascendancy was concerned—by the long-drawn-out Dreyfus case, in which he took an active and honourable part as a supporter of M. Zola and an opponent of the anti-Semitic and Nationalist campaign. He was the founder of the newspaper *L'Aurore*, in which M. Zola published his famous open letter "J'accuse," and thus prepared the way for the revision of the first Dreyfus trial

**Clemens Romanus** (see *Ency. Brit.*, ninth ed., vol. ii. p. 195). Further knowledge requires a restatement of the facts concerning the Epistle of Clement of Rome to the Corinthians. This epistle was occasioned by a dispute in the Church of Corinth, which had led to the ejection of several presbyters from their office. It does not contain Clement's name, but is addressed by "the Church of God which sojourneth in Rome to the Church of God which sojourneth in Corinth." But there is no reason for doubting the universal tradition which ascribes it to Clement, or the generally accepted date, *c.* A.D. 96. No claim is made by the Roman Church to interfere on any ground of superior rank; yet it is noteworthy that in the earliest document outside the canon which we can securely date, the Church in the imperial city comes forward as a peacemaker to compose the troubles of a Church in Greece. Nothing is known of the cause of the discontent; no moral offence is charged against the presbyters, and their dismissal is regarded by Clement as high-handed and unjustifiable, and as a revolt of the younger members of the community against the elder. After a laudatory account of the past conduct of the Corinthian Church, he enters upon a denunciation of vices and a praise of virtues, and illustrates his various topics by copious citations from the Old Testament scriptures. Thus he paves the way for his tardy rebuke of present disorders, which he reserves until two-thirds of his epistle is completed. Clement is exceedingly discursive, and his letter reaches twice the length of the Epistle to the Hebrews. Many of his general exhortations are but very indirectly connected with the practical issue to which the epistle is directed. Indeed, his latest editor, Rudolf Knopf, is convinced that he was drawing largely upon the homiletical material with which he was accustomed to edify his Roman congregation. This view receives some support from the long liturgical prayer at the close, which almost certainly represents the intercession which he was wont to use in his Roman Eucharists. But we must not allow such a theory to blind us to the true wisdom with which the writer defers his censure. He knows that the roots of the quarrel lie in a wrong condition of the Church's life. His general exhortations, courteously expressed in the first person plural, are directed towards a wide reformation of manners. If the wrong spirit can be exorcised, there is hope that the quarrel will end in a general desire for reconciliation. The most permanent interest of the epistle lies in the conception of the grounds on which the Christian ministry rests according to the view of a prominent teacher before the first century has closed. The orderliness of Nature is appealed to as expressing the mind of its Creator. The orderliness of Old Testament worship bears a like witness; everything is duly fixed by God: high priests, priests and Levites, and the people in the people's place. Similarly in the Christian dispensation all is in order due. "The apostles preached the gospel to us from the Lord Jesus Christ; Jesus Christ was sent from God. Christ then is from God, and the apostles from Christ. . . . They appointed their first-fruits, having tested them by the Spirit, as bishops and deacons of those who should believe. . . . Our apostles knew through our Lord Jesus Christ that there would be strife about the name of the bishop's office. For this cause, therefore, having received perfect foreknowledge, they appointed the aforesaid, and afterwards gave a further injunction (ἐπινομήν has now the further evidence of the Latin *legem*) that, if these should fall asleep, other approved men should succeed to their ministry. . . . It will be no small sin in us if we eject from the bishop's office those who have offered the gifts blamelessly and holily" (cc. xlii. xliv.).

The epistle was published in 1633 by Patrick Young from Cod. Alexandrinus, in which a leaf near the end was missing, so that the great prayer (cc. lv.–lxiv.) remained unknown. In 1875 (six years after Lightfoot's first edition) Bryennius published a complete text from the MS. in Constantinople (dated 1055), from which in 1883 he gave us the *Didaché*. In 1876 Bensly found a complete Syriac text in a MS. recently obtained by the University Library at Cambridge. Lightfoot made use of these new materials in an Appendix (1877); his second edition, on which he had been at work at the time of his death, came out in 1890. This must remain the standard edition, notwithstanding Dom Morin's most interesting discovery of a Latin version (1894), which was probably made in the 3rd century, and is a valuable addition to the authorities for the text. Its evidence is used in a small edition of the epistle by R. Knopf, Leipzig, 1899 (J. A. R.)

**Clemens, Samuel Langhorne,** better known as MARK TWAIN (1835-——), the most widely popular of American humorists, and a writer of striking vigour and directness, was born 30th November 1835, at Florida, Missouri. His father was a country merchant from Tennessee, who moved soon after his son's birth to Hannibal, Missouri, a little town on the Mississippi. When the boy was only twelve his father died, and thereafter he had to get his education as best he could. Of actual schooling he had little. He learned how to set type, and as a journeyman printer he wandered widely, going even as far east as New York. At seventeen he went back to the Mississippi, determined to become a pilot on a river steamboat. In his *Life on the Mississippi* he has recorded graphically his experiences while "learning the river." But in 1861 the war broke out, and the pilot's occupation was gone. After a brief period of uncertainty the young man started west with his brother, who had just been appointed lieutenant-governor of Nevada. He went to the mines for a season, and there he began to write in the local newspapers, adopting the pen name of "Mark Twain." He drifted in time to San Francisco, and it was a newspaper of that city which in 1867 supplied the money for him to join a party going on a chartered steamer to the Mediterranean ports. The letters which he wrote during this voyage were gathered in 1869 into a volume, *The Innocents Abroad*, and the book immediately won a wide and enduring popularity. This popularity was of service to him when he appeared on the platform with a lecture—or rather with an apparently informal talk, rich in admirably-delivered anecdote. He edited a daily newspaper in Buffalo for a few months, and in 1870 he married Miss Olivia L. Langdon, removing a year later to Hartford, where he established his home. *Roughing It* was published in 1872, and in the year after he collaborated with Charles Dudley Warner in *The Gilded Age*

from which he made a play, acted many hundred times with John T. Raymond as "Colonel Sellers." In 1875 he published *Tom Sawyer*, the sequel to which, *Huckleberry Finn*, did not appear until 1884. The result of a second visit to Europe was humorously recorded in *A Tramp Abroad*, published in 1882, in which year he also issued a more or less historical romance, *The Prince and the Pauper;* and a year later came *Life on the Mississippi*. *Huckleberry Finn*, the next of his books, was published (in 1884) by a firm in which the author was chief partner. This firm prospered for a while, and issued in 1889 Mark Twain's own comic romance, *A Connecticut Yankee at King Arthur's Court*, and in 1892 a less successful novel, *The American Claimant*. But after a severe struggle the publishing house failed, leaving the author charged with its very heavy debts. Since this disaster he has issued



SAMUEL CLEMENS.
*(From a photo by Elliott and Fry, London.)*

a third Mississippi Valley novel, *Pudd'nhead Wilson*, in 1894, and in 1896 another historical romance, *Joan of Arc*, wherein the maid is treated with the utmost sympathy and reverence. He went on a tour round the world, partly to make money by lecturing and partly to get material for another book of travels, published in 1897, and called in America *Following the Equator*, and in England *More Tramps Abroad*. From time to time he had collected into volumes his scattered sketches; of these the first, *The Jumping Frog*, appeared in 1867, and the latest, *The Man that Corrupted Hadleyburg*, in 1900. To be recorded also is a volume of essays and literary criticisms, *How to Tell a Story*, printed in 1897. A complete edition of his works was published in twenty-two volumes in 1899–1900 by the American Publishing Company of Hartford. And in this last year, having paid off all his debts, he returned to America to be most cordially welcomed by his fellow-countrymen.

Mark Twain is commonly considered as a humorist, and no doubt he is a humorist of a remarkable comic force and of a refreshing fertility. But the books in which his humour is broadly displayed, the travels and the sketches, are not really so significant of his power as the three novels of the Mississippi, *Tom Sawyer*, *Huckleberry Finn*, and *Pudd'nhead Wilson*, wherein we have preserved a vanished civilization, peopled with typical figures, and presented with inexorable veracity. There is no lack of humour in them, and there is never a hint of affectation in the writing; indeed, the author, doing spontaneously the work nearest to his hand, was very likely unconscious that he was making a contribution to history. But such *Huckleberry Finn* is, beyond all question; it is a story of very varied interest, now comic, now almost tragic, frequently poetic, unfailingly truthful, although not always sustained at its highest level. And in these three works of fiction there are not only humour and pathos, character and truth, there is also the largeness of outlook on life such as we find only in the works of the masters. Beneath his fun-making we can discern a man who is fundamentally serious, and whose ethical standards are ever lofty. Like Cervantes at times, Mark Twain reveals a depth of melancholy beneath his playful humour, and like Molière always, he has a deep scorn and a burning detestation of all sorts of sham and pretence, a scorching hatred of humbug and hypocrisy. Like Cervantes and like Molière, he is always sincere and direct. (B. M.)

**Clermont-Ferrand,** chief town of department Puy-de-Dôme, 261 miles south of Paris by rail. It is the headquarters of the 13th army corps, and there are a commercial museum and a meteorological observatory. Amongst the principal manufactures are india-rubber goods and alimentary pastes; textile industries are no longer important. It has mineral waters in repute locally. Population (1881), 32,256; (1896), 38,913, (comm.) 43,688; (1901), 52,933.

**Clermont-Ganneau, Charles Simon** (1846–——), French orientalist, the son of a sculptor of some repute, was born in Paris, 19th February 1846. After an education at the École des Langues Orientales, he entered the diplomatic service as dragoman to the consulate at Jerusalem, and afterwards at Constantinople. He laid the foundation of his reputation by his discovery (in 1870) of the "stele" of Mesha, which bears the oldest Semitic inscription known. In 1874 he was employed by the British Government to take charge of an archæological expedition to Palestine, and was subsequently entrusted by his own Government with similar missions to Syria and the Red Sea. He was made Chevalier of the Legion of Honour in 1875. After serving as vice-consul at Jaffa from 1880 to 1882, he returned to Paris as "Secrétaire-Interprète" for oriental languages, and in 1886 was appointed consul of the first class. He subsequently accepted the post of director of the École des Langues Orientales and professor at the Collège de France. In 1889 he was elected a member of the Académie des Inscriptions et Belles Lettres, of which he had been a correspondent since 1880. His chief publications, besides a number of contributions to journals, are:—*Palestine Inconnue* (1886), *Études d'Archéologie Orientale* (1880, &c.), *Les Fraudes Archéologiques* (1885), *Recueil d'Archéologie Orientale* (1885, &c.), *Album d'Antiquités Orientales* (1897, &c.). He was principally instrumental in exposing the famous Shapira forgeries of Hebrew texts.

**Cleveland,** the seventh largest city in the United States, and the largest of the state of Ohio, situated at the mouth of the Cuyahoga river, on the southern shore of Lake Erie, in lat. 41° 30′ N. and long. 81° 47′ W. Divided unequally by the river, it stretches along the shore for 10 miles, with a maximum depth of 6 miles. It is connected by steamship lines with all the lake ports

from Duluth to Buffalo, Toronto, Ogdensburgh, and with those along the St Lawrence. It lies on or near all the trunk lines from New York to Chicago. The Lake Shore and Michigan Southern, the New York, Chicago, and St Louis (Nickel Plate) Railways pass through; the Erie, Pennsylvania, Baltimore, and Ohio have terminal facilities; while the Cleveland, Columbus, Cincinnati, and St Louis (Big Four), and several Ohio lines start from the city. The Ohio Canal, which gave Cleveland its original prosperity, is little used, and in 1879 its terminal facilities were granted to the Valley, now the Baltimore and Ohio Railway. Seven suburban electric railways, from 20 to 40 miles long, radiate from the Public Square, and carry package freight as well as passengers. There are 160 miles of streets, paved chiefly with Medina dressed stone. The improved public dock frontage on the river and lake amounts to 2500 feet, the unimproved to 3000 feet. Since 1879 the national Government has been building and improving a breakwater to create a harbour of refuge, which already affords a protected shore-line of over 2 miles. The widening of the river mouth from a minimum of 165 feet to a uniform width of 325 feet, and the widening and straightening of the lower course of the river, are also far advanced. These improvements were vital to the city, which is the greatest ore market in the world. At its own docks, not to mention the harbours within the customs district, the business of which is nearly all done in the city, were received in 1890, 1,945,432 tons of Lake Superior iron ore, and in 1900, 3,823,314 tons. The total tonnage in 1890 was 4,668,040; in 1900, 7,488,396. As a manufacturing town Cleveland owes its greatness to the facility with which iron can be brought from the Lake Superior district by water-route, and coal by rail from the Ohio and Pennsylvania mines. The capital invested in national banks in 1890 was $7,550,000; in 1900, $10,965,000. The deposits were for these years $15,037,606 and $48,780,227. For the same years capital in savings banks was $2,469,460 and $7,725,000; the deposits, $36,914,354 and $96,328,461. Of these deposits $34,632,732 were in one institution, the Society for Savings. The population in 1890 was 261,353. In 1900 it was 381,768, of whom 124,631 were foreign-born and 5988 were negroes. The death-rate in 1890 was 20·2; in 1900 it was 17·1. The water-supply from the old tunnel into the lake became unsatisfactory, and a new tunnel 26,000 feet in length was projected, of which 16,000 feet were completed in 1900. The school system was reorganized in 1892 by a law which placed the management of school affairs in the hands of a director and an elective council of seven members. The director was given power to appoint a superintendent of instruction, who was to receive authority to name the whole teaching force. Besides large private schools, among which is the University School for boys, with an eight years' course, emphasizing manual training and the supervision of athletic exercises, there are the Western Reserve University, with its medical school (opened 1843), the School of Law (1892), the Dental College (1893), the Adelbert College (until 1882 the Western Reserve College (1826) at Hudson, Ohio), the College for Women (1888); the Case School of Applied Sciences, the Cleveland College of Physicians (a part of Ohio Wesleyan University, Delaware, Ohio), and the Cleveland Homœopathic Medical College. There are 15 hospitals, including the United States Marine Hospital. The Public Library, the Case Library, the University Library, and the Western Reserve Historical Society possess about 300,000 volumes. There are over 245 churches, and the leading sects are the Roman Catholics with 39 churches, the Methodists with 24, the Baptists with 24, and the Congregationalists with 24. By the Municipal Reform Bill, 16th March 1891, a new city charter embodying the federal plan was granted The mayor appoints as his cabinet six directors—law, public works, police, fire, accounts, and charities and corrections. In order that responsibility might be fixed these directors were to appoint their subordinates. At first the system worked well, but in course of time interested officials, to serve their own ends, constructed a dangerous "machine," the ramifications of which reached into the council, the courts, and the state legislature. At length the independent voters organized a revolt, and overthrew the "boss" in the April elections of 1899. The total valuation of property in the city in 1880 was $73,647,194; in 1890, $99,614,055; in 1900, $142,768,280. The tax-rate for all purposes, city, county (Cuyahoga), and state, was in 1890, $29.30, and in 1900, $30.00. The total indebtedness in 1890 was $8,330,035, and in 1900, $14,121,530. The park system includes 22 parks and drives, with an extent of 1326·19 acres. There are 27·94 miles of roads. Since much of the land was presented to the city the money expended ($3,032,944 from 1st January 1894 to 1st January 1900) on the system has largely gone for improvements. In recent history the most notable events were the elaborate celebration of the centennial of the city in 1896 and the street railway strike of 1899, in which the workers attempted to force a redress of grievances and a recognition of their union. Mobs attacked the cars, and cars were blown up by dynamite. The strikers were beaten, but certain abuses were corrected.

CHARLES WHITTLESEY. *Early History of Cleveland*, 1867.—J. H. KENNEDY. *History of the City of Cleveland*, 1896.

(H. E. B.)

**Cleveland, Grover** (1837——), President of the United States from 1885 to 1889, and again from 1893 to 1897, was born in the village of Caldwell, New Jersey, 18th March 1837. His father was a clergyman of the Presbyterian Church. The Clevelands were of good colonial stock, descendants of Moses Cleveland who emigrated from Ipswich, England, in 1635. Grover was the fifth in a family of nine children. They removed to Fayetteville, and afterwards to Clinton, New York. It was intended that Grover should be educated at Hamilton College, but this was prevented by his father's death in 1852. A few years later he drifted westward with twenty-five dollars in his pocket. The autumn of 1855 found him in a law office in the city of Buffalo, where he was privileged to use the books in the library and pick up knowledge by observing what was going on around him. This was the customary way at that time for a young man to equip himself for the legal profession. At the end of four years he passed the required examination for admission to the bar. During these years he had made a place for himself by force of character in the office where he had studied. Industry, intellectual integrity, and calm courage were then, as in after life, his marked traits. It cost him no effort to stand firmly by any principle which he deemed right or to defend any opinion which he had espoused. In 1863 he was appointed assistant district attorney, or public prosecutor, of Erie county, of which Buffalo is the chief city. This was his first public office, and it came to him, like all later preferments, without any solicitation of his own. He was a member of the Democratic party, and Erie county was usually Republican by a decisive majority. In 1869 Mr Cleveland was named by his party for the office of sheriff and was elected. In 1881 he was elected mayor of Buffalo, and in the following year governor of New York, receiving a majority of nearly 200,000 votes. As governor Mr Cleveland's course was marked by the sterling qualities that he had displayed in his other public

positions. His appointees were chosen for their business qualifications. The demands of party leaders were made subordinate to public interests. He promoted the passage of a good civil service law. All bills passed by the legislature were subjected to the governor's laborious personal scrutiny, and the veto power was used without fear or favour.

The Democratic party had been out of power in national affairs more than twenty years. In the interval a great civil war had been fought, slavery had been abolished, and the Union reconstructed. New subjects of national concern had begun to awaken attention. Serious abuses had crept into the civil service, and some scandals of considerable magnitude had been exposed from time to time, pointing to the necessity of radical measures of reform. While the public mind was in a sensitive state on this subject (1884), the Republican party nominated

GROVER CLEVELAND.
(*From a photo by B. J. Falk, Waldorf-Astoria, N. Y.*)

James G. Blaine for president, and the Democrats nominated Mr Cleveland. The latter was elected, gaining the vote of the state of New York by a plurality of 1047 in a total of 1,171,263. He took the oath of office and delivered the usual address 4th March 1885. He had never been in Washington City in a public capacity before. He had been known to the country at large only two years. He was a stranger to most of the men who stood around him at the ceremony of inauguration. Yet it was noticed that he entered upon his new duties with the same equipoise that he had shown in the humbler stations he had filled. When his brief inaugural address was finished, the older statesmen present felt that no apologies were needed for his being there, and that the executive branch of the Government was in safe hands.

Mr Cleveland's first term of four years was uneventful, but was marked by firmness, justice, and steady adherence on his part to the principles which he deemed salutary to the nation. He was especially concerned in promoting a non-partisan civil service. Congress had passed a law in 1883 to classify the subordinate places in the service, and to make entrance to it, and promotion therein, depend upon competitive examination of applicants, instead of mere political influence. The first test of the efficiency and permanence of this law came with the shifting of political power at Washington. The new president stood firmly by the new law. It applied only to places of the rank of clerkships, but the president was authorized to add others to the classified service from time to time. He added 11,757 during his first term.

President Cleveland made large use of the veto power upon bills passed by Congress. The most important one vetoed was the Dependent Pension Bill, a measure of extreme profligacy opening the door, by the vagueness of its terms, to enormous frauds upon the Treasury. In 1887 there was a large and growing surplus in the Treasury. As this money was drawn from the channels of business and locked up in the public vaults, the president looked upon the condition as fraught with danger to the commercial community, and he addressed himself to the task of reducing taxation. About two-thirds of the public revenue was derived from duties on imports, in the adjustment of which the doctrine of protection to native industry had a large place. Mr Cleveland attacked the system with great vigour in his annual message of 1887. He did not propose the adoption of free trade. Yet he alarmed and exasperated the protected classes, among whom were many Democrats, and spurred them to extraordinary efforts to prevent his re-election.

In the following year (1888) the Democrats re-nominated Mr Cleveland, and the Republicans nominated Benjamin Harrison of Indiana. The latter received a majority of the electoral votes and accordingly became president. Mr Cleveland retired to private life and resumed the practice of the legal profession in the city of New York. He had married, 2nd June 1886, Miss Frances Folsom, a daughter of a former law partner in Buffalo.

Congress had passed a law in 1878 requiring the Treasury department to purchase a certain amount of silver bullion each month and coin it into silver dollars to be full legal tender. As no time had been fixed for this operation to cease, it amounted to an unlimited increase of a kind of currency that circulated at a nominal value much above its real value. Both political parties were committed to this policy, and strong passions were aroused whenever it was called in question. Mr Cleveland had written a letter for publication before he became president, saying that a financial crisis of great severity must result if this coinage were continued, and expressing the hope that Congress would speedily put an end to it. In 1890 Congress, which was now controlled by the Republican party, passed the McKinley Tariff Act, which repealed the duties on sugar, from which about $60,000,000 of revenue was derived. Simultaneously it passed a new Pension Bill that added $50,000,000 to the public disbursements. Another measure was enacted which nearly doubled the Government's purchases of silver, to be added to the already vitiated currency. Steps had thus been taken which would change an annual surplus of $100,000,000 into a deficit of $70,000,000 as soon as the new laws should take full effect.

In 1892 Mr Cleveland was nominated for president a third time in succession. The only other man in the nation's history thus distinguished was General Jackson. Mr Cleveland was nominated against the unanimous vote and protest of the delegates in the Democratic National Convention from his own state, New York. This was something quite unprecedented. Mr Harrison was the opposing candidate. Mr Cleveland received 277 electoral

votes and Mr Harrison 145. Mr Cleveland's second term embraced some notable events. The most important was the repeal of the silver legislation, which had been a growing menace for fifteen years. Nearly $600,000,000 of "fiat money" (currency circulating on the faith of the Government) had been thrust into the channels of commerce in addition to $346,000,000 of legal tender notes that had been issued during the civil war. A reserve of $100,000,000 of gold had been accumulated for the redemption of these notes. In April 1893 the reserve fell below this sum. A panic ensued. President Cleveland called an extra session of Congress to repeal the silver law. The House promptly passed the repealing act. In the Senate there was a protracted struggle. The Democrats now had a majority of that body and they were more decidedly pro-silver than the Republicans. The president had undertaken to coerce his own party to do something against its will. This was perhaps his greatest public service. The repealing bill passed the Senate 30th October. The mischief, however, was not ended. The deficit in the Treasury made it inevitable that the gold reserve should be used to meet current expenses. Holders of the Government's legal tender notes anticipating this fact presented them for redemption. Borrowing was resorted to by the Government. Bonds were issued and sold to the amount of $162,000,000. The business world was in a state of constant agitation. Bank failures were numerous and commercial distress widespread. The Republican party, which had laid the train for this disaster, escaped unhurt, because the final explosion took place during a Democratic administration. The underlying causes were too involved and intricate for popular understanding. Among the consequences of the panic was a reduction of wages in many employments, accompanied by labour troubles more or less serious. The centre of disturbance was at Chicago where one Debs, a labour agitator, undertook to compel the Pullman Palace Car Company to raise the wages of its workmen, by boycotting its cars. Twenty-three railways were disabled at one time by the refusal of their employees to operate trains containing Pullman cars, or allow others to do so. The disorder extended to the Pacific coast, causing riot and bloodshed in several places. President Cleveland waited a reasonable time, as he conceived, for the governor of Illinois to put an end to the disorder in that state. On 6th July 1894 he directed the military forces of the United States to clear the way for trains carrying the mails. The rioters in and around Chicago were dispersed in a single day, and within a week the boycott was everywhere broken. No act of his career gave Mr Cleveland more éclat than the suppression of the Debs riots.

On 17th December 1895 President Cleveland astounded the country and the civilized world by sending a special message to Congress virtually recommending war against Great Britain unless she should accept his views respecting an undetermined boundary line between Venezuela and British Guiana. Mr Cleveland's foreign policy hitherto had been marked by prudence, conservatism, and a scrupulous regard for the rights of other peoples. He had put a strong curb on Cuban filibustering. He had withdrawn a treaty negotiated by his predecessor to annex Hawaii, because, as he said, its lawful government had been overthrown by the diplomatic and naval representatives of the United States. In short, he had won almost unbounded confidence, and now when his voice was for war he carried the country with him as no other man could have done. Yet a large body of sober-minded people throughout the country, who had been Mr Cleveland's firm supporters and his chief reliance in all previous emergencies, were now detached from him, more in sorrow than in anger. In the money market the Venezuela message came as "a bolt from the blue." A panic of great severity ensued, a run on the Treasury began, and the president was compelled to make a fresh loan, in time of peace, of $100,000,000. On 12th November 1896 an agreement was made for arbitration of the Venezuelan controversy, in which the contention of Great Britain was safeguarded by a clause that adverse holding during a period of fifty years should make a good title. It has been said that Mr Cleveland was vindicated by the result, but this view overlooks two facts of importance, viz., that war was avoided only by the calmness of the British ministry and the British public; and that Mr Cleveland gave the greatest spur and impetus to the war spirit among his countrymen that the present generation has known. On 8th January 1897 Mr Cleveland transmitted to the Senate a treaty for the arbitration of all future differences between the United States and Great Britain, earnestly recommending its approval. The Senate did not ratify this treaty, but its aims have been partially accomplished on a larger scale by the agreements of the Hague Conference.

During his second term Mr Cleveland added 44,004 places in the civil service to the classified list, bringing them within the rules of the merit system. This was a greater number than all that had been placed in the list before, and brought the whole number up to 86,932.

Mr Cleveland's second term expired 4th March 1897, and he then retired into private life in the university town of Princeton, New Jersey. (H. WH*.)

**Cleves,** in German *Kleve*, a town and watering-place of Prussia, in the Rhine province, between the Rhine and the frontier of Holland, 40 miles by rail north-north-west from Crefeld. It has a monument to the legendary Knights of the Swan (1882); a collection of antiquities, preserved in the town hall; and an agricultural school: also, manufactures of cheese, tobacco, agricultural implements, &c. Population (1885), 10,170; (1895), 10,986; (1900), 14,678.

**Clichy,** or CLICHY LA GARENNE, a town of France, department of Seine, in the arrondissement of St Denis, and immediately north of the outer circle of Paris, of which it is a suburb. Its manufactures include oil and starch. It was a residence of the Merovingian kings, and was then known as *Clippiacum*. Population (1881), 24,223; (1891), 30,561; (1901), 39,521.

**Clifford, William Kingdon** (1845–1879), English mathematician and philosopher, was born 4th May 1845 at Exeter, where his father was a prominent citizen. He was educated at a private school in his native town, at King's College, London, and at Trinity College, Cambridge, where he was elected fellow in 1868, after being second wrangler in 1867 and second Smith's prizeman. In 1871 he was appointed professor of mathematics at University College, London, and in 1874 became fellow of the Royal Society. In 1875 he married Lucy, daughter of John Lane of Barbados, a lady who has since won distinction as a novelist. In 1876 Clifford, a man of high-strung and athletic, but not robust, physique, began to fall into ill-health, and after two voyages to the South died during the third of pulmonary consumption at Madeira, 3rd March 1879. His works, published wholly or in part since his death, are *Elements of Dynamic* (1879–87), *Seeing and Thinking*, popular science lectures (1879), *Lectures and Essays*, with an introduction by Sir F. Pollock (1879), *Mathematical Papers*, with an introduction by Henry J. S. Smith (1882), and *The Common Sense of the Exact Sciences*, completed by Professor Karl Pearson (1885). Owing to his early death, Clifford's abilities and achievements cannot be fairly judged without reference to the opinion formed of

him by his contemporaries. He impressed every one as a man of extraordinary acuteness and originality; and these solid gifts were set off to the highest advantage by quickness of thought and speech, a lucid style, wit and poetic fancy, and a social warmth which made him delightful as a friend and companion. His powers as a mathematician were of the highest order. It harmonizes with the concrete visualizing turn of his mind that, to quote Professor Henry Smith, "Clifford was above all and before all a geometer." In this he was an innovator against the excessively analytic tendency of Cambridge mathematicians. Among his best papers are those "On the Theory of Distances" and "On the Classification of Loci." In his theory of graphs, or geometrical representations of algebraic formulæ, there are valuable suggestions which have been worked out by others. He was much interested too in those curious investigations into imaginary kinds of space by Gauss, Riemann, and Lobatschewsky, which suggest thoughts upon the ultimate nature and source of mathematical truth. As a philosopher Clifford's name is chiefly associated with two phrases of his coining, "mind-stuff" and the "tribal self." The former symbolizes his metaphysical conception, which was suggested to him by his reading of Spinoza. "Briefly put," says Sir F. Pollock, "the conception is that mind is the one ultimate reality; not mind as we know it in the complex forms of conscious feeling and thought, but the simpler elements out of which thought and feeling are built up. The hypothetical ultimate element of mind, or atom of mind-stuff, precisely corresponds to the hypothetical atom of matter, being the ultimate fact of which the material atom is the phenomenon. Matter and the sensible universe are the relations between particular organisms, that is, mind organized into consciousness, and the rest of the world. This leads to results which would in a loose and popular sense be called materialist. But the theory must, as a metaphysical theory, be reckoned on the idealist side. To speak technically, it is an idealist monism." The other phrase, "tribal self," gives the key to Clifford's ethical view, which explains conscience and the moral law by the development in each individual of a "self," which prescribes the conduct conducive to the welfare of the "tribe." Much of Clifford's contemporary prominence was due to his attitude towards religion. Animated by an intense love of truth and devotion to public duty, he waged war on such ecclesiastical systems as seemed to him to favour obscurantism, and to put the claims of sect above those of human society. The alarm was greater, as theology was still unreconciled with the Darwinian theory; and Clifford was regarded as a dangerous champion of the anti-spiritual tendencies then imputed to modern science. (H. ST.)

**Clifton.** See BRISTOL.

**Clinton,** capital of Clinton county, Iowa, U.S.A., situated in 41° 51′ N. lat. and 90° 11′ W. long., on the west bank of the Mississippi river, at an altitude of 589 feet. It is entered by four great railway systems, the Burlington, Cedar Rapids, and Northern, the Chicago, Burlington, and Quincy, the Chicago and North-Western, and the Chicago, Milwaukee, and St Paul Railways, and it is in the main a commercial city. The Mississippi is here crossed by a fine iron bridge, some 4000 feet in length. Clinton is the site of Wartburg College, a Lutheran institution. Population (1880), 9052; (1890), 13,619. By the addition of the city of Lyons in 1895 the population was increased to 23,377, and in 1900 it was 22,698.

**Clinton,** capital of Henry county, Missouri, U.S.A., situated in 38° 23′ N. lat. and 93° 46′ W. long., in the western part of the state, at an altitude of 800 feet. It has three railways, the Missouri, Kansas, and Texas, the Kansas City, Fort Scott, and Memphis, and the Kansas City, Osceola, and Southern. Population (1880), 2868; (1890), 4737; (1900), 5061.

**Clinton,** a town of Worcester county, Massachusetts, U.S.A., situated near the centre of the state, on branches of the Boston and Maine, and the New York, New Haven, and Hartford Railways, at an altitude of 308 feet. It is small in area, containing but 7 square miles of hilly surface. The village of Clinton is on Nashua river, and has extensive manufactures of cotton and woollen goods, wire-cloth, and iron and steel. Population (1880), 8029; (1900), 13,667.

**Clitheroe,** a municipal borough and market town in the Clitheroe parliamentary division (since 1885) of Lancashire, England, on the Ribble, 20 miles south-west of Burnley by rail and 12 miles by road. A public hall has been erected, and in 1895 Clitheroe Castle, formerly extra-parochial, became part of Clitheroe borough. Area, 2381 acres; population (1881), 10,177; (1901), 11,414.

**Clonmel,** an inland town, in the province of Munster, Ireland, on the river Suir, 104 miles south-west of Dublin, on the Waterford, Limerick, and Western Railway. It ceased to be a parliamentary borough in 1885, and in 1898 the portion situated in Waterford was added to Tipperary. By the Local Government Act, 1898, the borough retains its mayor and corporation, which, however, has now practically the status of an urban district council. It is an agricultural centre, and there are frequent fairs. Population (1881), 9325; (1891), 8480; (1901), 10,163. The area of the borough was recently extended and now comprises 1301 acres.

**Closure.** See PARLIAMENT.

**Clovelly,** a fishing village of Devonshire, England, which climbs up the sides of a rocky cleft of the steep (400 feet) south coast of Barnstaple Bay, 11 miles west from Bideford. Its quaintness and the charm of its surroundings make it a favourite excursion from Ilfracombe. Dickens describes the place in *A Message from the Sea*. Population (1901), 621.

**Clyde, The,** a river and firth of Scotland. The river rises as the Daer water in the parish of Crawford, Lanarkshire, 1600 feet above sea-level. Its length from that point to Dumbarton, where the firth may be taken to begin, is 106 miles, and the drainage area is estimated at 1481 square miles. At Lanark (61 miles) it is broken by four falls, which occur within a distance of $3\frac{3}{4}$ miles, the river descending in that space 230 feet, or about 61 feet in the mile. Thence to the sea the fall is about 4 feet and a $\frac{1}{2}$ inch in the mile. The firth measures about 64 miles from Dumbarton to Ailsa Craig, an island lying between Girvan on the Ayrshire coast and the Mull of Kintyre in Argyllshire, and its breadth varies from a mile at Dumbarton to 37 miles on a line drawn through Ailsa Craig. In depth it varies from a minimum of 22 feet (in the navigable channel) at Dumbarton to 99 fathoms between Ardlamont and Kintyre. The tide ascends above Glasgow, to which its rise is to be limited by the construction of a weir, replacing an older one which was destroyed in 1884. Head ports are Glasgow, Port-Glasgow, Greenock, Ardrossan, Irvine, Troon, Ayr, and Campbeltown.

**Clydebank,** a police burgh of Dumbartonshire, Scotland, on the right bank of the Clyde, $6\frac{3}{4}$ miles from Glasgow by road. There are eight stations. Shipbuilding works were planted in 1875 in a purely rural district, and were followed by a large sewing-machine factory. In 1886 the villages of Dalmuir and Yoker and Kilbowie were formed into a burgh, and the municipality is one of the most enterprising in Scotland. The works and factory each

employ about 7000 hands. There are various other works, including the building and repairing yards of the Clyde Navigation Trust. Municipal buildings, including baths, are being erected at a cost of £40,000. Population (1891), 9998; (1901), 18,654.

**Coahuila,** a state of Mexico, bounded on the N. by the United States, on the E. by the state of Nuevo León, on the S. by those of San Luis Potosí and Zacatecas, on the W. and S.W. by Durango, and on the N.W. and W. by Sonora, has an area of 62,376 square miles. In 1879 the population was 130,026, and in 1895 it was 241,026. The flora comprises over sixty varieties of trees of the cold and temperate zones, and fifty belonging to the hot lands. Agriculture is the principal industry, cotton, maize, wheat, beans, sugar-cane, linseed, and about thirty species of leguminous plants being the chief products. Cattle-raising is also extensively followed. The mines are being rapidly developed, especially in the Sierra Mojada, Sierra del Carmen, and in the valley of Santa Rosa. The state, which is divided into five districts and thirty-three municipalities, is one of the most prosperous commercial regions of the Republic, due principally to its excellent railway system. The capital, Saltillo (population, 26,801), is 615 miles from Mexico City by rail. It has good public buildings, a State college, public library, &c., and is noted for its manufacture of shawls (*sarapes*), cotton cloth, knit goods, and flour. Amongst other towns are Parras (8326), Monclova, Ciudad Porfirio Díaz, Viesca, Matamoros.

**Coal.**—During the period that has elapsed since the publication of the article contained in the ninth edition of this Encyclopædia, the development in the methods of winning and working coal has been very considerable, especially in the direction of increasing the output from individual centres of production concurrently with a general diminution in the length of the working day. This has been attended, at any rate in the older coal-fields, with a rapid increase in the depth of workings and greatly increased cost and difficulty in opening new mines, with the result that the comparatively rough methods and appliances of earlier times have given way to more economical methods of working underground, and machinery of more refined construction. The main winding engines, especially, are now constructed upon the most improved types, in order to save fuel in working. Similar improvements have been introduced in the methods of underground haulage, and horses on underground lines have been largely replaced by mechanical traction, the substitution of electric for steam driven motors, and the use of electric locomotives being specially noticeable. In the main operation of getting or removing the coal, machine-cutting has to some extent taken the place of hand labour, although the progress in this direction has been more marked in America than in Europe, and even there the proportion of the output obtained with the use of such mechanical aids is only small when compared with that due to hand labour. This, however, is rapidly changing, owing to the increased flexibility in working of electric motors, which will in the near future probably take the first place in this as in other branches of coal-mining. To enter, however, into the details of these and other changes would involve discussion of mechanical and other technical matters beyond the scope of the present work, which is to be regarded as supplementary to the article in the ninth edition, the additional matter being noticed somewhat in the same order as that previously adopted.

During the past few years the question of the origin and mode of formation of coal has received considerable attention from geologists, but it cannot be said that any authoritative new solution of the problem has been propounded. Speaking generally, the tendency is towards a modification of the view of which Logan, De la Beche, Dawson, and Newberry may be taken as the principal exponents, that coal seams are essentially the remains of forests upon the sites of their original growth, a detrital origin being supposed for a part, if not the whole, of the carbonaceous material, which may have been derived from adjacent higher-lying land by the action of river currents. This view, known as the delta hypothesis, has found considerable favour in France, especially from study of the coal-field of Saint Étienne, where the seams vary very irregularly in thickness and character, in a way which seems to be incompatible with the hypothesis of a tranquil accumulation *in situ*. As regards the changes involved in the actual transformation of plant structures into lignite and coal, one of the most important series of researches is due to M. B. Renault (*Bulletin de la Société de l'Industrie Minérale*, 3 Ser., vol. xiii. p. 865), who, starting from the study of peat, finds that the chief agents in the transformation of cellulose into peaty substances are saprophytic fungi and bacterial ferments. As the former are only active in the presence of air, while the latter are anærobic, the greater or less activity of either agent is conditioned by variation in the water-level of the bog. The destructive agency of bacteria seems to be limited by the production of ulmic acid of the composition, carbon 65·31, hydrogen 3·85 per cent., which is a powerful antiseptic. By the progressive elimination of oxygen and hydrogen, partly as water and partly as carbon dioxide and marsh gas, the ratio of carbon to oxygen and hydrogen in the residual product increases in the following manner:—

*Origin and composition of coal.*

| | C : H. | C : O. |
|---|---|---|
| Cellulose | 7·2 | 0·9 |
| Peat | 9·8 | 1·8 |
| Lignite, imperfect | 12·2 | 2·4 |
| ,, perfect | 12·6 | 3·6 |

The constituents of lignite are generally similar to those of peat, with the addition of some animal (infusorial) remains, the degraded vegetable tissues forming a paste originally plastic, which has converted the more resisting parts of the plants into a compact mass. From the figures given above it will be seen that oxygen is less rapidly eliminated than hydrogen, the change to lignite being similar to that obtaining in the case of peat, but further advanced.

Bituminous shale and Boghead or Torbane Hill coal are considered by Renault to be mainly alteration-products of masses of gelatinous fresh-water algæ, which by an almost complete elimination of oxygen have been transformed into substances approximating to the formulæ $C_2H_3$ and $C_3H_5$, where $C:H = 7{\cdot}98$ and $C:O+N = 46{\cdot}3$. In cannel coals the prevailing vegetable constituents are spores of cryptogamic plants, algæ being rare and in many cases absent. The detection of bacilli in coal is a difficult matter, owing to its opacity; but by making very thin sections and employing high magnification, 1000 to 1200 diameters, Renault has been enabled to detect numerous forms in the woody parts included in coal. One of these, named *Micrococcus carbo*, in many respects resembles the living *Cladothryx* found in the wood of trees buried in peat-bogs in process of formation. Clearer evidence has been obtained from wood partially mineralized by silica or carbonate of lime included in the coal.

The transformation of woody fibre into coal is attended with considerable contraction, which may be from $\frac{1}{12}$ to $\frac{1}{13}$ of the original volume, but this is unequally distributed; it is mainly in the direction of the thickness, so that minute objects seen on the flat may keep nearly their

original dimensions. The evidence for this is to be seen in the large number of microphotographs in the memoir just referred to, which represents the result of twenty-one years' work. Approximately the change of wood into coal, and the proportion of the valuable product eliminated, may be represented as follows:—

$$\underset{\text{Cellulose.}}{4(C_6H_{10}O_5)} = \underset{\text{Coal.}}{C_9H_6O} + \underset{\text{Methane.}}{7CH_4} + \underset{\text{Carbon dioxide.}}{8CO_2} + \underset{\text{Water.}}{3H_2O}.$$

The solid product $C_9H_6O$ corresponds to an average bituminous coal of the composition, carbon 83·1, hydrogen 4·6, oxygen 12·3 per cent., and represents about 20 per cent. of the original weight of cellulose and 45 per cent. of its heating power. Another aid to the study of the structure of coal has been found by H. M. Couriot (*Annales de la Société Géologique de Belgique*, vol. xxiii. p. 105) in Rontgen photography, the carbonaceous or combustible portion being readily permeable by X-rays, while the mineral matter is comparatively opaque. In this way photographs showing the arrangement of the ash in parallel thin bands may be obtained from a piece of coal about an inch thick when exposed perpendicularly to the planes of bedding; included masses of iron pyrites appear as dark spots. The suggestion has also been made to use this agent as a means of determining the proportion of incombustible matter in coal, the sample being ground to powder and enclosed in a wooden box of a long, tapered wedge form, with a fluorescent screen along one side, which becomes sensitive to the rays passing through a greater or less thickness of the coal wedge in proportion to its freedom from mineral matter. According to Kotte (*Stahl u. Eisen*, vol. xx. p. 392), however, this method is unreliable for quantitative purposes, since for equal contents of ash the permeability varies with the nature of the mineral matter, a small proportion of iron being more effective in increasing the opacity than much larger amounts of the ordinary ash constituents, silica, alumina, &c. Thus for equal total amounts of ash, that containing the least amount of iron, 0·07 per cent., gave the clearest photograph, and that with 5·4 per cent. the worst.

**Development of coal-fields.**

The existence of coal-fields below the secondary strata in the south-east of England, along the line joining the South Wales and Westphalian basins, as inferred by the late Mr Godwin Austen, has of late years been verified by the discovery of carboniferous strata with workable coal seams below the chalk and other secondary formations in the vicinity of Dover, where in 1890 a borehole reached coal at a depth of 1180 feet from the surface, and in a further depth of 1042 feet several seams were subsequently proved of various thicknesses up to 4 feet. In another boring at Ropersole, between Dover and Canterbury, 1774 feet deep, the last 197 feet are in carboniferous strata with two coal seams. In the Dover sinking a bed of oolitic brown iron ore, resembling that of Cleveland and Luxemburg, has been discovered at a depth of 600 feet. Most extensive developments have also been made on the eastern side of the great Midland coal-field, and numerous pits have been sunk through the magnesian limestone and other overlying strata along the whole length of the basin, from Yorkshire to Nottinghamshire. At South Carr, near Gainsborough, in Lincolnshire, the regular succession of the seams in the coal-field has been proved under 1700 feet of New Red Sandstone rocks down to the Barnsley hard coal at 3186 feet, the greatest depth at which coal has as yet been proved in the United Kingdom. It has been suggested that the coal brought up by the trawlers on the fishing bank known as the Coal Pit in the North Sea, 65 miles east of the mouth of the Humber, may be derived from the eastern outcrop of the seams in this basin, which, if this be the case, would be the largest coal-field in Europe.

In the Rhenish Westphalian coal basin, the most important one in Continental Europe, great activity prevails both in exploration and opening of new mines. This is in many respects similar in structure to that of South Wales, a large number of seams, none very thick, being distributed through a great thickness of strata. These are folded transversely into three principal troughs whose axes have a general north-westerly strike, but with the important difference that the carboniferous strata are exposed for only a short distance along the southern margin, the greater part being covered by secondary and tertiary rocks, which increase in thickness rapidly to the north. The newer sinkings have therefore to pass through constantly increasing depths of water-bearing measures, with the result that special methods of overcoming such difficulties have been brought to a high degree of perfection in this region. According to Schultz (*Mittheilungen über den Niederrheinisch-Westfälischen Steinkohlen-Bergbau*, 1901, p. 28) the proved area in 1900 was 1157 square miles, estimated to contain in workable seams:—

| | Tons. |
|---|---|
| Down to 700 metres (2300 feet) | 11,000,000,000 |
| 700 to 1000 metres (3280 feet) | 18,300,000,000 |
| 1000 to 1500 metres (4920 feet) | 25,000,000,000 |
| Total within maximum working depth | 54,300,000,000 |
| At greater depths | 75,000,000,000 |

The development of the coal-fields of the newer mining regions can be best appreciated by the statistical table compiled by Mr B. H. Brough in the *Journal of the Iron and Steel Institute*:—

| | | Tons. |
|---|---|---|
| Europe— | | |
| United Kingdom | 1900 | 225,170,360 |
| Germany, coal | ,, | 109,271,726 |
| ,, lignite | ,, | 40,279,332 |
| France | ,, | 33,270,385 |
| Belgium | 1899 | 22,072,068 |
| Austria, coal | ,, | 11,455,139 |
| ,, lignite | ,, | 21,751,794 |
| Hungary, coal | ,, | 1,238,855 |
| ,, lignite | ,, | 4,292,584 |
| Spain | 1900 | 2,680,193 |
| Russia | ,, | 13,104,000 |
| Holland | 1899 | 212,973 |
| Bosnia, lignite | ,, | 303,425 |
| Rumania, ,, | ,, | 78,000 |
| Servia, ,, | 1896 | 11,726 |
| Italy, ,, | 1899 | 388,534 |
| Sweden, ,, | ,, | 239,344 |
| Asia— | | |
| India | ,, | 4,937,000 |
| Japan | 1898 | 6,598,033 |
| Borneo | 1899 | 35,675 |
| Africa— | | |
| Transvaal | 1898 | 1,938,424 |
| Natal | 1899 | 324,161 |
| Cape Colony | ,, | 209,000 |
| America— | | |
| United States | 1900 | 238,877,182 |
| Canada | 1899 | 4,142,242 |
| Mexico | ,, | 113,191 |
| Peru | 1898 | 10,000 |
| Australasia— | | |
| New South Wales | 1900 | 5,507,497 |
| Queensland | 1899 | 494,000 |
| Victoria | ,, | 262,380 |
| Western Australia | ,, | 54,000 |
| Tasmania | ,, | 42,000 |
| New Zealand | ,, | 975,234 |

**Shaft-sinking.**

In putting down new pits, while the methods formerly described are generally followed, much has been done towards accelerating the rate of work. In hard ground for instance, boring machines, supported on radial arms attached to a central pillar, are

substituted for hand labour. Twelve or more holes are bored and charged, and after the removal of the machines and their support to a safe height, are fired either simultaneously or in groups, the boring frame being replaced after the removal of the broken stuff. Much time can also be saved when sinking and walling are carried on simultaneously by the method used in several deep sinkings in South Wales by Professor W. Galloway, where the bricklayers work upon a suspended platform with hinged flaps which completely fill the hollow of the shaft when in use, but can be rapidly shifted by the engine at the surface as the top of the wall rises. One or more central holes are provided with wire-rope guides, to allow of the passage of the bucket bringing up the débris broken by the sinkers. In sinking through soft or water-bearing strata within moderate depths, excavation by hand is practised, the ground being secured with segmented cast-iron tubbing and pumps or water tubs used to keep the bottom dry when the inflow does not exceed 6 or 8 tons of water per minute. Beyond this, the water-cost becomes so great that the Kind and Chaudron system of boring, which has of late years been considerably improved in detail, particularly by the addition of methods for continuously removing the boring detritus, is usually to be preferred. With increase in depth, however, the thickness and weight of the cast-iron tubbing in a large shaft become almost unmanageable; in one instance, at a depth of 1215 feet, the bottom rings in a shaft 14½ feet in diameter are about 4 inches thick, which is about the limit for sound castings. It has therefore been proposed, for greater depths, to put four columns of tubbings of smaller diameters, 8½ and 5½ feet, in the shaft, and fill up the remainder of the boring with concrete, so that with thinner and lighter castings a greater depth may be reached. This, however, has not as yet been tried. Another extremely useful method of sinking through water-bearing ground, introduced by Messrs A. & H. T. Poetsch in 1883, and originally applied to shafts passing through quicksands above brown coal seams, has of late years been applied with advantage in opening new pits through the secondary and tertiary strata above the Coal Measures in the north of France and Belgium, some of the most successful examples being those at Lens, Anzin and Vicq, in the north of France basin. In this system the soft ground or fissured water-bearing rock is rendered temporarily solid by freezing the contained water within a surface a few feet larger in diameter than the size of the finished shaft, so that the ground may be broken either by hand tools or blasting in the same manner as hard rock. The miners are protected by the frozen wall, which may be 4 or 5 feet thick. The freezing is effected by circulating brine (calcium chloride solution) cooled to 5° F. through a series of vertical pipes closed at the bottom, contained in boreholes arranged at equal distances apart around the space to be frozen, and carried down to a short distance below the bottom of the ground to be secured. The chilled brine enters through a central tube of small diameter, passes to the bottom of the outer one and rises through the latter to the surface, each system of tubes being connected above by a ring main with the circulating pumps. The brine is cooled in a tank filled with spiral pipes, in which anhydrous ammonia, previously liquefied by compression, is vaporized *in vacuo* at the atmospheric temperature by the sensible heat of the return-current of brine, whose temperature has been slightly raised in its passage through the circulating tubes. When hard ground is reached, a seat is formed for the cast-iron tubbing, which is built up in the usual way and concreted at the back, a small quantity of caustic soda being sometimes used in mixing the concrete, to prevent freezing. In a recent application of this method at Vicq, near Anzin, two shafts of 12 and 16·4 feet diameter, in a covering of cretaceous strata, were frozen to a depth of 300 feet in fifty days, the actual sinking and lining operations requiring ninety days more. The freezing machines were kept at work for 200 days, and 2191 tons of coal were consumed in supplying steam for the compressors and circulating pumps. In some cases cement concrete has been usefully employed in lining shafts instead of brickwork, a layer about 10 inches thick being much stronger than an equal thickness of brickwork. This is especially applicable to the repair of old shafts, and also to the lining of the excavations for underground pumping engines. Some excellent examples of this method were shown at Paris in 1901 by the Cockerill Company of Seraing. The cement used, as well as the ballast in the concrete, was produced from blast-furnace slags.

***Coal-working at great depths.***

With the increased activity of working characteristic of modern coal mining, the depth of the mines has rapidly increased, and at the present time the level of 4000 feet, formerly assumed as the possible limit for working, has been nearly attained. The following list gives the depths reached in the deepest collieries in Europe in 1900, from which it will be seen that the larger number, as well as the deepest, are in Belgium:—

| | | Metres. | Feet. |
|---|---|---|---|
| Saint Henriette, Cie des Produits, Flenu, | Belgium | 1150 | 3773 |
| Viviers Gilly . . . . . . . | ,, | 1143 | 3750 |
| Marcinelle, No. 11, Charleroi . . . | ,, | 1075 | 3527 |
| Marchienne, No. 2 ,, . . . | ,, | 1065 | 3494 |
| Agrappe, Mons . . . . . . | ,, | 1060 | 3478 |
| Pendleton dip workings . . . | Lancashire | 1059 | 3474 |
| Sacré Madame, Charleroi . . . | Belgium | 1055 | 3461 |
| Ashton Moss dip workings . . . | Lancashire | 1024 | 3360 |
| Ronchamp, No. 11 pit . . . . | France | 1015 | 3330 |
| Viernoy, Anderlues . . . . . | Belgium | 1006 | 3301 |
| Astley Pit, Dukinfield, dip workings . | Cheshire | 960 | 3150 |
| Saint André, Poirier, Charleroi . . | Belgium | 950 | 3117 |

The greatest depth attained in the Westphalian coal at the present time is at East Recklinghausen, where there are two shafts 841 metres (2759 feet) deep.

The subject of the limiting depth of working has been very fully studied in Belgium by Professor Stassart of Mons ("Les Conditions d'exploitation à grande profondeur en Belgique," *Bulletin de la Société de l'Industrie Minérale*, 3 Ser., vol. xiv.), who finds that no special difficulty has been met with in workings above 1100 metres deep from increased temperature or atmospheric pressure. The extreme temperatures in the working faces at 1150 metres were 79 degrees and 86 degrees F., and the maximum in the end of a drift, 100 degrees; and these were quite bearable on account of the energetic ventilation maintained, and the dryness of the air. The yield per man on the working faces was 4·5 tons, and for the whole of the working force underground, 0·846 tons, which is not less than that realized in shallower mines. From the experience of such workings it is considered that 1500 metres would be a possible workable depth, the rock temperature being 132 degrees, and those of the intake and return galleries, 92 degrees and 108 degrees respectively. Under such conditions work would be practically impossible except with very energetic ventilation and dry air. It would be scarcely possible to circulate more than 120,000 to 130,000 cubic feet per minute under such conditions, and the number of working places would thus be restricted, and consequently the output reduced to about 500 tons per shift of ten hours, which could be raised by a single engine at the surface without requiring any very different appliances from those in current use.

Except in modifications of details, no great alterations in the methods of working away coal seams are to be noted, the pillar-and-stall system of removal by two stages and the long-wall or continuous method being representative of all the systems in use. In Europe the tendency is toward the substitution of the latter method wherever possible, but in America pillar-and-stall work in some form is most prevalent. In France and Germany the method of filling the space left by the removal of the coal with waste rock, quarried underground or sent down from the surface, which was originally used in connexion with the working of thick inclined seams by the method of horizontal slices, is now largely extended to long-wall workings on thin seams, and in Westphalia is made compulsory where workings extend below surface buildings, and safety pillars of unwrought coal are found to be insufficient. With careful packing it is estimated that the surface subsidence will not exceed 40 per cent. of the thickness of the seam removed, and will usually be considerably less. The material for filling may be the waste from earlier workings stored in the spoil banks at the surface; where there are blast furnaces in the neighbourhood, granulated slag mixed with earth affords excellent packing. In thick seams packing adds about 5d. per ton to the cost of the coal, but in thinner seams the advantage is on the other side. In America culm and waste are washed into the workings by water, giving a compact mass when the water has drained away.

***Methods of working.***

In securing the roof and sides of coal workings, malleable iron and steel are now used to some extent instead of timber, although the consumption of the latter material is extremely large, the forest areas of Northern Europe and Russia and other countries being laid under contribution, in addition to native woods, to furnish the ever-increasing quantities of pit wood required. As a substitute for timber props at the face, pieces of steel joists, with the web cut out for a short distance on either end, with the flanges turned back to give a square-bearing surface, have been introduced by Mr Firth. In large levels only the cap pieces for the roof are made of steel joists, but in smaller ones complete arches made of pieces of rails fish-jointed at the crown are used. For shaft linings steel rings of H or channel section supported by intermediate struts are also used, and cross-bearers or buntons of steel joists and rail guides are now generally substituted for wood.

***Coal-cutting machines.***

The substitution of machinery for hand labour has been comparatively slow as compared with the changes in other directions, and is by no means general in Europe, although in America the progress has been considerable, especially since the systematic introduction of electric power underground. Of the earlier types, those with a swinging pick, imitating the action of a miner in undercutting, represented by the machines of Firth & Donisthorpe and Jones & Levick, have been superseded by those of the circular or chain saw types, to which have been added others with percussive and rotatory drill cutters. In the North of England and Midland districts the circular-saw type, cutting in a horizontal plane at or near the ground-level, is largely used, one of the best known being the Diamond coal-cutter of Mr W. Garforth, which is similar in construction to Winstanly & Barker's machine (vol. vi. Fig. 14, p. 68), but cuts to a depth of 5½ or 6 feet. The Baird type of chain-saw machine, working round a fixed over-hanging frame, is still used in Scotland, and a modified form adapted for electric driving has been lately proposed by Mr E. K. Scott (*Proc. Inst. Civ. Eng.* vol. cxliv. p. 247). In the United States percussive and chain-saw machines are used almost exclusively. The former of these are represented by the Harrison, Sullivan, & Ingersoll-Sergeant machines, which are essentially large rock-drills without turning gear for the cutting tool, and mounted upon a pair of wheels placed so as to allow the tool to work on a forward slope. When in use the machine is placed upon a wooden platform inclining towards the face, upon which the miner lies and controls the direction of the blow by a pair of handles at the back of the machine, which is kept stationary by wedging the wheels against a stop on the platform. These machines, which are driven by compressed air, are very handy in use, as the height and direction of the cut may be readily varied; but the work is rather severe to the driver on account of the recoil shock of the piston, and an assistant is necessary to clear out the small coal from the cut, which limits the rate of cutting to about 125 square feet per hour. The chain machines represented by the Jeffrey, Link-Belt, and Morgan-Gardner coal-cutters are similar in principle to the Baird machine, the cutting agent being a flat link chain carrying a double set of chisel points, which are drawn across the coal face at the rate of about 5 feet per second; but, unlike the older machines, in which the cutting is done in a fixed plane, the chain with its motor is made movable, and is fed forward by a rack-and-pinion motion as the cutting advances, so that the cut is limited in breadth (3½ to 4 feet), while its depth may be varied up to the maximum travel (8 feet) of the cutting frame. The carrying frame, while the work is going on, is fixed in position by jack-screws bearing against the roof of the seam, which, when the cut is completed, are withdrawn, and the machine shifted laterally through a distance equal to the breadth of the cut and fixed in position again. The whole operation requires from 8 to 10 minutes, giving a cutting speed of 120 to 150 square feet per hour. These machines weigh from 20 to 22 cwt., and are mostly driven by electric motors of 25 up to 35 H.P. as a maximum. By reason of their intermittent action they are only suited for use in driving galleries or in pillar-and-stall workings. The saving effected by the substitution of machines for hand coal-cutting in English Midland collieries varies from about 9·75d. to 21d. per ton, about two-thirds of this being due to the smaller fall of slack as compared with that produced in hand driving. In America the saving is less apparent, owing to the increased wages demanded by the drivers and assistants, and the principal advantage is in the increased rate of production, which is from 6 to 7 tons daily per man underground, instead of 3 to 4 tons with hand work. In 1898, 25·3 per cent. of the output of Pennsylvania (15 out of 59 million tons) was obtained by machine cutting, which was exclusively confined to the bituminous coal district; the coal in the anthracite districts is too hard and the seams too much disturbed to allow the cutting to be done except by hand.

***Ventilation and lighting.***

In new mines the ventilation is now generally effected by an exhausting fan, the old system of ventilating furnaces being almost obsolete. The large slow-going fan of the Guibal type still maintains its character for efficiency, although the tendency is towards using smaller and more rapidly-driven machines; and the heavy casings and chimneys in brickwork are generally giving way to lighter structures in sheet-iron. Fans with curved instead of flat blades, and with spiral diffusers resembling turbines, are now largely used, that of M. Rateau being specially popular with Continental colliery engineers, on account of its high mechanical efficiency. The use of small auxiliary blowing ventilators underground, for carrying air into workings away from the main circuits, which was largely advocated a few years since, has lost its popularity, but a useful substitute has

been found in the induced draught produced by jets of compressed air or high-pressure water blowing into ejectors. With a jet of $\frac{1}{200}$-inch area, a pipe discharging $1\frac{2}{3}$ gallon of water per minute at 165 ℔ pressure per square inch, a circulation of 850 cubic feet of air per minute was produced at the end of a level, or about five times that obtained from an equal volume of air at 60 ℔ pressure. The increased resistance, due to the large extension of workings from single pairs of shafts, the ventilating currents having often to travel several miles to the upcast, has led to great increase in the size and power of ventilating fans, and engines from 250 to 500 H.P. are not uncommonly used for such purposes. Electric driving from central-power stations has been found to be well suited for this particular use.

The numerous forms of safety-lamps employed in fiery mines have received several additions in late years, and old forms have been improved and modified to meet the requirements of safety in air-currents travelling at a high velocity. Prominent among the new forms is the Hepplewhite-Gray lamp, which has a conical glass surrounding the light, with a gauze chimney, protected by an outer metal cylinder; the air supply to the flame is carried downwards through three tubes forming the standards of the cage. This, in addition to giving a good light overhead owing to the shape of the glass, is peculiarly sensitive to gas, and therefore valuable in testing for fire-damp. Other approved lamps are the Deflector and those of Marsaut & Mueseler when specially bonneted to resist extra high-speed currents. The illuminant now generally used in Great Britain is a mixture of rape oil with half its volume of petroleum, which is more suitable than vegetable or animal oil alone. In Germany Wolf's lamp, burning benzoline or petroleum spirit upon an asbestos wick, is very popular, as giving a much better light than oil. Special care is, however, required in filling, so that no free liquid may be left in the holder; the spirit must be entirely absorbed by a filling of sponge, and any superfluous quantity poured off. Portable electric lamps, supplied by accumulators or dry batteries, have been introduced into coal-mines; but owing to the weight and cost, their use is as yet very restricted. For the use of exploring parties after explosions, where irrespirable gases are encountered and compressed air or oxygen must be carried, they are especially valuable, as light is obtained without any demand on the air supply. Fire-damp, when present in the air, lengthens the flame of an ordinary safety-lamp, but the effect is not apparent with less than about $2\frac{1}{2}$ per cent. of gas; and for more delicate testing, special lamps with non-luminous flames are adopted. In Pieler's lamp, which is of the ordinary Davy form, alcohol is burned on a silk wick, and a screen is provided so that the flame can be hidden. When exposed in air containing $\frac{1}{4}$ per cent., a cap of $1\frac{1}{8}$ inch is formed, which increases to 2 inches with $\frac{1}{2}$ per cent., and with $1\frac{1}{4}$ per cent. the lamp is filled with a deep blue glow. Another and more useful method is that of Dr. F. Clowes, who uses a hydrogen flame 0·4 inch long, obtained by attaching a cylinder containing compressed hydrogen to an ordinary safety-lamp; the gas is turned into the oil flame, which is for the time extinguished, and relighted when the observation is finished. As little as 0·2 per cent. of gas can be detected by this method.

*Coal dust.*

The danger arising from the presence of coal dust in the air of dry mines, with or without the addition of fire-damp, has, since it was first pointed out by Professor W. Galloway, been made the subject of special inquiries in the principal European countries interested in coal mining; and although certain points are still debatable, the fact is generally admitted as one calling for special precautions. The conclusions arrived at by the Royal Commission of 1891, which may be taken as generally representative of the views of British colliery engineers, are as follows:—

1. The danger of explosion when gas exists in very small quantities is greatly increased by the presence of coal dust.
2. A gas explosion in a fiery mine may be intensified or indefinitely propagated by the dust raised by the explosion itself.
3. Coal dust alone, without any gas, may cause a dangerous explosion if ignited by a blown-out shot; but such cases are likely to be exceptional.
4. The inflammability of coal dust varies with different coals, but none can be said to be entirely free from risk.
5. There is no probability of a dangerous explosion being produced by the ignition of coal dust by a naked light or ordinary flame.

Danger arising from coal dust is best guarded against by systematically sprinkling or watering the main roads leading from the working faces to the shaft, where the dust falling from the trams in transit is liable to accumulate. This may be done by water-carts or hose and jet, but preferably by finely divided water and compressed air distributed from a network of pipes carried through the workings. This is now generally done, and in some countries is compulsory, when the rocks are deficient in natural moisture. According to Behrens, the quantity of water required to keep down the dust in a mine raising 850 tons of coal in a single shift was 28·8 tons, apart from that required by the jets and motors. The distributing network extended to more than 30 miles of pipes, varying from $3\frac{1}{2}$ inches to 1 inch in diameter.

*Safety explosives.*

In all British coal-mines, when gas in dangerous quantities has appeared within three months, and in all places that are dry and dusty, blasting is prohibited, except with permitted explosives, whose composition and properties have been examined at the testing station at the Royal Arsenal, Woolwich. A list of those sanctioned is published by the Home Office. They are mostly distinguished by special trade names, and are mainly of two classes—those containing ammonium nitrate and nitro-benzole or nitro-naphthalene, and those containing nitro-glycerine and nitro-cellulose, which are essentially weak dynamites. The safety property attributed to them is due to the depression of the temperature of the flame or products of explosion to a point below that necessary to ignite fire-damp or coal dust in air from a blown-out shot. New explosives that are found to be satisfactory when tested are added to the list from time to time, the composition being stated in all cases.

*Pumping.*

The most noticeable feature in the arrangements for draining modern collieries is the general abandonment of surface engines, with heavy wooden or iron rods in the shaft, in favour of high-speed engines placed underground, and supplied with power either by steam sent down from the surface, or in a less direct manner by water circulating under high pressure or by electric transmission. Compressed air may also be used, but is mostly restricted to small installations, on account of its low mechanical efficiency. The earlier underground steam-pumps were very wasteful machines, on account of the low steam pressures available and the loss by condensation in the steam conduit pipes, but with improvements in construction and the adoption of multiple expansion in several cylinders with high initial steam pressure, the fuel consumption has been reduced nearly to the level of that of good surface or marine engines. Several engines of this class of considerable size have been erected in the deep Westphalian pits, *e.g.*, one of 1900 to 2000 H.P., lifting a maximum quantity of 17 tons of water per minute 1300 feet high, with an expenditure of

$10\frac{1}{2}$ to 11 tons of steam at 180 ℔ pressure per hour, the loss by condensation in the steam supply pipe, which is rather more than a quarter of a mile long, being only 12 cwt. per hour. The engines are of the four-cylinder triple expansion class in twin tandem form. A still larger example of the same kind, now under construction for the Harpen Collieries, is intended for a maximum duty of 25 tons of water raised 1640 feet per minute, representing about 3500 H.P. Probably the heaviest existing colliery pumping plant is that at the Miike Colliery in Japan, which has a capacity of 40·3 tons per minute lifted 900 feet. This is done by four Davy compound engines placed side by side at the surface, each working two lines of rods in the shaft, which is of the unusual size of 40 by 12 feet. In the indirect system of hydraulic transmission a steam-engine at the surface pumps water continuously into a system of pipes against a resistance of 2500 to 3000 ℔ per square inch, and the pressure so obtained drives a pump underground through a pipe carried down the shaft, the water returning by another pipe to the surface engine in a continuous circuit. This system, originally used as a method of transmitting small power underground by Messrs West & Darlington in Cornwall, and since developed to a high degree by Mr R. Moore, Mr H. Davey, Messrs Kaselowsky & Prott, and other hydraulic engineers, has many advantages, particularly in the small dimension of the engines, which require much smaller walled chambers in the mine than steam-engines of similar power; but great care is required to keep the driving water perfectly clean, to prevent wear on the valves, as on account of the high pressure employed a very small leakage gives rise to a large waste of power. Engines of this class are made in a great variety of forms, both reciprocating with long stroke, and rotating with short stroke high speed pumps. The largest class in use forces 7 tons per minute 2000 to 2300 feet high. Pumping by electric transmission, although of comparatively recent introduction, has taken up a leading position in deep mining, and probably will be almost exclusively used at no very distant date. At first it was mainly applied to small special purposes, such us raising feeders of water from isolated workings to a main pumping engine, but now large self-contained installations, with generating dynamos from 800 to 1000 H.P., are in use. In the largest plant of this class, intended for a maximum duty of 15 tons per minute lifted 1260 feet, three compound engines of 750 H.P. are provided, each driving its pump by a separate generator and motor by an alternating current of 2000 volts. Under ordinary conditions the water charge in coal mining is considerable, and in old mines with a large extent of open workings it becomes very burdensome, the weight of water to be lifted being often many times that of the coal produced. In the Westphalian coal-field in 1899, 169·5 million tons of water were lifted for an output of 55 million tons of coal, or rather more than 3 tons to 1 ton of coal. In the older and partly worked-out districts the proportion rises to as much as 8 to 1. In South Staffordshire, where the ground is honeycombed with old thick coal workings, from 24 to $28\frac{1}{2}$ tons of water per ton of coal raised were pumped in 1898.

***Winding from deep mines.***

The principal improvements in the hoisting arrangements of modern colliery plants have been in the direction of larger engine power, and arrangements for loading and discharging the cages with the smallest loss of time. Where deep cages, carrying from four to six tiers of tubs superposed, are employed, Fowler's hydraulic arrangement, using auxiliary cages upon hydraulic lifts at the surface and pit bottom (*Ency. Brit.* vol. vi. p. 76), is one of the best devices for the latter purpose. It has been lately extended by Tomson to six- and eight-decked cages. In another arrangement by Darphin the cage is received at the surface by hydraulic keeps, which support it at its highest level and progressively lower it to bring each deck in succession down to the landing place, when the loaded tubs are run out and replaced by empty ones without moving the main engine. The time occupied in landing and changing the load of twelve tubs is from 20 to 25 seconds. Many improvements have been made in the construction of winding engines of late years, in order to reduce the consumption of steam, by the adoption of variable expansion gear, and the substitution of compound for single engines. The two-cylinder compound engine has been used in some cases, but a preferable form is the twin tandem compound adopted by Mr W. Galloway at Llanbradach in 1894, and since introduced into many of the deep pits in France and Germany. The steam is exhausted into a central condenser, where a permanent vacuum is maintained, as the intermittent nature of the work prevents the use of a separate condenser.

In very deep mines the moment of the load at different points of the lift varies considerably when a cylindrical drum is used, and becomes negative during the last part of the lift, owing to the excess weight of the rope on the descending side. In order to keep the work of the engines more nearly constant, various systems of counterbalancing by auxiliary chains, &c., have been adopted, as previously described. In addition to these, Koepe's method of winding has of late years obtained some favour. In this system the drum is replaced by a disc with a grooved rim for the rope, which passes from the top of one cage over the guide pulley, round the disc, and back over the second guide to the second cage, and a tail rope, passing round a pulley at the bottom of the shaft, connects the bottoms of the cages, so that the dead weight of cage, tubs, and rope is completely counterbalanced at all positions of the cages, and the work of the engine is confined to the useful weight of coal raised. Motion is communicated to the rope by frictional contact with the drum, which is covered through about one-half of the circumference. This system was used for some time at Bestwood, in Nottinghamshire, and is still employed at Sneyd, in North Staffordshire. In Belgium it was tried in a pit 940 metres deep, but has since been replaced by flat hempen ropes, and is now restricted to shallower workings at 250 metres. In Westphalia it is applied in about thirty different pits to a maximum depth of 761 metres. The system of counterbalancing by the use of spiral drums is limited by their excessive size and weight when both ropes wind on the same drum. This has to some extent been met by Tomson's modification, where a separate conical drum is used for each rope. They are mounted upon parallel axes, but turned in opposite directions, the base of one towards the point of the other. In this way the weight and breadth of the drum is notably diminished, but the engine is complicated by the addition of a rocking beam and additional coupling rod for working the second drum. An engine of this kind has been in use since 1896 at Preussen Colliery, Westphalia, and has also been adopted for the 1015-metre pits at Ronchamp, in France.

As regards the form and material of winding ropes, while round ropes of steel wire of high tensile strength and tapered in thickness for great depths are generally preferred in England and Germany, opinion in Belgium, and to some extent in the north of France, favours the use of flat ropes made of "aloes" or Manilla hemp, really plantain fibre. Those in deep pits are of considerable size and weight, *e.g.*, tapering from 15·6 inches to 9 inches in breadth and 2 inches to $1\frac{1}{8}$ inch in thickness, and weighing 14·3

tons per 1200 metres. Stassart (*loc. cit.* p. 465) considers that they should be used in preference to flat steel wire ropes down to 1500 metres. The new large engine of the Anzi Company, to lift a gross load of 15 tons from 750 metres, is also fitted with flat ropes. These are 3 inches thick and $22\frac{1}{2}$ inches broad at the drum end, weigh 18 tons each, and coil upon a diameter increasing from 14 to 26·3 feet.

The continuous change in direction experienced by the rope between the head-gear pulley and the drum in coiling on or off (the so-called "angling" of the rope) is a source of wear when the depth becomes considerable. This is to some extent diminished by placing the engine at some distance from the pit, up to 50 or 60 yards; but a complete remedy has been proposed by Mr W. Morgan, who uses a winding engine upon a frame carried upon two lines of railway, which is shifted laterally though a distance equal to the thickness of the rope at each revolution of the drum, so that the end of the coil is always in the same vertical plane with the guide pulley and the cage. The first engine of this class has just been erected at Dolcoath tin mine in Cornwall, at a shaft which is to be carried down to 3000 feet in depth.

In the United Kingdom the drawing of coal is generally confined to the day shift of eight or ten hours, with an output of 100 to 150 tons per hour, according to the depth, capacity of coal tubs, and facilities for landing and changing tubs. With Fowler's hydraulic arrangement 2000 tons are raised 600 yards in eight hours. In the deeper German pits, where great thicknesses of water-bearing strata have to be traversed, the first establishment expenses are so great that in order to increase output the shaft is sometimes provided with a complete double equipment of cages and engines. In such cases the engines may be placed in line on opposite sides of the pit, or at right angles to each other. According to Köhne, the output of single shafts has been raised by this method to 3500 and 4500 tons in the double shift of sixteen hours. It is particularly well suited to mines where groups of seams at different depths are worked simultaneously. Some characteristic figures of the yield for British collieries in 1898 are given below:—

| | |
|---|---|
| Albion Colliery, South Wales | 551,000 tons in a year for one shaft and one engine. |
| Silksworth Colliery, Northumberland | 535,000 tons in a year for shaft 580 yards deep, two engines. |
| Bolsover Colliery, Derby | 598,798 tons in 279 days, shaft 365 yards deep. |
| Denaby Main Colliery, Yorkshire | 629,947 tons in 281 days, maximum per day 2673 tons. |

***Surface arrangements.***

Coal as raised from the pit is now generally subjected to some final process of classification and cleaning before being despatched to the consumer. The nature and extent of these operations vary with the character of the coal, which if hard and free from shale partings may be finished by simple screening into large and nut sizes and smaller slack or duff, with a final hand-picking to remove shale and dust from the larger sizes. But when there is much small duff, with intermixed shale, more elaborate sizing and washing plant becomes necessary. Where hand-picking is done, the larger-sized coal, separated by 3-inch bar screens, is spread out on a travelling band, which may be 300 feet long and from 3 to 5 wide, and carried past a line of pickers stationed along one side, who take out and remove the waste as it passes by, leaving the clean coal on the belt. The smaller duff is separated by vibrating or rotating screens into a great number of sizes, which are cleaned by washing in continuous-current or pulsating jigging machines, where the lighter coal rises to the surface and is removed by a stream of water, while the heavier waste falls and is discharged at a lower level, or through a valve at the bottom of the machine. The larger or "nut" sizes, from $\frac{1}{4}$ inch upwards, are washed on plain sieve plates, but for finer-grained duff the sieve is covered with a bed of broken felspar lumps about 3 inches thick, forming a kind of filter, through which the fine dirt passes to the bottom of the hutch. The cleaned coal is carried by a stream of water to a bucket elevator and delivered to the storage bunkers, or both water and coal may be lifted by a centrifugal pump into a large cylindrical tank, where the water drains away, leaving the coal sufficiently dry for use. Modern screening and washing plants, especially when the small coal forms a considerable proportion of the output, are large and costly, requiring machinery of a capacity of 100 to 150 tons per hour, which absorbs 350 to 400 horse-power. In this, as in many other cases, electric motors supplied from a central station are now preferred to separate steam-engines.

***Briquettes.***

In addition to its use as fuel, there are two principal outlets for small coal, namely, as briquettes, or patent fuel, and coke, the former being adopted for non-caking and the latter for caking coals. For briquettes the small coal, if previously washed, is dried to reduce the moisture to at most 4 per cent., and, if necessary, crushed in a disintegrator and incorporated in a pug mill with from 8 to 10 per cent. of gas pitch, softened by heating to between 70° and 90° C. to a plastic mass, which is then moulded into blocks and compacted by a pressure of $\frac{1}{2}$ to 2 tons per square inch in a machine with a rotating die plate somewhat like that used in making semi-plastic clay bricks. When cold, the briquettes, usually weighing from 7 to 20 ℔ each, although smaller sizes are made for domestic use, become quite hard, and can be handled with less breakage than the original coal. Their principal use is as fuel for marine and locomotive boilers, the evaporative value being about the same or somewhat more than that of coal. The principal seat of the manufacture in Great Britain is in South Wales, where the dust and smalls resulting from the handling of the best steam coals (which are very brittle) is obtainable in large quantities and finds no other use. Some varieties of lignite, when crushed and pressed at a steam heat, soften sufficiently to furnish compact briquettes without requiring any cementing material. These are now made to a very large extent from the tertiary lignites in the vicinity of Cologne, and are used mainly for house fuel on the Lower Rhine and in Holland.

***Coke-making.***

The principal novelty of interest in connexion with coke-making is the development of the so-called by-product ovens, where, in addition to the carbonized fuel, volatile products, such as tar, benzol, and ammonia, are recovered by condensation from the gases evolved in the oven before the latter are burnt to supply the necessary heat for the coking process. The first successful application of this principle was made by Mr Carvès at Besseges, in France, and it was introduced into Great Britain, with some modifications in details, by the late Mr H. Simon, under the name of the Simon-Carvès system. Other and subsequent developments were those of Semet-Solvay and Hüssener. The whole of these have a common feature in the narrow ∩-shaped oven, which is heated by a series of parallel horizontal flues in the side walls, while in the Otto-Hoffmann system, which has been most largely adopted, the Coppée oven with vertical heating flues is used. The condensing arrangements, which are generally similar for all the systems, resemble those of an ordinary gas-works, somewhat simplified. The gas given off by the coal is led by one or two openings in the roof, through water-sealed dip pipes, to a collecting main leading to a system of atmospheric condensers, pipes cooled by exposure

to the air, where its temperature is reduced, and the tar is condensed and removed. The flow of gas is maintained by rotating exhausters, which force it forward through a series of scrubber towers, where the ammonia vapour is separated by a graduated system of washing with water and ammoniacal liquor. The final removal of benzol is effected by washing the partially purified gas with creosote oil. When the condensible products are removed, the gas is returned by a common supply pipe for distribution to the heating flues of the ovens. In the Otto-Hoffmann oven of the earlier and most generally used form, the gas is fired with heated air in a horizontal flue running along the bottom of the coking chamber; this is divided into two parts by a partition in the middle of its length, and the flame rises through the vertical side passages of the first half of the oven to two horizontal collectors at the top, where the direction being reversed, it passes downwards along the second half to the chimney, after giving up some of the surplus heat to a Siemens regenerator, in which the air for combustion is heated after the next reversal. The gas supply is introduced alternately from the front and back of the oven, there being a regenerator for air-heating at either end. In the newer form of this oven the air regenerators and reversal of the flame have been abandoned in favour of a system of continuous heating, the gas distributed by pipes in a chamber below the bottom of the oven supplying a series of large Bunsen burners at equal distances apart along the bottom, whose flames pass continuously upward through the side flues. There is some difference of opinion as to the merits of the two forms, but the new system is generally held to give more uniform heating, as well as being simpler in construction. In the horizontally-heated ovens the flues are arranged as parallel superposed passages along the length of the wall. The gas entering the lowest one is fired, and passes four times backwards and forwards to the chimney flue. This is usually of thin brickwork, so that a portion of the waste heat is transmitted to the air supplied for combustion, which passes in the opposite direction through adjacent parallel flues in the brickwork of the foundation, forming a continuous "recuperator," as distinguished from the intermittent Siemens regenerator.

The time of coking in retort ovens varies with the quality of the coal and size of the charge, which may be from $5\frac{1}{2}$ to 7 tons, about thirty-six hours being required in the newer kinds. The coke produced is not so dense or brilliant as that made in beehive ovens, but the waste being less, there is a decided saving, apart from the value of the condensed products. In one instance the coke was found to be about 5 per cent. less efficient in the blast furnace, while the yield was increased 10 per cent. In the further treatment of the condensed products by distillation the tar gives burning oil and pitch, the benzol is separated from the creosote oil by steam-heated stills, and the ammoniacal liquor, after some lime has been added to decompose fixed ammonium compounds, is heated to vaporize the ammonia, which is condensed in lead or copper lined tanks containing strong sulphuric acid to produce a crystalline powder of ammonium sulphate, which accumulates in the receiver and is fished out from time to time. The yield of by-products averages about 1 per cent. of sulphate of ammonium, about $3\frac{1}{2}$ per cent. of tar, and 0·6 to 0·9 per cent. of benzol of the weight of the coal carbonized. Besides heating the ovens and supplying steam for the machinery of the condensing plant and the coke ovens, there is usually a considerable surplus of gas, which may be used for lighting or driving gas-engines. For the latter purpose, however, it is necessary to remove the last traces of tar, which acts very prejudicially in fouling the valves when the gas is not completely purified.

REFERENCES.—Most of the detailed information concerning improvements in the practice of coal mining and the improvement in plant and machinery is contained in the published proceedings of the different professional societies, including the *Transactions* of the Institution of Mining Engineers, the South Wales Institute of Engineers, the British Society of Mining Students, and the American Institute of Mining Engineers. Among special works dealing with modern practice, Professor Galloway's lectures (published by the South Wales Institute, Cardiff, 1900), and the larger *Text-Book on Coal Mining*, by Mr H. W. Hughes (fourth edition, London, 1901), are the most notable, the latter being especially valuable for the detailed classified list of original authorities given at the end of each chapter. Very complete references are also given in the systematic abstracts published in the half-yearly volumes of the *Journal of the Iron and Steel Institute*. (H. B.)

**Coaling Stations.**—Maritime war in all ages has required that the ships of the belligerents should have the use of sheltered waters for repairs and for replenishment of supplies. The operations of commerce from the earliest days demanded natural harbours, round which, as in the conspicuous instance of Syracuse, large populations gathered. Such points, where wealth and resources of all kinds accumulated, became objects of attack, and great efforts were expended upon their capture. As maritime operations extended, the importance of a seaboard increased, and the possession of good natural harbours became more and more advantageous. At the same time, the growing size of ships and the complexity of fitments caused by the development of the sailing art, imposed new demands upon the equipment of ports alike for purposes of construction and for repairs; while the differentiation between warships and the commercial marine led to the establishment of naval bases and dockyards provided with special resources. From the days when the great sailors of Elizabeth carried war into distant seas, remote harbours began to assume naval importance. Expeditionary forces required temporary bases, such as Guantanamo Bay, in Cuba, which was so utilized by Admiral Vernon in 1741. As outlying territories began to be occupied, and jurisdiction to be exercised over their ports, the harbours available for the free use of a belligerent were gradually reduced in number, and it became occasionally necessary to take them by force. Thus, in 1782, the capture of Trincomalee was an object of sufficient importance to justify special effort, and Suffren gained a much-needed refuge for his ships, at the same time compelling his opponent to depend upon the open roadstead of Madras, and even to send ships to Bombay. In this case a distant harbour acquired strategic importance, mainly because sheltered waters, in the seas where Hughes and Suffren strove for naval supremacy, were few and far between. A sailing man-of-war usually carried from five to six months' provisions and water for 100 to 120 days. Other needs required to be met, and during the wars of the French Revolution it was usual, when possible, to allow ships engaged in blockade to return to port every five or six weeks "to refresh." For a sailing fleet acting on the offensive, a port from which it could easily get to sea was a great advantage. Thus Raleigh protested against the use of closely landlocked harbours. "Certain it is," he wrote, "that these ships are purposely to serve His Majesty and to defend the kingdom from danger, and not to to be so penned up from casualitie as that they should be less able or serviceable in times of need." Nelson for this reason made great use of Maddalena Bay, in Sardinia, and was not greatly impressed with the strategic value of Malta in spite of its fine natural harbour. The introduction of steam gave rise to a new naval requirement—coal—which soon became vital. Commerce under steam quickly settled down upon fixed routes, and depots of coal were established to meet its needs. Coaling stations thus came into existence by a natural process, arising from the exi-

gencies of trade, and began later to supply the needs of navies.

For many years there was no inquiry into the war requirements of the British fleet as regards coal, and no attempt to regularize or to fortify the ports at which it was stored. Successful naval war had won for Great Britain many points of vantage throughout the world, and in some cases the strategic value of ports had been proved by actual experience. The extreme importance of the Cape of Good Hope, obscured for a time after the opening of the Suez Canal, was fully realized in sailing days, and the naval conditions of those days to some extent determined the choice of islands and harbours for occupation. There does not, however, appear to have been any careful study of relative strategic values. Treaties were occasionally drafted by persons whose geographical knowledge was at fault, and positions were, in some cases, abandoned which ought to have been retained, or tenaciously held when they might have been abandoned. It was left to the personal exertions of Sir Stamford Raffles to secure such a supremely important roadstead as that of Singapore for the empire. Although, therefore, the relative values of positions was not always recognized, Great Britain obtained as a legacy from sailing days a large number of harbours admirably adapted for use as coaling stations. Since the dawn of the era of steam, she has acquired Aden, Perim, Hong Kong, North Borneo, Fiji, part of New Guinea, Fanning Island, and many other islands in the Pacific, while the striking development of Australia and New Zealand has added to the long roll of British ports. The coaling stations, actual and potential, of the empire are unrivalled in number, in convenience of geographical distribution, and in resources. Of the numerous British ports abroad which contained coal stores, only the four so-called "fortresses"—Gibraltar, Malta, Halifax, and Bermuda—were at first fortified as naval stations after the introduction of rifled ordnance. The term fortress is a misnomer in every case except Gibraltar, which, being a peninsula separated only by a neck of neutral ground from the territory of a foreign Power, exists under fortress conditions. Large sums were expended on these places with little regard to principles, and the defences of Bermuda, which were very slowly constructed, are monuments of misapplied ingenuity.

***British coaling stations.***

In 1878 great alarm arose from strained relations with Russia. Rumours of the presence of Russian cruisers in many waters, and of hostile projects, were readily believed, although the Russian navy, which had just shown itself unable to face that of Turkey, would at this period have been practically powerless. Widespread fears for the security of coaling stations led to the appointment of a strong royal commission, under the presidency of the earl of Carnarvon, which was instructed to inquire into and report upon the protection of British commerce at sea. This was the first attempt to formulate any principles, or to determine which of the many ports where coal was stored should be treated as coaling stations essential for the purposes of war. The terms of the reference to the commission were ill-conceived. The basis of all defence of sea-borne commerce is a mobile navy. It is the movement of commerce upon the sea during war, not its security in port, that is essential to the British Empire, and a navy able to protect commerce at sea must evidently protect ports and coaling stations. The first object of inquiry should, therefore, have been to lay down the necessary standard of naval force. The vital question of the navy was not referred to the royal commission, and the four fortresses were also strangely excluded from its purview. It followed inevitably that the protection of commerce was approached at the wrong end, and that the labours of the commission were to a great extent vitiated by the elimination of the principal factor. Voluminous and important evidence, which has not been made public, was, however, accumulated, and the final report was completed in 1881. The commissioners recalled attention to the extreme importance of the Cape route to the East; they carefully examined the main maritime communications of the empire, and the distribution of trade upon each; they selected certain harbours for defence, and they obtained from the War Office and endorsed projects of fortification in every case; lastly, they condemned the great dispersion of troops in the West Indies, which had arisen in days when it was a political object to keep the standing army out of sight of the British people, and had since been maintained by pure inadvertence. Although the principal outcome of the careful inquiries of the commission was to initiate a great system of passive defence, the able reports were a distinct gain. Some principles were at last formulated by authority, and the information collected, if it had been rendered accessible to the public, would have exercised a beneficial influence upon opinion. Moreover, the commissioners, overstepping the bounds of their charter, delivered a wise and statesmanlike warning as to the position of the navy.

***Carnarvon Commission.***

Meanwhile, the impulse of the fears of 1878 caused indifferent armaments to be sent to Cape Town, Singapore, and Hong Kong, there to be mounted after much delay in roughly designed works. At the same time, the great colonies of Australasia began to set about the defence of their ports with commendable earnestness. There is no machinery for giving effect to the recommendations of a royal commission, and until 1887, when extracts were laid before the first colonial Conference, the valuable report was veiled in secrecy. After several years, during which Lord Carnarvon persistently endeavoured to direct attention to the coaling stations, the work was begun. In 1885 a fresh panic arose out of the Panjdeh difficulty, which supplied an impetus to the belated proceedings. Little had then been accomplished, and the works were scarcely completed before the introduction of long breech-loading guns rendered their armaments obsolete.

The fortification of the coaling stations for the British Empire is still proceeding on a scale which, in some cases, cannot easily be reconciled with the principles laid down by the president of the Cabinet committee of defence. At the Guildhall, London, on 3rd December 1896, the duke of Devonshire stated that "The maintenance of sea supremacy has been assumed as the basis of the system of imperial defence against attack from over the sea. This is the determining factor in fixing the whole defensive policy of the empire." It was, however, he added, necessary to provide against "the predatory raids of cruisers"; but "it is in the highest degree improbable that this raiding attack would be made by more than a few ships, nor could it be of any permanent effect unless troops were landed." This is an unexceptionable statement of the requirements of passive defence in the case of the coaling stations of the British Empire. Their protection must depend primarily on the navy. Their immobile armaments are needed to ward off a raiding attack, and a few effective guns, well mounted, manned by well-trained men, and kept in full readiness, will amply suffice.

If the command of the sea is lost, large expeditionary forces can be brought to bear upon coaling stations, and their security will thus depend upon their mobile garrisons, not upon their passive defences. In any case, where coal is stored on shore, it cannot be destroyed by the fire of a ship, and it can only be appropriated by landing men. A small force, well armed and well handled, can effectually prevent a raid of this nature without any assistance from heavy guns. In war, the possession of secure coal stores in distant ports may be a great advantage, but it will rarely suffice for the needs of a fleet engaged in offensive operations, and requiring to be accompanied or met at prearranged rendezvous by colliers from which coal can be transferred in any sheltered waters. In the British naval manœuvres of 1892, Admiral Sir Michael Seymour succeeded in coaling his squadron at sea, and by the aid of mechanical appliances this is frequently possible. In the Spanish-American war of 1898 some coaling was thus accomplished; but Guantanamo Bay served the purpose of a coaling station during the operations against Santiago. Watering at sea was usually carried out by means of casks in sailing days, and must have been almost as difficult as coaling. As, however, it is certainty of coaling in a given time that is of primary importance, the utilization of sheltered waters as improvised coaling stations is sure to be a marked feature of future naval wars. Although coaling stations are now eagerly sought for by all Powers which cherish naval ambitions, the annexation of the Sandwich Islands by the United States being a case in point, it is probable that they will play a somewhat less important part than has been assumed. A fleet which is able to assert and to maintain the command of the sea, will not find great difficulty in its coal supply. Moreover, the increased coal endurance of ships of war tends to make their necessary replenishment less frequent. On the other hand, the modern warship, being entirely dependent upon a mass of complex machinery, requires the assistance of workshops to maintain her continuous efficiency, and unless docked at intervals suffers a material reduction of speed. Prolonged operations in waters far distant from home bases will therefore be greatly facilitated in the case of the Power which possesses local docks and means of

***Modern conditions.***

executing repairs. Injuries received in action, which might otherwise disable a ship during a campaign, may thus be remedied. During the hostilities between France and China in 1884 the French ship *La Galissonnière* was struck by a shell from one of the Min forts, which, though failing to burst, inflicted serious damage. As, by a technical fiction, a state of war was not considered to exist, the *La Galissonnière* was repaired at Hong Kong and enabled again to take the sea. Local stores of reserve ammunition and of spare armaments confer evident advantages. Thus, independently of the question of coal supply, modern fleets employed at great distances from their bases require the assistance of ports furnished with special resources, and a Power like Japan with well-equipped naval bases in the China Sea, and possessing large sources of coal, occupies, for that reason, a favoured position in regard to naval operations in the Far East. As the term "coaling station" refers only to a naval need which can often be satisfied without a visit to any port, it appears less suitable to modern conditions than "secondary base." Secondary bases, or coaling stations, when associated with a powerful mobile navy, are sources of maritime strength in proportion to the services they can render, and to their convenience of geographical position. In the hands of an inferior naval Power, they may be used, as was Mauritius in 1809–10, as points from which to carry on operations against commerce; but unless situated near to trade routes, which must be followed in war, they are probably less useful for this purpose than in sailing days, since convoys can now be more effectively protected, and steamers have considerable latitude of courses. Isolated ports dependent on sea-borne resources, and without strong bodies of organized fighting men at their backs are now, as always, hostages offered to the Power which obtains command of the sea. (G. S. C.)

*Secondary bases.*

**Coatbridge,** a municipal burgh (since 1885) of Lanarkshire, Scotland, about 9 miles east of Glasgow by rail. The surrounding coal and iron field is the most important in the country. There are some 20 active collieries, and the iron and steel industry of the town is very important. Modern erections are a theatre, three churches, a technical school and mining college (1891, under parish school board), and municipal buildings (at a cost of £40,000). There are two public parks, one opened in 1887. Population (1881), 24,812; (1891), 30,034; (1901), 36,981. The parish of Old Monkland contains ten villages in addition to Coatbridge.

**Coatesville,** a borough of Chester county, Pennsylvania, U.S.A., on Brandywine Creek, 40 miles west of Philadelphia. It contains rolling-mills and boiler-works. Population (1890), 3680; (1900), 5721.

**Coban,** a city of Guatemala, Central America, has greatly increased in prosperity, owing partly to the fertility of the district, but chiefly to the amazing industry of the Quecchi Indians, who are its main inhabitants. The chief trade is in coffee and Peruvian bark. An exceptionally large number of foreigners, especially Germans, have settled in the city, but it consists mainly of native cottages embosomed in gardens of flowering shrubs. It is divided into eleven "barrios" or wards, each named after a particular saint. In the plaza is the great church, with the *convento*. The population is about 18,000.

**Cobar,** a town in New South Wales, Australia, 459 miles west of Sydney, in the county of Robinson, with a terminal station on the railway line from Nyngan. Large quantities of copper ore are raised in the district, and gold-bearing reefs have been discovered and worked successfully of late years. The Great Cobar copper mine is the most important in the state. Population (1881), 1859; (1901), about 5500.

**Cobet, Carel Gabriel** (1813–1889), one of the most famous classical scholars of the 19th century, was born at Paris on 28th November 1813, of a Dutch father and French mother. It has often been said that the twofold origin is apparent in his work, which shows traces of Gallic brilliancy along with Dutch erudition. Cobet was educated in Holland at the Hague Gymnasium, where he was fortunate enough to have as his master a man of remarkable teaching power and genuine love of learning, Kappeyne van de Capello. In 1832 Cobet entered the University of Leyden, and devoted himself exclusively to classical scholarship. In 1836 he won a gold medal for an essay entitled "Prosopographia Xenophontea," a brilliant characterization of all the persons introduced into the "Memorabilia," "Symposium," and "Œconomicus" of Xenophon. In 1840 he published and defended a thesis entitled *Observationes criticæ in Platonis comici reliquias*, which first revealed his remarkable critical faculty. The university now conferred on him an honorary degree, since he had declined to follow the course that led to the ordinary one, and recommended him to the Government for a travelling pension, to enable him to study manuscripts in foreign libraries. The ostensible purpose of his journey was to collate the texts of Simplicius, but the Aristotelian commentator seems to have engaged but little of Cobet's time, and he never even published an edition of Simplicius. Instead, he contrived to make a careful study of almost every Greek manuscript in the Italian libraries, and returned after five years with an intimate knowledge of the peculiarities of copyists and the history of manuscripts. In 1846 he married, and in the same year he was appointed to a professorship at Leyden. His inaugural address, *De arte interpretandi grammatices et critices fundamentis innixa*, has been called the most perfect piece of Latin prose written in the century. The rest of his life was passed uneventfully at Leyden in study and work. In 1856 he became joint editor of *Mnemosyne*, a philological review, which he soon raised to a leading position among classical journals. In it appeared from time to time critical notes and suggested emendations from Cobet's pen, dealing with a great variety of Greek authors. These were afterwards collected in book form under the titles *Novæ Lectiones*, *Variæ Lectiones*, and *Miscellanea Critica*. In 1875 he took a prominent part at the Leyden Tercentenary, and impressed all hearers by his wonderful facility in Latin improvisation. In 1884, when his health was failing, he retired as emeritus professor. He died on 26th October 1889. Cobet's special weapon as a critic was his consummate knowledge of palæography, but he was no less distinguished for his rare acumen and the extensive command of classical literature with which he illustrated and defended his criticisms. He has been sometimes blamed for rashness in attempting to emend difficult passages, and for neglecting the comments of other scholars. He had little sympathy for the German school of criticism, and maintained that the best combination for a scholar was English good sense with French taste. He always expressed his obligation to the English, saying that his masters were three Richards—Bentley, Porson, and Dawes. (A. Z.)

**Coblenz,** or Coblentz, a town of Prussia, capital of the Rhine province, on the left bank of the Rhine, 57 miles south-south-east from Cologne by rail, headquarters of the Eighth German Army Corps. About a mile above the town the river is crossed by an iron bridge of double span (completed in 1879), carrying the Berlin-Metz Railway.

In 1890 the demolition of the landward defences was begun, and since then a great alteration has taken place on that side of the town. In 1897 a magnificent monument by Bruno Schmitz and Hundrieser to the Emperor William I. was erected at the point where the Moselle meets the Rhine. Coblenz also boasts of a museum (1891) of antiquities; monuments to General von Goeben (died here in 1880), the physiologist Johannes Müller (born here in 1801), the poet Max von Schenkendorf (died here in 1817), and the Empress Augusta (1896), who loved to reside at Coblenz; a new Roman Catholic church, St Joseph's (1896–98); a handsome promenade by the Rhine, 1½ miles long; a theatre and a musical institute. Coblenz is a principal seat of the Rhenish and Moselle wine trade, and its manufactures include pianos, paper, cardboard, machinery, and boats and barges. It is an important transit centre for the Rhine railways and those of the Lahn and Moselle, and for the Rhine navigation. Population (1885), 31,669; (1900), 45,039.

**Cobourg,** the capital of Northumberland county, Ontario, Canada, 70 miles east of Toronto by rail, on Lake Ontario. It has a safe and commodious harbour, and has steamboat communication with St Lawrence and Lake Ontario ports. It contains car-works, carpet and woollen factories, and foundries. Population (1881), 4957; (1900), 4239.

**Coburg,** a town of Germany, capital (alternating with Gotha) of the duchy of Saxe-Coburg-Gotha, 72 miles by rail north from Nuremberg. The most notable addition to the public buildings is the Edinburgh palace (1881). The old castle of Coburg now contains a museum of art and antiquities; the town also possesses an anthropological museum. A bronze statue of Prince Albert (consort of Queen Victoria), by Theed, adorns the market-place (1865); and there is a monument of the 1870–71 war in Ernest Square. Both trade and industry are flourishing, the chief branches of the latter being brewing, manufactures of machinery, colours, and porcelain, iron-founding, and saw-milling. Population (1885), 16,210; (1895), 18,688.

**Cocanada** or **Coconada,** a town of British India, in the Godavari district of Madras, on the seacoast in the extreme north of the Godavari delta, about 315 miles north of Madras. It had in 1881 a population of 28,856, in 1891 of 40,068, and in 1901 of 47,866, showing an increase of 18 per cent. The municipal revenue in 1897–98 was Rs.2,09,460. As the administrative headquarters of the district, and the chief port on the eastern coast after Madras, Cocanada is steadily growing in importance. It is connected by navigable channels with the canal system of the Godavari delta, and by a branch line with Samalkot on the East Coast Railway. The anchorage is an open roadstead, with two lighthouses. In 1897–98 the total sea-borne trade amounted to Rs.2,07,82,027, of which just one-half was conducted with foreign countries; 25 vessels entered and cleared for foreign trade, with an aggregate burthen of 23,367 tons. The chief exports are rice, cotton, sugar, and oilseeds. Mills have been established for cleaning rice. It contains a college, a high school with 408 pupils, a literary association, and five printing-presses.

**Cochabamba,** a department of Bolivia, bounded on the N. by that of La Paz, on the E. by Santa Cruz, on the S. by Chuquisaca and Potosi, and by Oruro and La Paz on the W., has an area of 21,420 square miles. In 1893 the population numbered 360,220, and was estimated in 1898 at 375,800. The capital, Cochabamba, has 40,000 inhabitants. The department is divided into nine provinces. It had in 1878, 120 schools, attended by 8337 pupils.

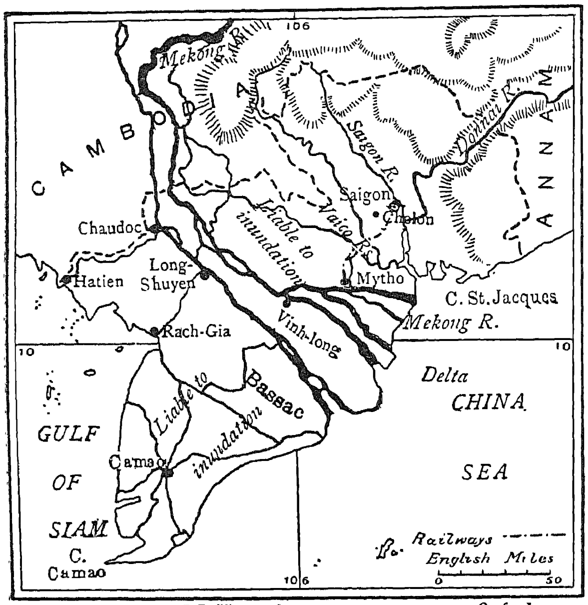
**Cochin,** a feudatory state of Southern India, in political subordination to Madras, with an area of 1362 square miles. The population in 1891 was 722,906, being 531 persons per square mile; in 1901 the population was 815,218, showing an increase of 13 per cent. More than one-fifth are Christians, mostly Syrians and Roman Catholics. The revenue is estimated at Rs.20,00,000, subject to a tribute of Rs.2,00,000. During recent years a balance has been accumulated of Rs.44,00,000, most of which is invested in securities of the Indian Government. The principal products are rice, coconuts, timber, cardamoms, pepper, and a little coffee. Salt is manufactured along the coast. The capital is Ernakolam, but the raja resides at Tripunthora. Apart from the British town of Cochin, the principal seaport is Malipuram. The chief means of communication is by boat along the backwaters; but a metre gauge line is being constructed at the cost of the state across the hills, from Ernakolam to Shoranur on the Madras Railway. The length will be 65 miles, and the estimated cost is £337,000. In 1897–98 the total number of schools was 1020, attended by 30,550 pupils.

The town of Cochin is comprised within the British district of Malabar. Its population in 1891 was 16,147; the municipal income in 1897–98 was Rs.21,530. Considerable sea-borne trade is still carried on. In 1897–98 the number of vessels that entered and cleared for foreign trade was 58, with an aggregate burthen of 99,775 tons. A lighthouse stands on the ruins of the old fort. The chief exports are coconut products, for the preparation of which there are factories. There are a missionary high school, three printing-presses, and a library

**Cochin-China.**—This term formerly included the whole Annamese Empire—Tongking, Annam, and Lower Cochin-China, but it now comprises only the French colony of Lower Cochin-China; this consists of the six southern provinces of the Annamese Empire which were taken possession of by France after a war with the Emperor Tu Duc. It lies between 8° and 11° 30′ N. lat. and 104° 25′ 55″ and 107° 29′ 55″ E. long., and is bounded on the N. by Annam and Cambodia, on the W. by Cambodia, on the E. by the China Sea, and on the S. and W. by the Gulf of Siam. It embraces almost the whole of the Mekong delta, which is intermingled with the mouths of the Saigon river and of the two rivers Vaico, and consists mainly of a vast plain, almost entirely flooded. In the east, however, lies a mountain group of moderate altitude (extending from Cape St Jacques to the frontier of Annam), from which descend the rivers Donnai and Saigon. This region is inhabited by the Mois. The Mekong enters the sea by numerous mouths, which shift position under the varying effects of flood currents. Canals from Chaudoc to Hatien (Cancao) and from Long-Xuyen to Rash-Gia unite it with the Gulf of Siam. Several canals connect the Saigon river with the eastern arm of the Mekong. The ports of Saigon and Mytho are accessible to the largest vessels, and are connected by a railway. The roadsteads of Rash-Gia, Camao, and Hatien can accommodate only vessels of low tonnage. The climate, which is hot and damp, is divided into two very regular seasons by the north-east and south-west monsoons, the former prevailing from October 15th to April 15th, the latter from April 15th to October 15th. The temperature varies from 60°·8 to 86° F. during the former, to 82°·4 to 95° F., or even higher, during the latter. Rains and tornadoes occur daily from

May to July, and from the middle of August to the end of September.

The area of Cochin-China is returned at 23,160 square miles, and in 1899 the inhabitants numbered 2,323,499, of whom 4451 were Europeans, 1601 being officials, and 1023 the members of their families. The Annamese number 2,054,831; the Cambodians, 182,659; the Mois, 6374; the Chams, 2656; the Chinese, 65,801; the Malays, 4130. The remainder consists of Tagals, Indians, Japanese, &c. Saigon, which in 1882 numbered only 13,000 inhabitants, has now a population of 44,764, and is the capital not only of Cochin-China, but also of French Indo-China. In 1899 there were in the colony 232 schools, with 115 European and 1183 native teachers, and 28,000 pupils. The Roman Catholic population numbered 73,234; and the Buddhists, 1,688,270. Cochin-China was autonomous until 1887, when it was divided into six provinces under the authority of a governor, assisted by a Colonial Council. The prosperity of the colony grew rapidly, and when Tongking and Annam were conquered, Cochin-China contributed 5,000,000 piastres to the Tongking budget. This contribution fell in 1892 to 4,000,000

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SKETCH MAP OF COCHIN-CHINA.

piastres, and on the unification of Indo-China it ceased, Cochin-China furnishing, as do the other countries, its share to the general budget. The local budget for 1900 was estimated at 4,439,500 piastres for revenue and expenditure; for 1901 it was estimated at 4,204,244 piastres, revenue and expenditure. According to official accounts, the actual receipts to August 31, 1899, amounted to 4,253,192 piastres. The local government is now administered by a lieutenant-governor, who has a seat on the Superior Council of Indo-China, and is assisted by a Colonial Council composed of fifteen members, of whom eight are Europeans and seven Asiatics. Four of the European members are elected by universal suffrage, two are delegated by the Chamber of Commerce, and two by the Privy Council, which assists the governor-general. Cochin-China is divided into six provinces, Saigon, Mytho, Vinh-Long, Bassac, Saigon, and Cholon; and twenty districts, each having at its head an administrator of native affairs, who presides over all civil service not undertaken by the general government. The self-administering municipalities of Saigon and Cholon districts used to be, but by a recent decision these *arrondissements* were made provinces, to secure uniformity of nomenclature of administrative areas. Cochin-China is represented in the French Chamber by a deputy. Asiatic foreigners are subjected to a *déclaration de séjour*, and also pay a capitation fee. Besides French troops maintained by France, there are 2405 native soldiers maintained by the budget of Indo-China.

*Commerce.*—About one-sixth of the total area is cultivated, the chief crop being rice. The imports of merchandise in 1898 amounted to 54,964,222 francs; the exports to 108,010,322 francs. The chief exports in 1898 were rice, 772,789 tons (of which 296,845 tons were cargo rice, and 286,841 tons white rice), of a total value, according to the customs returns, of £3,557,525; fish, value £233,440; cotton, £64,928; silk, £77,225; hides, isinglass, pepper, cardamom. Coffee culture is increasing, the number of coffee plants in 1899 being 429,228, mostly belonging to Europeans. Cochin-China and Cambodia now forms a single customs district, and the commercial statistics for both are included under one head. The total trade for 1889 amounted to 177,238,958 francs, of which 66,234,008 francs represented imports and 111,004,950 francs exports. At Saigon, in 1899, 669 vessels of 811,157 tons entered; of these, 234 of 333,714 tons were French, and 435 of 477,443 tons foreign. There are 51 miles of railway, Saigon to Mytho, and 2676 miles of telegraph line, and 85 telegraph offices. There are 79 post offices. The construction of 850 miles of new railway is proposed.

See also Indo-China. (J. M. A. de L.)

**Cock, Edward** (1805–1892), British surgeon, was born in 1805. He was a nephew of Sir Astley Cooper, and through him became at an early age a member of the staff of the Borough Hospital in London, where he worked in the dissecting room for thirteen years. Afterwards he became in 1838 assistant surgeon at Guy's, where from 1849 to 1871 he was surgeon, and from 1871 to 1892 consulting surgeon. He rose to be president of the College of Surgeons in 1869. He was an excellent anatomist, a bold operator, and a clear and incisive writer, and though in lecturing he was afflicted with a stutter, he frequently utilized it with humorous effect and emphasis. From 1843 to 1849 he was editor of *Guy's Hospital Reports*, which contain many of his papers, particularly on stricture of the urethra, puncture of the bladder, injuries to the head, and hernia. He was the first English surgeon to perform pharyngotomy with success, and also one of the first to succeed in trephining for middle meningeal hæmorrhage; but the operation by which his name is known is that of opening the urethra through the perinæum (see *Guy's Hospital Reports*, 1866). He died at Kingston in 1892.

**Cockburn, Sir Alexander James Edmund,** Bart. (1802–1880), Lord Chief Justice of England, was born on 24th December 1802, and came of ancient Scottish stock. An ancestor, Alexander de Cockburn (descended from Petrus de Cockburn of Berwickshire, A.D. 1214), was granted in 1358 the barony of Carriden, county Linlithgow, and was appointed with his heirs for ever Ostiarius Parliamenti (usher of the White Rod) by King David II. A subsequent ancestor, Sir William Cockburn, who was created a baronet of Nova Scotia in 1627, had some difficulty in asserting his right to this office, but ultimately succeeded, and afterwards alienated a moiety of it, becoming a joint usher with Colonel Cunningham. His son, Archibald, however, in 1674, bought back the half-right so disposed of, and obtained a fresh grant. The fifth baronet fell at Fontenoy in 1745, and his cousin, James Cockburn, at one time M.P. for Peebles, succeeded him as sixth

baronet. This gentleman, who in 1757 sold Langton, which had been the seat of the family since the fourteenth century, had a large family. His three elder sons held the title in succession, while the future Lord Chief Justice of England was the only son of the fourth son, Alexander, and eventually in 1858 followed his uncle, Sir William Cockburn, dean of York, as tenth baronet. Mr Alexander Cockburn, the father of Sir Alexander, was British Envoy Extraordinary and Minister Plenipotentiary to the State of Columbia, and married Yolande, daughter of the Vicomte de Vignier. Young Alexander was at one time intended for the diplomatic service, and frequently during the legal career which he ultimately adopted he was able to make considerable use of the knowledge of foreign languages, especially French, with which birth and early education had equipped him. He went eventually to Trinity Hall, Cambridge, where he did well, winning prizes for Latin and English composition, and appearing second in the first class of the law-tripos in 1825, although he does not seem to have proceeded to his degree until 1829. He was elected a fellow, and afterwards an honorary fellow of his college, and having entered at the Middle Temple in 1825, was called to the Bar in 1829; but though he had shown himself a young man of considerable gifts, he had not exhibited promise of the industry and energy which, in spite of a pleasure-loving temperament, ultimately won for him success. He joined the Western Circuit, and for some time such practice as he was able to obtain lay at the Devon Sessions, Quarter Sessions at that time affording an opening and a school of advocacy to young counsel not to be found anywhere fifty years later. In London he had so little to do that only the persuasion of friends induced him to keep his London Chambers open. Three years after his call to the Bar, however, the Reform Bill was passed, and the petitions which followed the ensuing general election gave rise to a large number of new questions for the decision of Election Committees, and afforded an opening of which he promptly availed himself. The decisions of the Committees had not been reported since 1821, and with Mr Rowe, another member of the Western Circuit, Cockburn undertook a new series of Reports. They only published one volume, but the work was well done, and in 1833 Cockburn had his first parliamentary brief on behalf of Mr Henry Lytton Bulwer, and Mr Ellice, Secretary to the Treasury, the sitting members for Coventry. In 1834 Cockburn was well enough thought of to be made a member of the Commission to inquire into the state of the corporations of England and Wales. Other parliamentary work followed; but he had ambition to be more than a parliamentary counsel, and he attended diligently on his Circuit, besides appearing before Committees. In 1841 he was in a position to take silk; and in that year a charge of simony, brought against his uncle, the dean of York, enabled him to appear conspicuously in a case which attracted considerable public attention, the proceedings taking the form of a motion for prohibition duly obtained against the Ecclesiastical Court, which had deprived Dr Cockburn of his office. Not long after this, Sir Robert Peel's secretary, Mr Drummond, was shot by the crazy Scotchman, M'Naughten, and Cockburn, briefed on behalf of the assassin, not only made a very brilliant speech, which established the defence of insanity, but also secured the full publicity of a long report in the *Morning Chronicle* of the 6th of March 1843. Another well-known trial in which he appeared a year later was that of Wood *v.* Peel (*Times*, 2nd and 3rd July 1844), the issue being in form to determine the winner of a bet (the Gaming Act was passed in the following year) as to the age of the Derby winner Running Rein — in substance to determine, if possible, the vexed question whether Running Rein was a four-year-old or a three-year-old when he was racing as the latter. Running Rein could not be produced by Mr Wood, and Baron Alderson took a strong view of this circumstance, so that Cockburn found himself on the losing side, while his strenuous advocacy of his client's cause had led him into making, in his opening speech, strictures on Lord George Bentinck's conduct in the case which had better have been reserved to a later stage. He was, however, a hard fighter, but not an unfair one,—a little irritable at times, but on the whole a courteous gentleman, and his practice went on increasing. In 1847 he decided to stand for Parliament, and was elected without a contest at Southampton, standing as a Liberal and a reformer. During his first year or two in Parliament he showed himself to be a useful speaker on topics of legal reform, and gained the respect of his fellow members; and in 1850 he had a chance, of which he availed himself to the utmost. The "Pacifico" dispute with Greece related, it will be remembered, to the treatment of a M. Pacifico, and other persons said to be British subjects, by a Greek mob, and to the forcible methods of Lord Palmerston in causing a British fleet to blockade the Piræus in order to enforce attention to his demands for compensation. The Government was defeated in the House of Lords on this question, and in the House of Commons had a hard fight to carry the vote of confidence proposed by Mr Roebuck, member for Sheffield. A lawyer was wanted to bring out the legal position of the Government. Mr Crowder, afterwards a judge, was not equal to the task; but on the third night of the debate Cockburn moved the adjournment of the House after Mr Gladstone had spoken, and on the following night made a speech, of which Lord Palmerston wrote to Lord Normanby:—"As to Cockburn's, I do not know that I ever in the course of my life heard a better speech from anybody, without any exception." Cockburn made another excellent speech very soon after this on the question of the treatment by Austria of the Magyar rebels; and when, less than a month later, Sir John Jervis retired, and Sir John Romilly was promoted to be Attorney-General, he became Solicitor-General and was knighted. He succeeded to the Attorney-Generalship in 1851, on the appointment of Romilly as Master of the Rolls.

In February 1852 the Ministry resigned, and Cockburn vacated his post. During the short administration of Lord Derby which followed, Thesiger was Attorney-General, and Cockburn was engaged against him in the case of R. *v.* Newman, on the prosecution of Achilli. This was the trial of a criminal information for libel filed against John Henry Newman, who had denounced a scandalous and profligate friar named Achilli, then lecturing on Roman Catholicism in England. Newman pleaded justification; but the jury who heard the case in the Queen's Bench, with Lord Campbell presiding, found that the justification was not proved except in one particular: a verdict which, together with the methods of the judge and the conduct of the audience, attracted considerable comment. The verdict was set aside, and a new trial ordered, but none ever took place. In December 1852, under Lord Aberdeen's Ministry, Cockburn became again Attorney-General, with Bethell as Solicitor-General, and so remained until 1856, taking part in many celebrated trials, such as the Hopwood Will Case in 1855, and the Swynfen Will Case, but notably leading for the Crown in the trial of William Palmer of Rugeley in Staffordshire,—an ex-medical man who had taken to the turf, and who had poisoned a friend of similar pursuits named Cook with strychnine, in order to obtain money from his estate by forgery and

otherwise. Sir Alexander Cockburn made an exhaustive study of the medical aspects of the case, and the prisoner's comment when convicted after a twelve days' trial was, alluding to the Attorney-General's advocacy, "It was the riding that did it." In 1854 Cockburn was made recorder of Bristol. In 1856 Sir John Jervis died, and Cockburn became Chief Justice of the Common Pleas. In 1859 Lord Campbell became Chancellor, and Cockburn became Chief Justice of the Queen's Bench, continuing as a judge for twenty-four years, and dying in harness. On Friday, the 19th of November 1880, he tried causes with special juries at Westminster; on Saturday, the 20th, he presided over a Court for the consideration of Crown Cases Reserved; he walked home, and on that night he died of *angina pectoris* at his house in Hertford Street. It is characteristic of the man that when he learnt that he was dying, his comment to his doctor was, "Well, I have had a good time."

Sir Alexander Cockburn earned and deserved a high reputation as a judge. He was a man of brilliant cleverness and rapid intuition, rather than of profound and laboriously cultivated intellect. He had been a great advocate at the Bar, with a great charm of voice and manner, as well as a fluent and persuasive tongue, rather than a learned lawyer, but he was considered to be a good lawyer before he died, some assigning his unquestioned improvement in this respect to his frequent association on the bench with Blackburn. He had notoriously little sympathy with the Judicature Acts. Many were of opinion that he was inclined to take an advocate's view of the cases before him, making up his mind as to their merits prematurely and, in consequence, wrongly, as well as giving undue prominence to the views which he so formed; but he was beyond doubt always in intention, and generally in fact, scrupulously fair. Lord Russell of Killowen, L.C.J., writing of his immediate predecessor Lord Coleridge in 1894, gave his opinion that the beauty of Lord Coleridge's voice was unsurpassed in his experience, except perhaps by Sir Alexander Cockburn, Mr Gladstone, Sir Robert Peel, and Father Burke of the Dominican Order. Coleridge, he further says, "could not have made the great Don Pacifico speech of Sir Alexander Cockburn; but then, who could?" Commenting on the case of Saurin *v.* Starr (Feb. 1869), in which Coleridge led for the plaintiff, Lord Russell also wrote: "Sir Alexander Cockburn tried the case, and it afforded a strong illustration of a peculiarity in that remarkable man which those who practised before him will recognize. He began by being breast-high for the plaintiff, and so continued during the earlier stages of the trial; but as the trial progressed, and especially after Mr Mellish's opening speech, he speedily turned round, and did all he could to secure a verdict for the defendants. But it was too late. The case was of a kind, not unnaturally, to excite prejudice against them, and the minds of the jury could not be turned back from the direction which the earlier action of the Chief Justice had given them." This criticism is interesting as coming from so great an advocate and so masterful a Lord Chief Justice, himself by no means given to concealing his prejudices. It will further be remembered, however, that in this case Lord Russell, then Mr Charles Russell, was counsel on the losing side, that the case involved charges against a Roman Catholic religious establishment, and that he was himself a staunch Roman Catholic. Mr Justin M'Carthy calls Cockburn "one of the few great advocates who ever made a political figure in the House of Commons." Disraeli, in a characteristic speech, once said of him in the House: "He is a man of transcendent abilities; . . . he sustained the reputation which he had attained here and in the Courts of his country with learning and majesty . . . He has shown himself a jurist and a publicist of the highest character" (*Times*, 24th April 1875). This was on the occasion of an attack upon him by Dr Kenealy, M.P., the Tichborne claimant's counsel in the trial at Bar which consigned the claimant to penal servitude for perjury. Sir Alexander Cockburn, with Mr Justice Mellor and Mr Justice Lush, had tried him, the case lasting one hundred and eighty-eight days, of which the Lord Chief Justice's summing up occupied eighteen. It is not necessary to enumerate the many *causes célèbres* at which Sir Alexander Cockburn presided as a judge. It was thought that he went out of his way to arrange that they should come before him, and his successor, Lord Coleridge, writing in 1881 to Lord Bramwell, to make the offer that he should try the murderer Lefroy as a last judicial act before retiring, added, "Poor dear Cockburn would hardly have given you such a chance." Be this as it may, Cockburn tried all cases which came before him, whether great or small, with the same thoroughness and with great courtesy and dignity, so that no counsel or suitor could complain that he had not been fully heard in a matter in which the issues were seemingly trivial; while he certainly gave great attention to the elaboration of his judgments and charges to juries.

The greatest public occasion on which Sir Alexander Cockburn acted, outside his usual judicial functions, was that of the *Alabama* Arbitration, held at Geneva in 1872, in which he represented the British Government, and dissented from the view taken by the majority of the arbitrators, without being able to convince them. He prepared, with Mr C. F. Adams, the representative of the United States, the English translation of the award of the arbitrators, and published his reasons for dissenting in a vigorously worded document which did not meet with universal commendation. He admitted in substance the liability of England for the acts of the *Alabama*, but not on the grounds on which the decision of the majority was based, and he held England not to be liable in respect of the *Florida* and the *Shenandoah*. His opposition to the appointment of Sir Robert Collier to the Judicial Committee of the Privy Council had, shortly before the arbitration, so embroiled him with the Government that, stung by a speech of the duke of Argyll, he had threatened to resign his position as arbitrator. His views on the Collier controversy were chiefly expressed in letters to Lord Westbury; he was at all times fond of controversy and controversial writing.

In personal appearance Sir Alexander Cockburn was of small stature, but his dignity of deportment caused this to be forgotten. His courtesy and polish of manner have been referred to. In private life he was fond of sport, and he was engaged in writing a series of articles on the "History of the Chase in the Nineteenth Century" at the time of his death. He took his relaxation during his last years in his yacht the *Zouave*, and he was also fond of music. He was fond, too, of society; and in the interesting debate on the Tichborne trial, to which reference has been made, some aid was lent to Kenealy's attack by a jocular, but somewhat imprudent, remark of Cockburn's to a lady at a dinner-party, which she was foolish enough to repeat. He was also throughout his life addicted to frivolities not altogether consistent with advancement in a learned profession, or with the positions of dignity which he successively occupied. Shooting once at Hinton with Lord Westbury, when a high rocketing pheasant was nearly dropped on his head by another gun, Sir Alexander Cockburn, who had not seen the bird, called out, "Fire high, fire high." Whereupon Lord Westbury said, "Don't be alarmed, Chief Justice: you are quite safe. You are not as near heaven as that bird was when it was shot, and I am sadly afraid, after those stories of yours at luncheon, that you never will be." At the same time he showed no lack of dignity in his public capacity. He had a high sense of what was due to, and expected from, his profession; and his utterance upon the limitations of advocacy, in his speech at the banquet given in the Middle Temple Hall to Mons. Berryer, the celebrated French advocate, may be called the classical authority on the subject. Lord Brougham, replying for the guests other than Berryer, had spoken of "the first great duty of an advocate to reckon everything subordinate to the interests of his client." The Lord Chief Justice, replying to the toast of "the Judges of England," dissented from this sweeping statement, saying, amid loud cheers from a distinguished assembly of lawyers, "The arms which an advocate wields he ought to use as a warrior, not as an assassin. He ought to uphold the interests of his clients *per fas*, not *per nefas*. He ought to know how to reconcile the interests of his clients with the eternal interests of truth and justice" (*Times*, 9th Nov. 1864). Sir Alexander Cockburn was never married, and the baronetcy became extinct at his death.

AUTHORITIES.—*Times*, 22nd Nov. 1880; *Law Journal*; *Law Times*; *Solicitors' Journal*, 27th Nov. 1880; *Law Magazine*, new series, vol. xv. p. 193, 1851; Ashley's *Life of Lord Palmerston*; Nash's *Life of Lord Westbury*; "Reminiscences of Lord Chief Justice Coleridge," by Lord Russell of Killowen, in the *North American Review*, Sept. 1894; *The Greville Memoirs*; Croker's *Correspondence and Diaries*; Justin M'Carthy's *History of Our Own Times*; Serjeant Ballantine's *Experiences*; *Bench and Bar*, by Serjeant Robinson; Fairchild's *Life of Lord Bramwell*; Manson's *Builders of Our Law*; Burke's *Peerage*, ed. 1879; Fosters' *Peerage*, 1880.

(E. A. AR.)

**Cockermouth,** a market-town in the Cockermouth parliamentary division (since 1885) of Cumberland, England, on the Derwent, 27 miles south-west of Carlisle by rail. A statue was erected in 1875 to the sixth earl of Mayo, who represented the borough in parliament and was subsequently viceroy of India. Ironworks, tanneries, and confectionery works have been established. Area of township (an urban district), 2425 acres. Population (1881), 5353; (1901), 5355.

**Cocos Islands.** See KEELING ISLANDS.

**Codex Bezæ.**—The MS. which is known by the name of Codex Bezæ, after the great Reformer, and which is marked amongst the MSS. of the New Testament by the sign D (or rather by the two signs D, d, according as its Greek or Latin side is under discussion), is a bilingual [Græco-Latin] codex, containing, with some lacunæ, the text of the Four Gospels and the Acts, in an uncial hand which is commonly ascribed to the sixth century. From the fact that a fragment of the 3rd Epistle of John precedes the Acts, it has been inferred that it at one time contained the Catholic Epistles, though not in the common order, and from a study of the ancient numbering of the quires, it appears that the missing matter was not confined to the Catholic Epistles, and that some other book was also included, but no satisfactory conjecture has yet been made as to the character of the missing portion. The order of the Gospels is that which was once common in the West, in which the Apostolic Evangelists come first, namely, Mt, Joh, Lu, Mc, the whole book being denoted by

Mt + Joh + Lu + Mc + X + Cath + Acts,

where X stands for the unknown missing matter, and *Cath* for the portions of the Catholic Epistles which it once contained (the three epistles of John, at the least).

The MS. was presented by Beza to the University of Cambridge, in whose public library it has since been preserved, in the year 1582. If Beza's own account can be trusted, it was brought to him from the monastery of St Irenæus at Lyons, where it had been lying mutilated and covered with dust, the time of its discovery being the sack of Lyons in 1562. Some superficial grounds for doubting the exactness of this statement are found in the facts (1) that Beza in his latest Greek Testament (1598) calls it Claromontanus, and not Lugdunensis (a term he never seems to apply, using instead the colourless *vetustissimus*); (2) that it was in Italy shortly before 1550, for this is undoubtedly the MS. marked β′ from which readings are given on the margin of Robert Stephen's edition of the N.T. in that year, and which is expressly stated by him to have been collated by "our friends in Italy." But these statements can be reconciled by adding the further evidence of Marianus Victorius as to the production at the Council of Trent (in 1546?) of an ancient Greek MS. confirming the Latin reading of John 21²². This MS. was produced by William à Prato, bishop of Clermont in the Auvergne, and the neighbourhood of Clermont Ferrand to Lyons may be thought sufficient to explain at once the presence of the book in Italy and the fluctuation as to its title in the last Bezan N.T. It should be remarked, however, that there has recently been a recrudescence of suspicions as to the accuracy of Beza's statements concerning the Codex, and that some modern scholars, becoming sceptical as to its connexion with Lyons at all, are looking for a home for the Codex in Italy, previous to its passing into Beza's hands.

Whatever may be the outcome of this demand for re-examination of the Bezan statements, it should be noted that Beza had not the slightest suspicion that his beloved *vetustissimus* was the same as the β′ of Stephen; for he quotes them as if they were two separate authorities, even in places where the Bezan Codex is most singular. Perhaps we must not be too severe on him in this, for the very same doubling of the authorities is found in Bianchini, *Ev. Quadruplex*, p. 483 ("Lucæ, c. 6, v. 4, extat hic et in Steph. β′ insignis pericope de homine operante die sabbati"), where the reading discussed is the most conspicuous singularity in the whole MS., the passage at which the MS. usually stands open in the University Library at Cambridge. If Bianchini fell into the same trap, we must not judge Beza too hardly. In any case he cannot have known that his MS. had been collated for Robert Stephen in Italy. One would like to know something more about this collation. Who were the friends that collated? The term seems too vague for his son Henry, who probably was in Italy just at the right time for making the collation. Was there another hand? Perhaps that of Vatablus? And was the collating done at Trent? On these points some further information may be accessible. Meanwhile we adhere provisionally, but with some hesitation, to the belief that it is a Lyons MS.

We have already alluded, in passing, to two singular readings of the MS. in which it appears to be unique, namely, the reading in Joh 21²², εαν αυτον θελω μενειν ουτως εως ερχομαι ("if I wish him to remain thus until I come"), and the unique interpolation in Lu 6⁴ (τη αυτη ημερα θεασαμενος τινα εργαζομενον τω σαββατω ειπεν αυτω, ανθρωπε, ει μεν οιδας τι ποιεις, μακαριος ει· ει δε μη οιδας, επικαταρατος και παραβατης ει του νομου = "on the same day having observed one working on the Sabbath he said to him, Man, if thou knowest what thou dost, blessed art thou; but if thou knowest not, thou art accursed and a transgressor of the law"). These singular readings and interpolations are characteristic of the Codex Bezæ, and apparently Beza himself, though he quotes many of the most surprising readings, felt some alarm at them, for he explained to the University of Cambridge that the MS. ought not to be published, for fear of giving offence (*asservandum potius quam publicandum*). At the same time he was alive to its critical value, and appears to have recognized its relation to the old Latin and Syriac texts of the New Testament.

The MS. was not long in the possession of the university before its text was transcribed, more or less completely. It was transcribed in 1583 for Archbishop Whitgift, and partly collated by Patrick Young. Archbishop Usher collated it for Walton's Polyglot (1657), and Wetstein studied it closely in 1716. In 1732 it was collated by John Dickinson, with a view to remedy the errors in the critical apparatus of Mill. However imperfect these and other collations may be, they have an occasional scientific value at the present day in cases where the MS. has become illegible or damaged, *e.g.*, Ac 21¹⁶, where Whitgift's transcript should be consulted, along with the other early readers and collators. Whitgift's copy is in the Trinity College Library, Dickinson's in Jesus College Library, the others are to be consulted in the several New Testaments to which they belong. In 1793 the first great attempt was made by the University of Cambridge to publish an accurate transcript of the whole text. The work was entrusted to Dr Thomas Kipling, and splendidly issued in two folio volumes. The prolegomena were poor, but the transcript was fairly accurate; the work was, however, fiercely attacked on two sides on which it was singularly vulnerable, the Latin of the preface and its logic. Thomas Edwards, of Clare Hall, produced a tract on Kipling's work, which was written in the liveliest style of 18th century polemic. The tract is, however, hardly intelligible without a knowledge of contemporary university politics into which Edwards frequently diverges, and which have little interest at the present day. A more serious defect was the use of a single fount of type, both for the text and the marginal annotations, which are centuries later than the body of the text, a fault which led Credner, and in our own time Resch, into serious errors with regard to the origin of the text. The next great step in the knowledge of the text was taken when the MS. was edited by the Rev. F. H. Scrivener, in 1864, with a very complete series of annotations and prolegomena, in which everything was done, or almost everything that an editor could do, to furnish the student with an exact representation, in ordinary type, of the contents of the MS., and to supply at the same time criteria for discriminating the various hands by which the MS. had experienced correction or annotation, and generally recording the fortunes and the history both of the MS. and the peculiar text which it transmits. Facsimiles were engraved of two corresponding pages of the Greek and Latin, and of a number of places where correcting or annotating hands had been at work; and, on the whole, a notable advance was made in the materials for the history of the Codex. In 1900 the whole MS. was photographically reproduced for the university by the hands of Dujardin of Paris, the very fragile and much worn book being thus rendered the secure possession of scholars everywhere. The use of the photolithograph may sometimes mislead the reader, in cases where the shades of colour of the inks employed are no longer discriminated, and where the extreme tenuity of the vellum has allowed both the obverse and reverse of a leaf to appear at once in the transcript.

A word should be said at this point with regard to the text and its annotators and correctors. Naturally, after Kipling and Scrivener there is not much to be added in the way of readings to the text; but it should be observed that Blass (to whom we shall presently refer) has read several places in the text where Scrivener had to resort to conjecture, *e.g.*, the reading of Scrivener in

Acts 18⁷ is μεταβας [δε απο ακυ] λα
[εισ]ηλθεν εις τον [ο]ι[κ]ον τινος,

where Blass reads

μεταβας [απο του] ακυλα in the first line,

and Harris reads

και ηλθεν εις τον [ο]ι[κ]ον τινος

in the second line.

The importance of the correction lies in the explanation

that Paul left, not Aquila, but Aquila's house; and in the restoration of a curious syntactical construction which is peculiar to Codex Bezæ. Other corrections may be made. But it is in the annotations that the student will, by the aid of the facsimile, add most to the Scrivener transcript, and where he will make many corrections both as to the matters deciphered and the dates to which the hands are assigned. Of publications which in recent times have dealt with the Codex Bezæ, and the peculiar Western text of which it is the chief representative, the following should be noted:—(1) J. Rendel Harris, *Study of Codex Bezæ* (1891), in which the problem of the Bezan text was reopened, and an attempt was made to explain the peculiarities by the hypothesis of Latin reactions upon a Greek text, accompanied in a lesser degree by some Syriac reactions, the additional matter being largely due to a glossator who was probably under the influence of the Montanist movement. (2) F. H. Chase, *Old Syriac Element in the Codex Bezæ* (1893) and *The Sylo-Latin Text of the Gospels* (1895), in which substantially the whole of the Bezan peculiarities were referred to Syriac influence, and an attempt was made to find the original home of the text in Antioch. (3) The reply by Harris in *Four Lectures on the Western Text* (1894) should be studied, both for what it contradicts and what it concedes, and especially for the proof it contains of the early diffusion of the Bezan accretions to the Acts in Mesopotamia and other parts of the East. (4) But these and other attempts to explain the genesis of the Bezan text were cast into the shade by a brilliant hypothesis of Professor Blass of Halle, who maintained that the Lucan writings (St Luke and the Acts) in which the deviation of the Codex Bezæ from canonical form is most conspicuous, were in reality extant in two separate editions produced by St Luke himself, one of which he calls Antiochian, and the other Roman, a hypothesis which Blass defends with astonishing learning and skill, and in which he enlisted, almost at once, a body of sympathizers such as Nestle, Hilgenfeld, Belser, Salmon, and others, whose writings must be referred to. Blass himself not only published the Acts in what he supposed to be the original double edition, but defended himself against all attacks with amazing vigour, so that even Harnack has hardly succeeded in demolishing his theory. Whether, however, this theory can be finally sustained is still *in lite*. What is certain is that the Western text, as represented in the Codex Bezæ and cognate authorities, is older and more widely diffused than had been generally recognized; that it was extant in Greek, Latin, and Syriac in the earliest times; and that no single series of linguistic reactions can explain it away. And whatever be the exact value of the Blass demonstrations and reconstructions, it is evident that a great increase of critical weight has accrued to the Western readings generally in consequence of them; so that, even if it be conceded, as it must be, that the Codex Bezæ is subject to all kinds of corrupting influences, such as lectionary prefaces, harmonizations, and bad transcriptions, the nucleus of the text is as old as anything which we have in evidence for the text of the New Testament. A striking instance of this may be found in a far-reaching observation of a pupil of Professor Blass, named Lippelt, who found on examining the spelling of the name Ἰωάννης in the Codex Bezæ, that the name was almost uniformly spelt with one ν in the two Lucan books, although in the rest of the Codex the conventional spelling has prevailed. This striking testimony to the fact that the Bezan Luke and Acts once circulated together in a separate volume, though they are not now side by side, may be further extended by examining the Latin version, from which it appears that the spelling with one *n* prevails in Luke, but not in Acts, the inference being that the combined Lucan volume was not translated all at once, but at two different times and by two different hands. The Bezan text, therefore, retains traces of the history and collection of the books of the N.T. and of their translation which are not to be found in any other MS., and to be faithful thus *in minimis* renders it certain that it is also trustworthy in greater matters. The ultimate discrimination of the various elements in the Bezan (Western) text has yet to be made, and the suspicion is that the problem has not yet found its Newton. (J. R. HA.)

**Cœlentera** form a Group or Grade of the Animal Kingdom, the zoological importance of which has risen considerably since the time (1887) of the publication of the original article in the *Ency. Brit.*, even though their numbers have been reduced by the elevation of the Sponges or Porifera to the rank of an independent Phylum under the title Parazoa (Sollas, 1884). For the Cœlentera thus restricted, the term Enterocœla, in contrast to Cœlomocœla (the old Cœlomata), was suggested by Lankester (1900). From the more complex colonial Protozoa the Cœlentera are readily separated by their possession of two distinct sets of cells, with diverse functions, arranged in two definite layers,—a condition found in no Protozoan. The old criterion by which they and other Metazoa were once distinguished from Protozoa, namely, the differentiation of large and small sexual cells from each other and from the remaining cells of the body, has been broken down by the discovery of numerous cases of such differentiation among Protozoa. The Cœlentera, as contrasted with other Metazoa (but not Parazoa), consist of two layers of cells only, an outer layer or ectoderm, an inner layer or endoderm. They have hence been described as Diploblastica. In the remaining Metazoa certain cells are budded off at an early stage of development from one or both of the two original layers, to form later a third layer, the mesoderm, which lies between the ectoderm and endoderm; such forms have therefore received the name Triploblastica. At the same time it is necessary to observe that it is by no means certain that the mesoderm found in various groups of Metazoa is a similar or homologous formation in all cases. A second essential difference between Cœlentera and other Metazoa (except Parazoa) is that in the former all spaces in the interior of the body are referable to a single cavity of endodermal origin, the "gastro-vascular cavity," often termed the cœlenteron: the spaces are always originally continuous with one another, and are in almost every case permanently so. This single cavity and its lining serve apparently for all those functions (digestion, excretion, circulation, and often reproduction) which in more complex organisms are distributed among various cavities of independent and often very diverse origin.

In the Cœlentera the ectoderm and endoderm are set apart from one another at a very early period in the life-history; generally either by delamination or invagination, processes described in the article EMBRYOLOGY. Between these two cell-layers a mesoglœa (Bourne, 1887) is always intercalated as a secretion by one or both of them; this is a gelatinoid, primitively structureless lamella, which in the first instance serves merely as a basal support for the cells. In many cases, as, for example, in the Medusæ or jelly-fish, the mesoglœa may be so thick as to constitute the chief part of the body in bulk and weight. The ectoderm rarely consists of more than one layer of cells: these are divisible by structure and function into nervous, muscular, and secretory cells, supported by interstitial cells. The endoderm is generally also an epithelium one cell in thickness, the cells being digestive, secretory, and sometimes muscular. Reproductive sexual cells may be found in either of these two layers, according to the class and

sub-class in question. The mesoglœa is in itself an inert non-cellular secretion, but the immigration of muscular and other cells into its substance, both from ectoderm and endoderm, gives it in many cases a strong resemblance to the mesoderm of Triploblastica,—a resemblance which, while probably superficial, may yet serve to indicate the path of evolution of the mesoderm.

The Cœlentera may thus be briefly defined as Metazoa which exhibit two embryonic cell-layers only,—the ectoderm and endoderm,—their body-cavities being referable to a single cavity or cœlenteron in the endoderm. Their position in the Animal Kingdom and their main subdivisions may be expressed in the following table :—

I. PROTOZOA.
II. PARAZOA.
III. METAZOA.

Cœlentera = Diploblastica. | Triploblastica (including Cœlomata).

Hydromedusæ. | Scyphozoa. | Ctenophora.

Scyphomedusæ. | Anthozoa.

On a comparison of these subdivisions with those adopted by Professor Lankester in the article Hydrozoa (*Ency. Brit.* vol. xii.), it will be noticed that the Scyphomedusæ then included with the Hydromedusæ as Hydrozoa are here placed nearer to the Anthozoa than to their old pendants. The reasons for this may be stated briefly.

The HYDROMEDUSÆ are distinguished from the Scyphozoa chiefly by negative characters; they have no stomodæum, that is, no ingrowth of ectoderm at the mouth to form an œsophagus; they have no mesenteries (radiating partitions) which incompletely subdivide the cœlenteron; and they have no concentration of digestive cells into special organs. Their ectodermal muscles are mainly longitudinal, their endodermal muscles are circularly arranged on the body-wall. Their sexual cells are (probably in all cases) produced from the ectoderm, and lie in those radii which are first accentuated in development. They typically present two structural forms, the non-sexual hydroid, and the sexual medusoid; in such a case there is an alternation of generations (metagensis), the hydroid giving rise to the medusoid by a sexual gemmation, the medusoid bearing sexual cells which develop into a hydroid. In some other cases medusoid develops directly from medusoid (hypogenesis), whether by sexual cells or by gemmation. The medusoids have a muscular velum of ectoderm and mesogloea only.

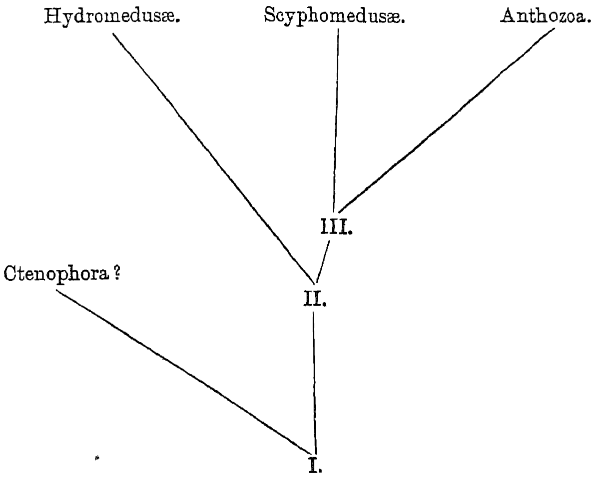
The SCYPHOZOA have the following features in common:—They typically exhibit an ectodermal stomodæum; partitions or mesenteries project into their cœlenteron from the body-wall, and on these are generally concentrated digestive cells (to form mesenterial filaments, phaceuæ, etc.); the external musculature of the body-wall is circular (except in *Cerianthus*); the internal, longitudinal; and the sexual cells probably always arise in the endoderm.

The SCYPHOMEDUSÆ, like the Hydromedusæ, typically present a metagenesis, the non-sexual scyphistomoid (corresponding to the hydroid) alternating with the sexual medusoid. In other cases the medusoid is hypogenetic, medusoid producing medusoid. The sexual cells of the medusoid lie in the endoderm on interradii, that is, on the second set of radii accentuated in the course of development. The medusoids have no true velum; in some cases a structure more or less resembling this organ, termed a velarium, is present, permeated by endodermal canals.

The ANTHOZOA differ from the Scyphomedusæ in having no medusoid form; they all more or less resemble a sea-anemone, and may be termed actinioid. They are (with rare exceptions, probably secondarily acquired) hypogenetic, the offspring resembling the parent, and both being sexual. The sexual cells are borne on the mesenteries in positions irrespective of obvious developmental radii.

The CTENOPHORA are so aberrant in structure that it has been proposed to separate them from the Cœlentera altogether: they are, however, theoretically deducible from an ancestor common to other Cœlentera, but their extreme specialization precludes the idea of any close relationship with the rest (see CTENOPHORA).

As regards the other three groups, however, it is easy to conceive of them as derived from an ancestor, represented to-day to some extent by the planula-larva (*Ency. Brit.*, HYDROZOA, vol. xii. p. 548), which was Cœlenterate in so far as it was composed of an ectoderm and endoderm, and had an internal digestive cavity (I. of the table).




At the point of divergence between Scyphozoa and Hydromedusæ (II. of the table of hypothetical descent), we may conceive of its descendant as tentaculate, capable of either floating (swimming) or fixation at will like Lucernaria to-day; and exhibiting incipient differentiation of myoepithial cells (neuro-muscular cells of HYDROZOA, *loc. cit.* p. 549). At the parting of the ways which led, on the one hand, to modern Scyphomedusæ, on the other to Anthozoa (III.), it is probable that the common ancestor was marked by incipient mesenteries and by the limitation of the sexual cells to endoderm. The lines of descent—II. to Hydromedusæ, and III. to Scyphomedusæ—represent periods during which the hypothetical ancestors II. and III., capable of either locomotion or fixation at will, were either differentiated into alternating generations of fixed sterile nutritive hydroids (scyphistomoids) and locomotor sexual medusoids, or abandoned the power of fixation in hypogenetic cases. During the period represented by the line of descent—III. to Anthozoa—this group abandoned its power of adult locomotion by swimming. During these periods were also attained those less important structural characters which these three groups present to-day. (G. H. FO.)

**Cognac,** chief town of arrondissement, department of Charente, France, 32 miles west by north of Angoulême, by rail. Large quantities of brandy and wine are exported to England, America, and Australia, and the total trade in alcoholic liquors of Cognac alone has a mean annual value of £1,200,000. Population (1881), 13,096; (1896), 18,932.

**Cohn, Ferdinand** (1828–1898), German botanist, was born on 24th January 1828 at Breslau. He was educated at Breslau and Berlin, subsequently being Professor of Botany at Breslau University. He had a remarkable career owing to his Jewish origin. He was contemporary with Pringsheim, and worked with Goeppert, Nees von Esenbeck, Ehrenberg, and Johannes Muller. At an early date he exhibited astonishing ability with the microscope, which he did much to improve, and his researches on cell-walls and the growth and contents of plant-cells soon attracted attention, especially as he made remarkable advances in the establishment of an improved cell-theory, discovered the cilia in, and analysed the movements of, zoospores, and pointed out that the protoplasm of the plant-cell and the sarcode of the zoologists were one and the same physical vehicle of life. Although these early researches were especially on the Algæ, in which group he instituted marked reforms of the rigid system due to Kutzing, Cohn had already displayed that activity in various departments which made him so famous as an all-round naturalist, his attention at various times being turned to such varied subjects as *Aldorovanda*, torsion in trees, the nature of waterspouts, the effects of lightning, physiology of seeds, the proteid crystals in the potato, which he discovered, the formation of travertin, the rotatoria, luminous worms, &c. &c., the mere notice of which would carry us too far.

It is, however, in the introduction of the strict biological and philosophical analysis of the life-histories of the lower and most minute forms of life that Cohn's greatest achievements consist, for he applied to these organisms the principle that we can only know the phases of growth of microscopic plants by watching every stage of development under the microscope, just as we learn how different are the youthful and adult appearances of an oak or a fern by direct observation. The success with which he attempted and carried out the application of cultural and developmental methods on the Algæ, Fungi, and Bacteria can only be fully appreciated by those familiar with the minute size and elusive evolutions of these organisms, and with the limited appliances at Cohn's command. Nevertheless his account of the life-histories of *Protococcus* (1850), *Stephanosphæra* (1852), *Volvox* (1856 and 1875), *Hydrodictyon* (1861), and *Sphæroplea* (1855–57) among the Algæ have never been put aside. The first is a model of what a study in development should be; the last shares with Thuret's studies on *Fucus* and Pringsheim's on *Vaucheria* the merit of establishing the existence of a sexual process in Algæ. Among the Fungi Cohn contributed important researches on *Pilobolus* (1851), *Empusa* (1855), *Tarichium* (1869), as well as valuable work on the nature of parasitism of Algæ and Fungi.

It is as the founder of bacteriology that Cohn's most striking claims to recognition will be established. He seems to have been always attracted particularly by curious problems of fermentation and coloration due to the most minute forms of life, as evinced by his papers on *Monas prodigiosa* (1850) and "Ueber blutähnliche Färbungen" (1850), on infusoria (1851 and 1852), on organisms in drinking-water (1853), "Die Wunder des Blutes" (1854), and had already published several works on insect epidemics (1869–70) and on plant diseases, when his first specially bacteriological memoir (*Crenothrix*) appeared in the journal (*Beiträge zur Biologie*) which he then started (1870–71), and which has since become so renowned. Investigations on other branches of bacteriology soon followed, among which "Organismen der Pockenlymphe" (1872), "Untersuchungen über Bacterien," I. (1872), II. (1875), IV. (1876), are most important, and laid the foundations of the new department of science which has now its own laboratories, literature, and votaries specially devoted to its extension in all directions. When it is remembered that Cohn brought out and helped Koch in publishing his celebrated paper on *Anthrax* (1876), the first clearly worked out case of a bacterial disease, the significance of his influence on bacteriology becomes apparent.

Among his most striking discoveries during his studies of the forms and movements of the Bacteria may be mentioned the nature of *Zooglœa*, the formation and germination of true spores,—which he observed for the first time, and which he himself discovered[1] in *Bacillus subtilis*,—and their resistance to high temperatures, and the bearing of this on the fallacious experiments supposed to support abiogenesis; as well as works on the bacteria of air and water, the significance of the bright sulphur-granules in sulphur bacteria, and of the iron-oxide deposited in the walls of *Crenothrix*. His discoveries in these and in other departments all stand forth as mementoes of his acute observation and reasoning powers, and the thoughtful (in every sense of the word) consideration of the work of others, and suggestive ideas attached to his principal papers, bear the same characteristics. If we overcome the always difficult task of bridging in imagination the interval between our present platform of knowledge and that on which bacteriologists stood in, say, 1870, we shall not undervalue the important contributions of Cohn to the overthrow of the then formidable bugbear known as the doctrine of "*Spontaneous Generation*," a dogma of despair calculated to impede progress as much in its day as that of "*Vitalism*" did in other periods. Cohn had also clear perceptions of the important bearings of Mycology and Bacteriology in infective diseases, as shown by his studies in insect-killing fungi, microscopic analysis of water, &c. He was a foreign member of the Royal Society and of the Linnean Society, and received the gold medal of the latter in 1895. He died in 1898. Lists of his papers will be found in the *Catalogue of Scientific Papers of the Royal Society*, and in *Ber. d. d. bot. Gesellsch.*, 1899, vol. xvii. p. (196). The latter also contains (p. (172)) a full memoir by F. Rosen. (H. M. W.)

**Cohoes,** a city of Albany county, New York, U.S.A., situated in 42° 46′ N. lat. and 73° 42′ W. long., in the eastern part of the state. Two railways enter the city—the Delaware and Hudson and the New York Central and Hudson River. It was built for manufacturing purposes at the Falls of the Mohawk, which furnish power. In 1890 there was an invested capital of $11,275,137, employing 8939 persons, with a product amounting to $10,836,260. Of this amount one-half was represented by hosiery and knit goods, for which the place is famous. Population (1880), 19,416; (1890), 22,509; (1900), 23,910.

**Coimbatore,** a town and district of British India, in the Madras Presidency. The town is situated on the left bank of the Noyil river, 304 miles by rail from Madras. In 1881 it had a population of 38,967, in 1891 of 46,383, and in 1901 of 52,931, showing an increase of 14 per cent. The municipal income in 1896–97 was Rs.55,730. The town stands 1437 feet above sea-level, and is well laid out and healthy. It has a station on the Nilgiri branch of the Madras Railway. It has two aided colleges, three high schools with 1185 pupils, several

[1] In August 1872 Cohn wrote: "So hat sich bei den Bakterien überhaupt keine eigentliche Fortpflanzung (Ei- oder Sporen- bildung) bis jetzt nachweisen lassen" (Beitr. B. i. H. 2, p. 179). In 1876 (Beitr. B. ii. H. 2, p. 263) he described the spores and their formation in *B. subtilis*.

missionary bodies and literary institutions, and four printing-presses. There is one cotton mill, with 20,384 spindles, employing 1000 hands.

The DISTRICT OF COIMBATORE has an area of 7860 square miles. The population in 1891 was 2,004,839, being 255 persons per square mile. In 1901 the population was 2,202,312, showing an increase of 10 per cent. The land revenue and rates were Rs.33,82,127, the incident of assessment being R. 1-2-5 per acre; the number of police was 906. In 1897–98, out of a total cultivated area of 2,266,851 acres, 390,262 were irrigated, including 74,973 from Government canals. The principal crops are millet, rice, other food grain, pulse, oilseeds, cotton, and tobacco, with a little coffee. Forests cover nearly $1\frac{1}{2}$ million acres, yielding valuable timber (teak, sandal-wood, &c.), and affording grazing ground for cattle. There are eight factories for pressing cotton, and two for cleaning coffee, two oilcake presses, three tanneries with an outturn valued at Rs.50,00,000, a sugar refinery, and 822 saltpetre refineries. The south-west line of the Madras Railway runs through the district. In 1896–97 the number of schools was 1242, attended by 35,477 pupils, being one pupil to every 57 of the total population. The registered death-rate in 1897 was 20·1 per thousand.

**Coimbra,** a city and episcopal see of Portugal, capital of district Coimbra, on the right bank of the Mondego, about 24 miles above its mouth. It has a scientific and literary institute. The average attendance at the university is 1350 students annually. There are manufactures of earthenware, hats, and leather; and lamprey fishing is important. Population (1900), 18,424. The district of Coimbra has an area of 1499 square miles, and a population of 333,505, giving a density of 211 inhabitants to the square mile. It has a fertile soil, and produces millet and wine, and possesses large herds of cattle. At Cape Mondego coal is mined.

**Coinage.** See NUMISMATICS.

**Coire,** or CHUR (often now spelt "Cur"), the capital of the Swiss canton of the Grisons or Graubunden. It is 1952 feet above the level of the sea. The new Raetian Museum has many antiquities, books, &c., relating to ancient Raetia, and includes also the geological collection of the monk Placidus à Spescha, who about 100 years ago thoroughly explored his native country. Father Theodosius, the founder of the hospital, died in 1865, and has a monument in front of the cathedral. Population, 9259 in 1888, and 11,513 in 1900. In 1888 Coire contained 6518 Romanists and 2729 Protestants, while 7799 spoke German and 1158 Romonsch. The see of Coire dates probably from the second half of the 4th century, and the first known bishop, Asimo, is mentioned in 455. In the troubled times of the 8th century the bishops were also great temporal lords, while in 831 Louis the Pious granted the bishop "immunity" for his territories, so that henceforth he was dependent simply on the empire. In 1170 he became a prince of the holy Roman Empire, and later extended his power over many of the neighbouring regions. In 1392 he became the chief of the "League of the House of God," originally formed in 1367 against him by his chapter, the city of Coire, &c. In 1526, by the "articles of Ilanz," the bishop lost all his temporal possessions and rights, having, so to speak, fulfilled his historical rôle of bringing together the elements of one of the three Raetian leagues that in 1803 formed the canton of the Grisons. The guild constitution of the city of Coire lasted from 1465 to 1839.

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**Colchester,** a municipal and parliamentary borough (coextensive; since 1885 returning only one member) and seaport of Essex, England, on the Colne and the Great Eastern Railway. The ancient church of the Holy Trinity has been restored, and St Runwald's removed. Recent erections are a new bridge over the Colne, assembly rooms, a corn exchange, a town-hall, a technical and university extension college, a drill-hall, a reading-room, a library, a dozen almshouses, and a new cattle market. The Essex and Colchester general hospital has been enlarged. Castle Park, of 9 acres, containing Colchester Castle, was opened in 1892. The harbour was taken over by the corporation in 1898. The oyster fisheries belonging to the corporation are held on a ninety-nine years' lease by the Colne Fishery Company, incorporated under an Act of 1870. The registered shipping at the end of 1900 consisted of 157 vessels of 4717 tons. In 1900, 537 vessels of 38,731 tons entered, and 505 of 34,338 tons cleared. These entrances and clearances do not include those of vessels trading between Colchester and London or other ports on the estuary of the Thames. Area, 11,331 acres. Population (1881), 28,374; (1891), 34,559; (1901), 38,351.

**Colchester,** a town of Chittenden county, Vermont, U.S.A., on the Lake Champlain. The principal village of the town is Winooski, on Onion river, a few miles above its mouth, and on the Central Vermont Railway, at an altitude of 326 feet. Population (1880), 4421; (1890), 5143; (1900), 5352.

**Cold Harbor,** a village of Hanover county, Virginia, U.S.A., 10 miles north-east of Richmond. It was the scene of a succession of battles, June 1, 2, and 3, 1864, between the Union army under Grant and the Confederate forces under Lee. The Union troops, who took the offensive in most of the fighting, lost heavily, the total number being reported at 12,738.

**Cold Storage.** See REFRIGERATING MACHINERY.

**Coldwater,** capital of Branch county, Michigan, U.S.A., situated in the south of the lower peninsula, on the east branch of Coldwater river, and on the Lake Shore and Michigan Southern Railroad, at an altitude of 982 feet. Population (1880), 4681; (1900), 6216.

**Cole, Sir Henry** (1808–1882), the English public servant whose name will always be associated with the early organization of "South Kensington," was born at Bath on 15th July 1808, and was the son of an officer in the army. At the age of fifteen he became clerk to Sir Francis Palgrave, then a subordinate officer in the Record Office, and, helped by Charles Buller, to whom he had been introduced by Thomas Love Peacock, and who became chairman of a Royal Commission for inquiry into the condition of the public records, worked his way up until he became an assistant keeper. He largely assisted in influencing public opinion in support of Sir Rowland Hill's reforms at the Post Office. A connexion with the Society of Arts caused him to drift gradually out of the Record Office: he was a leading member of the Commission that organized the great Exhibition of 1851, and upon the conclusion of its labours was made secretary to

the School of Design, which by a series of transformations became in 1853 the Department of Science and Art. Under its auspices the South Kensington Museum was founded in 1855 upon land purchased out of the surplus of the Exhibition, and Cole practically became its director, retiring in 1873. His proceedings were frequently criticized, but the Museum owes everything to his energy. Indefatigable, genial, and masterful, he drove everything before him, and by all sorts of schemes and devices built up a great institution, whose variety and inequality of composition seemed imaged in the anomalous structure in which it was temporarily housed. He also, though to the financial disappointment of many, conferred a great benefit upon the metropolis by originating the scheme for the erection of the Royal Albert Hall. He was active in founding the national training schools for cookery and music, the latter the germ of the Royal College of Music. He edited the works of his benefactor Peacock; and was in his younger days largely connected with the press, and the author of many useful topographical handbooks published under the pseudonym of "Felix Summerly." He died on 18th April 1882. (R. G.)

**Cole, Vicat** (1833–1893), English painter, born at Portsmouth on 17th April 1833, was the son of the landscape painter, George Cole, and in his practice followed his father's lead with marked success. He exhibited at the British Institution at the age of nineteen, and was first represented at the Royal Academy in 1853. His election as an Associate of this institution took place in 1870, and he became an Academician ten years later. He died in London on 6th April 1893. The wide popularity of his work was due partly to the simple directness of his technical method, and partly to his habitual choice of attractive material. Most of his subjects were found in the counties of Surrey and Sussex, and along the banks of the Thames. One of his largest pictures, "The Pool of London," was bought by the Chantrey Fund Trustees in 1888, and is now in the National Gallery of British Art.

See Robert Chignell. *The Life and Paintings of Vicat Cole, R.A.* London, 1899.

**Colenso, John William** (1814–1883), Bishop of Natal, was born at St Austell, Cornwall, on 24th January 1814. His family were in embarrassed circumstances, and he was indebted to relatives for the means of university education. Second Wrangler at Cambridge, and Fellow of St John's College, his mathematical distinction led him to be invited to Harrow in 1837, but the step proved an unfortunate one. The school was just then at the lowest ebb under an unpopular headmaster, and Colenso not only got few pupils, but lost most of his property by a fire which destroyed his house. He went back to Cambridge, and in a short time paid off heavy debts by diligent tutoring, and the proceeds of his marvellously successful series of manuals of algebra and arithmetic, which were adopted all over England. In 1846 he became rector of Forncett St Mary, Norfolk, and in 1853 was appointed Bishop of Natal. Full of zeal, he devoted himself on his arrival to acquiring the native language, of which he compiled a grammar and dictionary, and into which he translated the New Testament and other portions of Scripture. His ardour, however, was soon diverted into another channel by the puzzling objections of natives, who convinced him that the verbal inspiration and Mosaic authorship of the Pentateuch could not be maintained. Colenso brought his arithmetical attainments to bear upon the question, and published his conclusions, positive and negative, in a series of treatises on the Pentateuch, extending from 1862 to 1879. His conclusions were naturally disputed with a fervour of conviction equal to his own. While controversy raged in England, the South African bishops, whose suspicions Colenso had already incurred by the liberality of his views respecting polygamy among native converts and a commentary upon Romans alleged to savour of heresy, met in conclave to condemn him, and pronounced his deposition (December 1863). Colenso, who had refused to appear before their tribunal otherwise than as sending a protest by proxy, appealed to the Privy Council, which pronounced that the Cape Town Metropolitan had no coercive jurisdiction and no authority to interfere with the Bishop of Natal. No decision, therefore, was given upon the merits of the case; but it is significant that although many eminent clergymen have since expressed views agreeing in essentials with Bishop Colenso's, no prosecution has been instituted against any of them. His adversaries, though unable to obtain his condemnation, succeeded in causing him to be generally inhibited from preaching in England, and set up a rival bishop in Natal, who, however, assumed a different title. The contributions of the missionary societies were withdrawn, but an attempt to deprive him of his episcopal income was frustrated by a decision of the Courts. Colenso, encouraged by a handsome testimonial raised in England, to which many clergymen subscribed, returned to his diocese, and devoted the latter years of his life to further labours as Biblical commentator and translator, and especially to the defence of the natives against what he considered oppression and wrong. By this course he made more enemies among the colonists than he had ever made among the clergy. He died at Durban on 20th June 1883. The character of the man and of his works are summed up in ten words of Jowett: "He has made an epoch in criticism by his straightforwardness." (R. G.)

**Coleraine,** a maritime town and urban sanitary district, in the county of Londonderry, Ireland, on the river Bann and the Belfast and Northern Counties Railway, 145 miles north of Dublin. It ceased to be a parliamentary borough in 1885. The harbour has been much improved from grants by the Irish Society of London and from a loan under the River Bann Navigation Act, 1879. In all 420 vessels of 46,526 tons entered in 1899, and 256 of 32,631 tons cleared. The number of persons employed in the salmon fishery district in 1899 was 731. Population (1881), 6694; (1891), 6845; (1901), 6929.

**Coleridge, John Duke Coleridge,** 1st Baron (1820–1894), Lord Chief Justice of England, was the eldest son of Sir John Taylor Coleridge (see *Ency. Brit.*, 9th edition, vol. vi. p. 135). He was born at Heath's Court, Ottery St Mary, on the 3rd of December 1820. He was educated at Eton, an institution which, as managed in the 'thirties, sent most of its pupils into the world slenderly enough equipped for the battle of life. It was otherwise in the case of Coleridge, the system then prevailing, with its worship of Latin verses and the elegancies of classic scholarship in general, being just suited to bring out the rhetorical talents which did so much to make his fame; but he owed even more to his innate love of letters than he did to any formal teaching. He gained a scholarship at Balliol, and entered that college at a very auspicious moment, for the scholars' table there has never been occupied by a more brilliant company. The late Principal Shairp of St Andrews published in the year 1873 a poem called "The Balliol Scholars from 1840–43," which well described it.

Here is the sketch of Coleridge as he appeared to a contemporary:—

Fair-haired and tall, slim but of stately mien,
  Inheritor of a high poetic name,
Another, in the bright bloom of nineteen,
  Fresh from the pleasant fields of Eton came:
Whate'er of beautiful or poet sung
Or statesman uttered, round his memory clung;
  Before him shone resplendent heights of fame.

With friends around the board, no wit so fine
  To wing the jest, the sparkling tale to tell;
Yet ofttimes listening in St. Mary's shrine,
  Profounder moods upon his spirit fell:
We heard him then, England has heard him since,
Uphold the fallen, make the guilty wince,
  And the hushed Senate have confessed the spell.

The other Balliol scholars celebrated in the same poem were Clough, Pritchard, Archbishop Temple of Canterbury, Riddell, Matthew Arnold, and Seymour. The last of these, a man of very great promise, died early at Laibach in Carniola. His sister was Coleridge's first wife; they were married when Coleridge was only five and twenty, and just about the same time he was called to the Bar. Coleridge used to say that the difference between his father and himself was that the former had started in life with a thousand pounds he had borrowed, while, with better fortune, he had started with a thousand pounds of his own. He was called to the Bar on 6th November 1846, and went the Western Circuit, rising steadily, through more than twenty years of hard work, till in July 1865 he was returned as member for Exeter in the Liberal interest. The impression which he made on the heads of his party was so favourable that they determined, early in the session of 1867, to put him forward as the protagonist of their attack on the Conservative Government. But that move seemed to many of their staunchest adherents unwise, and it was frustrated by the active opposition of a section, including Hastings Russell (later ninth duke of Bedford), his brother Arthur, member for Tavistock, Alexander Mitchell of Stow, Kinglake, and Henry Seymour. They met to deliberate in the Tea-room of the House, and were afterwards sometimes confounded with the Tea-room party which was of subsequent formation and under the guidance of a different group. The protest was sufficient to prevent the contemplated attack being made, but the Liberals returned to power in good time with a large majority behind them in 1868. Coleridge was made, first, Solicitor-, and then Attorney-General.

As early as 1863 a small body of Oxford men in Parliament had opened fire against the legislation which kept their University bound by ecclesiastical swaddling clothes. They had made a good deal of progress in converting the House of Commons to their views before the General Election of 1865. That election having brought Coleridge into Parliament, he was hailed as a most valuable ally, whose great University distinction, brilliant success as an orator at the Bar, and hereditary connexion with the High Church party, entitled him to take the lead in a movement which, although gathering strength, was yet very far from having achieved complete success. The clerically-minded section of the Conservative party could not but listen to the son of Sir John Coleridge, the godson of Keble, and the representative of the man who had been the indirect cause of the Anglican revival of 1833,—for John Stuart Mill was right when he said that Coleridge and Bentham were, so far as England was concerned, the leaders of the two chief movements of their times: "it was they who taught the teachers, and who were the two great seminal minds."

Walking up one evening from the House of Commons to dine at the Athenæum with Henry Bruce (afterwards Lord Aberdare) and another friend, Coleridge said: "There is a trial coming on which will be one of the most remarkable *causes célèbres* that has ever been heard of." This was the Tichborne case, of which so much was said ere many weeks had passed over, and which led to proceedings in the criminal courts rising almost to the dignity of a political event. These two trials were the most conspicuous features of Coleridge's later years at the Bar, and tasked his powers as an advocate to the uttermost, though he was assisted by the splendid abilities and industry of Charles (afterwards Lord) Bowen. In November 1873 Coleridge succeeded Sir W. Bovill as Chief Justice of the Common Pleas, and was immediately afterwards raised to the Peerage as Baron Coleridge of Ottery St Mary. In 1880 he was made Lord Chief Justice of England on the death of Sir Alexander Cockburn.

In jury cases his quickness in apprehending facts and his lucidity in arranging them were very remarkable indeed. He was not one of the most learned of lawyers, but he was a great deal more learned than many people believed him to be, and as an ecclesiastical lawyer had perhaps few or no superiors. His fault—a natural fault in one who had been so successful as an advocate—was that of being too apt to take one side. He allowed, also, certain political or class prepossessions to interfere somewhat with the even course of justice. A game-preserving landlord had not to thank the gods when his case, however buttressed by undoubted right, came before Coleridge. Towards the end of his life his health failed, and he became somewhat indolent. On the whole, he was not so strong a man in his judicial capacity as Campbell or Cockburn; but when all has been said that could reasonably be said in his disparagement, even Rhadamanthus would have to admit that his scholarship, his refinement, his power of oratory, and his character raised the tone of the Bench while he sat upon it, and that if it has been adorned by greater judicial abilities, it has hardly ever been adorned by a greater combination of varied merits. It is curious to observe that of all judges the man whom he put highest was one very unlike himself, the great Master of the Rolls, Sir William Grant. He died in harness. Early in the 'nineties his friends could see that he began to feel his age. He made, indeed, no secret of it; but he might have lasted a little longer if a summer cold had not precipitated the end. He died on 14th June 1894.

Coleridge's work, first as a barrister and then as a judge, prevented his publishing as much as he otherwise would have done, but his addresses and papers would, if collected, fill several volumes and do much honour to his memory. One of the best, and one most eminently characteristic of the man, was his Inaugural Address to the Philosophical Institution at Edinburgh in 1870. He was an exceptionally good letter-writer. Of travel he had very little experience. He had hardly entered Paris; once, quite near the end of his career, he spent a few days in Holland, and came back a willing slave to the genius of Rembrandt; but his longest absence from England was a visit to the United States, which had something of a business character. It is strange that a man so steeped in Greek and Roman poetry, so deeply interested in the past, present, and future of Christianity, never saw Rome, or Athens, or the Holy Land. The chief cause, no doubt, was the fatal custom of neglecting modern languages at English schools. He felt himself at a disadvantage when he passed beyond English-speaking lands, and cordially disliked the situation. No notice of Coleridge can omit to make mention of his extraordinary store of anecdotes, which were nearly always connected with Eton, Oxford, the Bar, or the Bench. His exquisite voice, considerable

power of mimicry, and perfect method of narration added greatly to the charm. He once told, at the table of Dr Jowett, Master of Balliol, anecdotes through the whole of dinner on Saturday evening, through the whole of breakfast, lunch, and dinner the next day, through the whole journey on Monday morning from Oxford to Paddington, without ever once repeating himself. He was frequently to be seen at the Athenæum, was a member both of Grillion's and The Club, as well as of the Literary Society, of which he was president, and whose meetings he very rarely missed. Bishop Copleston is said to have divided the human race into three classes,—men, women, and Coleridges. If he did so, he meant, no doubt, to imply that the men of the family whose chief example was the poet of "Christabel" had a certain feminine charm combined with a trace of feminine weakness. In John Duke Coleridge the charm was certainly present.

Coleridge's first wife died in 1878. She was an artist of real genius, and her portrait of Cardinal Newman was considered much better than the one by Millais. A short notice of her by Dean Church of St Paul's was published in the *Guardian* on 13th February 1878, and was reprinted in her husband's privately printed collection of poems. Coleridge remained for many years a widower, but married in 1886 Amy Augusta Jackson Lawford, daughter of Henry Baring Lawford, Esq., who survived him. He was succeeded in the peerage by his eldest son, Bernard John Seymour. (M. G. D.)

**Colfax, Schuyler** (1823–1885), vice-president of the United States, was born in New York City on the 23rd of March 1823, and died in Mankato, Minn., 13th January 1885. After a meagre education he served as a clerk in Indiana, and then turned to journalism. From 1855 to 1869 he was a Republican representative in Congress from Indiana. In 1863 he was elected Speaker of the House, and served for three terms. In 1868 he was elected vice-president on the ticket with General Grant. Owing to his alleged connexion with the corrupt distribution of shares of stock in the Crédit Mobilier he was not renominated. In later years he was best known as a popular lecturer.

**Colima,** one of the smallest states of Mexico, bounded by the state of Jalisco on the N., N.E., and W., by that of Michoacan on the E., and by the Pacific on the S., with an area of 2273 square miles, including the islands of Revill Gigedo. The population in 1879 was 65,827, and in 1895 it was 55,752. The principal industries are agriculture, stock-raising, and the exploitation of the salt deposits; the products are coffee, cacao, tobacco, rice, cotton, indigo, sugar-cane, cereals, and leguminous plants. The state is divided into three *partidos* and seven municipalities. The capital, Colima, 570 miles from Mexico City, has a population of 18,977, and is situated in a beautiful and fertile valley, irrigated by the Colima river. The city has good public buildings, a cathedral, theatre, and a fine market-house. It has tramways and an electric light system. Amongst other towns are Manzanillo, Coquimatlan, Ixtahuacan, Almoloyan, Comala.

**Colle di Val d'Elsa,** a town and episcopal see of the province of Siena, Tuscany, Italy, 21 miles north-west from Siena, 13 by rail to Poggibonsi. It consists of two quarters, the upper old town, with a 13th-century cathedral, and the lower new town, with busy ironworks, glass, pottery, paper, and brick factories. There is a technical school (1873). Here the Florentines defeated the Sienese in 1269. Population, about 6000.

**College Point,** formerly a village of Queens county, New York, U.S.A., but since January 1, 1898, a part of the borough of Queens, one of the five boroughs constituting the city of New York; on the east shore of Flushing Bay, an arm of Long Island Sound. Population (1880), 4192; (1890), 6127. (See New York City.)

**Colley, Sir George Pomeroy** (1835–1881), British general, third son of George Pomeroy Colley of Rathangan, Co. Kildare, Ireland, and grandson of the fourth Viscount Harberton, was born on the 1st of November 1835, and entered the 2nd Queen's Regiment from Sandhurst as ensign in 1852. From 1854 to 1860 he served in South Africa, and was employed in surveying and as a magistrate in charge of the Bashi river district in Kaffraria. Early in 1860 he went with his regiment to China to join the Anglo-French Expedition, and took part in the capture of the Taku Forts and the entry into Peking (medal and clasp), returning to South Africa to complete his work in Kaffraria (brevet-majority). In 1862 he entered the Staff College and passed out in one year with honours. After serving as brigade-major at Devonport for five years he went to the War Office in 1870 to assist in the preparation of Mr Cardwell's measures of army reform. He was appointed professor of military administration at the Staff College in 1871. Early in 1873 he joined Sir Garnet Wolseley at the Gold Coast, where he took charge of the transport, and the success of the Ashanti Expedition was in no small degree due to his exertions (medal, brevet colonelcy, and C.B.). In 1875 he accompanied Wolseley to Natal (C.M.G.). On his return home he was appointed military secretary to Lord Lytton, Governor-General of India, and in 1877 private secretary (K.C.S.I.). In 1879 he joined Wolseley as Chief of the Staff and Brigadier-General in S.E. Africa, but, on the murder of Cavagnari at Kabul, returned to India. In 1880 he succeeded Wolseley in S.E. Africa as High Commissioner and General Commanding, and conducted the operations against the rebel Boers. He was defeated at Lang's Nek and at the Ingogo river, and killed at Majuba Hill on 27th February 1881. Colley contributed to periodical literature, and wrote the article "Army" in the ninth edition of the *Encyclopædia Britannica*. He had a very high reputation not only for a theoretical knowledge of military affairs, but also as a practical soldier; and his disastrous failure against the Boers completely upset all the estimates that had been made of his abilities.

**Collier, John Payne** (1789–1883), English critic, was born in London, 11th January 1789. His father's connexion with the press obtained for him a position on the *Morning Chronicle* as leader writer, dramatic critic, and reporter, which continued till 1847; he was also called to the Bar. All the time he could spare, however, was given to the study of Shakespeare and the early English drama. After some minor publications he produced, in 1831, his *History of English Dramatic Poetry and Annals of the Stage*, a badly arranged but valuable work. It obtained for him the post of librarian to the duke of Devonshire, and access to the chief collections of early English literature throughout the kingdom. These opportunities were unhappily misused to effect a series of literary fabrications, which may be charitably, and perhaps not unjustly, attributed to literary monomania, but of which it is difficult to speak with patience, so completely did they for a long time bewilder the chronology of Shakespeare's writings, and such suspicion have they thrown upon MS. evidence in general. After *New Facts*, *New Particulars*, and *Further Particulars* respecting

Shakespeare had appeared and passed muster, Collier produced (1852) the famous *Perkins Folio*, claiming to possess numerous MS. emendations of Shakespeare by "an old corrector." The authenticity of these was disputed in several quarters on internal evidence; and when in 1859 they were submitted to experts at the British Museum they were incontestably proved to be forgeries. The point whether Collier was deceiver or deceived was left undecided, but it must be feared that the falsifications of which he was unquestionably guilty among the MSS. at Dulwich College have left little doubt respecting it. Apart from these unhappy mystifications, which have thrown so much suspicion upon his antiquarian work that no statement of his can be accepted without verification, his literary career was useful and honourable. He published excellent editions of Shakespeare and Spenser, reprinted a great number of early English tracts of extreme rarity, and rendered good service to the numerous antiquarian societies with which he was connected. His *Old Man's Diary* is an interesting record, though even here the taint of fabrication is not absent. Unfortunately what he did amiss is more striking to the imagination than what he did aright, and he will be chiefly remembered by it. He was active with his pen almost to the end of his life; and died at Maidenhead, where he had long resided, on 17th September 1883. (R. G.)

**Collingwood,** a town and railway station of Simcoe county, Ontario, Canada, 71 miles north-north-west of Toronto, on Lake Huron. It is the eastern terminus of two lines of steamers plying to Lake Huron and Lake Superior ports. It contains a large stone dry-dock and shipyard, pork factory, and saw and planing mills, and has a large lumber, grain, and produce export trade, besides large shipbuilding plant and steel works. Exports for the year 1899–1900 were valued at $2,657,413; imports at $277,770. Population (1881), 4435; (1900), 5587.

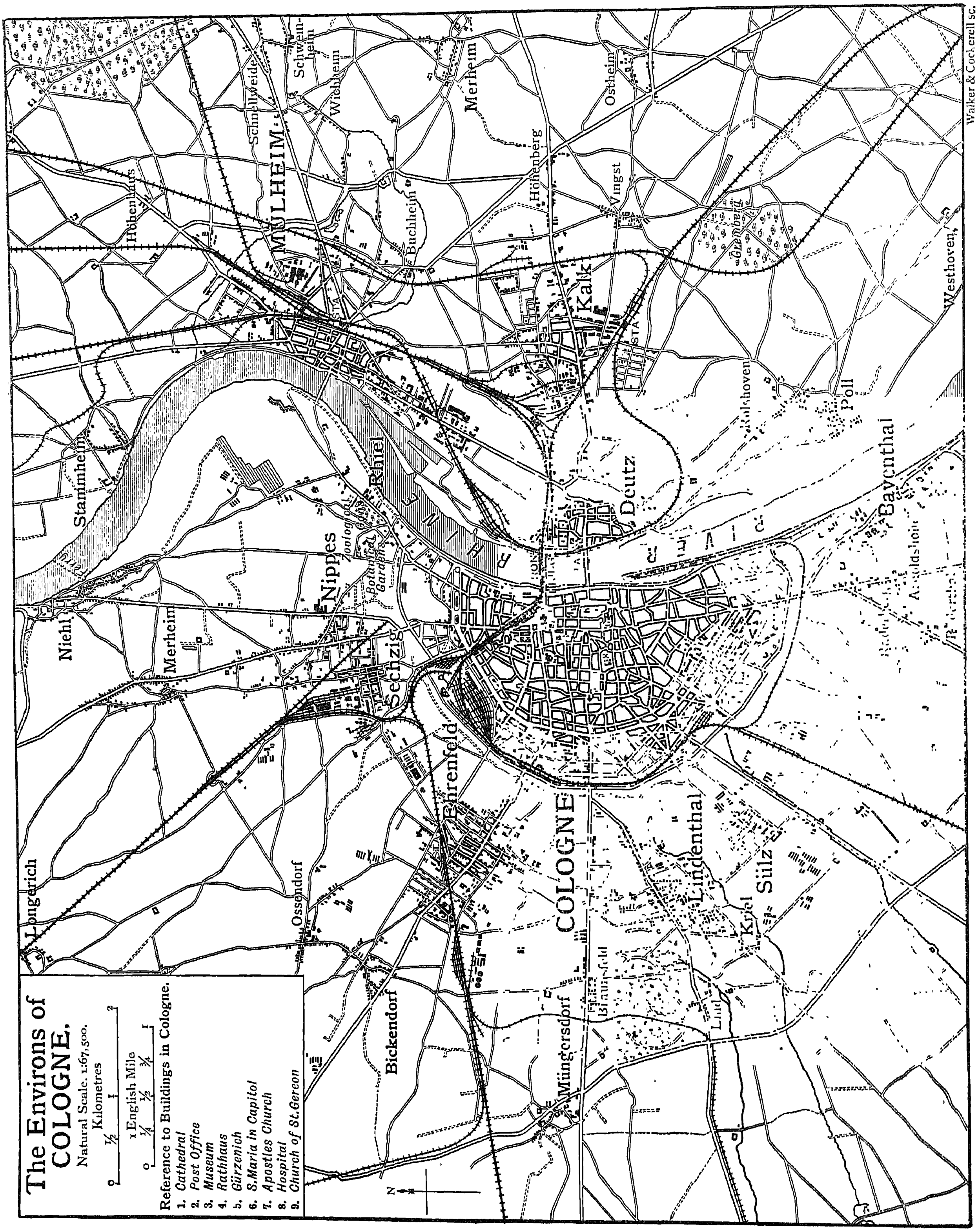
**Collins, William Wilkie** (1824–1889), English novelist, the elder son of William Collins, R.A., the well-known landscape painter, was born in London, 8th January 1824. He was educated at a private school in Highbury, and when only a small boy of twelve was taken by his parents to Italy, where the family lived for three years. On their return to England Wilkie Collins was articled to a firm in the tea trade, but four years later he abandoned that business for the law. He found little pleasure in his new career, however; though what he learned in it was exceedingly valuable to him later. On his father's death in 1847 young Collins made his first essay in literature, publishing the *Life of William Collins*, in two volumes, in the following year. This gave him an incentive towards writing, and in 1850 he put forth his first work of fiction, *Antonina, or the Fall of Rome*, which was clearly inspired by his life in Italy. *Basil* appeared in 1852, and *Hide and Seek* in 1854. About this time he made the acquaintance of Charles Dickens, and began to contribute to *Household Words*, where *After Dark* (1856) and *The Dead Secret* (1857) ran serially. His great success was achieved in 1860 with the publication of *The Woman in White*, which was first printed in *All the Year Round*. From that time he enjoyed as much popularity as any novelist of his day, and was continually employed in writing, *No Name* (1862), *Armadale* (1866), and *The Moonstone* (1868) being among his most successful achievements. The last-named story, for many of the details of which Collins was indebted to the curious history of the Road murder, is certainly the best detective novel ever written in the English language. After *The New Magdalen* (1873) his ingenuity became gradually exhausted, and his later stories were little more than faint echoes of earlier successes. He died in Wimpole Street, London, 23rd September 1889. Collins's gift was of the melodramatic order, and while many of his stories made excellent plays, several of them were actually reconstructed from pieces designed originally for stage production. But if his colours were occasionally crude, and his methods violent, he was at least a master of situation and effect. His trick of telling a story through the mouths of different characters is sometimes irritatingly disconnected; but it had the merit of giving an air of actual evidence and reality to the elucidation of a mystery. He possessed in the highest degree the gift of absorbing interest; the turns and complexities of his plots are surprisingly ingenious, and many of his characters are not only real, but uncommon. Count Fosco in *The Woman in White* is perhaps his masterpiece; the character has been imitated again and again, but no imitation has ever attained to the subtlety and humour of the original. (A. WA.)

**Colmar,** a town of Germany, in the imperial territory of Alsace-Lorraine, district of Upper Alsace, 40 miles south-south-west from Strasburg by the railway to Basel. The town still has numerous narrow and picturesque streets, with good houses of the 16th and 17th centuries. It is the seat of several textile industries, and manufactures sewing thread, starch, sugar, and machinery; there are also bleachfields, breweries, and cultivation of wine and fruit. Population (1885), 26,537; (1900), 36,824.

**Colne,** a municipal borough (1895) and market-town in the Clitheroe parliamentary division of Lancashire, England, 6 miles north-north-east of Burnley by rail. Area of borough, 5330 acres. Population (1901), 23,000.

**Cologne,** in German *Köln* (officially *Cöln*, since 1900), a town and archiepiscopal see of Prussia, in the Rhine province, on the left bank of the Rhine, by rail 44 miles east by north from Aix-la-Chapelle, 24 south by east from Düsseldorf, and 57 north-north-west from Coblenz. It is a much improved town, and is no longer distinguished by its smells as it used to be. In 1881–85 the old fortifications were dismantled and the site (bought by the municipality from the War Office for £600,000) converted into a fine boulevard, the Ring Street, nearly 4 miles long. Beyond the Ring Street now extends a new continuous line of fortifications, covering an area of 1000 acres, thus doubling the area of the city of Cologne. Within the outer municipal boundary are further included (1888) the suburbs of Bayenthal, Lindenthal, Ehrenfeld, Nippes, Deutz (on the opposite side of the river), Sülz, Bickendorf, Niel, and Poll, protected by another widely extended circle of detached forts on both banks of the Rhine. Of the former city gates four have been retained, restored, and converted into museums: the Severin gate, on the south, contains the geological section of the natural history museum; the Hahnen (cocks) gate, on the west, is fitted as the historical and antiquarian museum of the city; and the Eigelstein gate, on the north, accommodates the zoological section of the natural history museum. Along this same promenade are the technical trades school, the Roman Catholic church of the Heart of Jesus (1900), a monumental fountain to the memory of the Emperor William I. (1897), and the industrial art museum (1899–1900). The building of the cathedral was finally completed in 1880. It has since been supplied with fine bronze doors. The Great Bell (*Kaiserglocke*), cast in 1874, weighs 543 cwt., and is the largest and heaviest bell that is rung; it was put up in 1880. The view of the cathedral has been much improved by a clearance of the old houses in the Dom Platz, including the Archiepiscopal Palace. The new Platz is now flanked by fine buildings. Many new

churches have been built (*e.g.*, St Michael's, churches in Wiehl and in Riehl, the church of Christ, &c.), and several of the older churches have been more or less completely restored, *e.g.*, the church of the Apostles (1875–88 and 1895–97), St Peter (1890–92), St Ursula (1890–91), St Gereon, and St Cecilia. A handsome Roman




Catholic church was completed in Deutz in 1896; and in 1896–99 a large synagogue, west of the Ring. The church of St Andreas (1220 and 1414) contains the remains of Albertus Magnus in a gilded shrine. Turning to the secular buildings—the ground floor of the Gürzenich was in 1875 converted into a stock exchange, and in 1890–91 provided with a fine staircase. In the street Burgmauer stands the supreme court for the Rhine province, and off the street are the post office (1893), a fine early Gothic building, and the Imperial Bank (1897), also in the early Gothic style. Farther west is the municipal library and archives (1894–97), also Gothic.

A handsome central railway station (high level) was built in 1889–94. The railway now follows the line of the *ceinture* of the new inner fortifications, and there are three city stations in addition to the central. Like all important German towns, Cologne has of recent years been beautified by fine monuments. The most conspicuous is the colossal equestrian statue (22½ feet high) of Frederick William III. in the Heumarkt. There are also monuments to Moltke (1881), to Johann von Werth (1885), the cavalry leader of the Thirty Years' War, and to Bismarck (1879). Near the cathedral is an archiepiscopal museum of church antiquities. Cologne has, further, a large civic hospital, a conservatory of music, a commercial school (1900), a commercial high school (1901), a girls' commercial high school (1900), theological and teachers' seminaries, a girls' college (1900), and lunatic asylums. Commercially, Cologne is one of the chief centres on the Rhine, and has a very important trade in corn, wine, mineral ores, coals, drugs, dyes, manufactured wares, groceries, leather and hides, timber, porcelain, and many other commodities. A large new harbour, with spacious quays, has been constructed towards the south of the city. In 1898 a total of 3461 vessels of 1,323,800 tons entered and cleared the port. Industrially, too, Cologne is a place of very considerable importance. The manufacture of machinery, bricks, cottons and woollens, and india-rubber goods, and printing are carried on on a large scale, and there are factories for sugar, chocolate, and many others. The famous *Eau de Cologne* is produced in large quantities. Population (1885), 239,437; (1900), 370,685.

**Colomb, Philip Howard** (1831–1899), British vice-admiral, historian, critic, and inventor, the son of General T. Colomb, was born in Scotland, on the 29th of May 1831. He entered the Navy in 1846, and served first at sea off Portugal in 1847; afterwards he served, in 1848, in the Mediterranean, and from 1848–51 as midshipman of the *Reynard* in operations against piracy in Chinese waters; as midshipman and mate of the *Serpent* during the Burmese War of 1852–53; as mate of the *Phœnix* in the Arctic Expedition of 1854; as lieutenant of the *Hastings* in the Baltic during the Russian War, taking part in the attack on Sveaborg. He became what was known at that time as a "Gunner's Lieutenant" in 1857, and from 1859 to 1863 he served as flag-lieutenant to Rear-Admiral Sir Thomas Pasley at Devonport. Between 1858 and 1868 he was employed in home waters on a variety of special services, chiefly connected with gunnery, signalling, and the tactical characteristics and capacities of steam warships. From 1868 to 1870 he commanded the *Dryad*, and was engaged in the suppression of the slave trade. In 1874, while captain of the *Audacious*, he served for three years as flag-captain to Vice-Admiral Ryder in China; and finally he was appointed, in 1880, to command the *Thunderer* in the Mediterranean. Next year he was appointed captain of the Steam Reserve at Portsmouth; and after serving three years in that capacity, he remained at Portsmouth as flag-captain to the Commander-in-Chief until 1886, when he was retired by superannuation before he had attained flag rank. Subsequently he became Rear-Admiral, and finally Vice-Admiral on the retired list.

Few men of his day had seen more active and more varied service than Colomb. But the real work for the Navy on which his title to fame and remembrance rests was done in another sphere. He was, in his day, essentially the thinker of the service. Many of his contemporaries were his equals, not a few were his superiors, in the practical gifts and aptitude of the naval officer. But perhaps no officer of his time has left a more indelible mark on the thought and practice of the Navy. His mind was at once inquiring, aspiring, logical, reflective, and inventive. He was one of the first to perceive the vast and momentous changes which must ensue from the introduction of steam into the Navy. He foresaw that it must eventually carry all before it, that it would immensely increase the tactical mobility of ships, and would for that reason entail a complete revolution in the methods he found in use for the direction, conduct, and control of their movements—in other words, that it required a new system of signals and a new method of tactics. These he set himself to devise as far back as 1858. For the purposes of signalling Colomb adapted to naval use the methods employed by the electric telegraph. It is well known that for purposes of electric transmission the letters are represented by symbols composed of two elements variously combined, according to the Morse system. The idea of varying form is thus replaced by that of varying duration; and by suitable combinations of two intervals of different duration, one longer and one shorter, the whole alphabet and all numbers can be represented. If an electric current is continuous, its interruption for a longer or a shorter period can be made to represent the two intervals required, and the symbols thus transmitted to a distance can by suitable mechanism be recorded on paper in the form now universally known as "dots and dashes." Similarly, a beam of light can be made to transmit the same symbols to the eye by alternate periods, varying in duration, of occultation and display. Colomb invented a lantern for this purpose in 1861, but it was not adopted by the Navy until 1867. In some form or other it is now in use in every important navy in the world. In daytime a hand flagstaff, with flag attached, is made to transmit the required symbols by giving it a greater or less inclination from the perpendicular. In a fog, long and short blasts sounded on a fog-horn, steam-whistle, or steam-siren are employed for the same purpose. Before these methods were adapted by Colomb to naval use, the only signals employed were, in daytime, flags of different colours and shapes, and by night, lanterns variously disposed. In fog there was nothing, and at night the range of signalling was very restricted and its method very inefficient. Nowadays, thanks mainly to Colomb, and to others who have developed his methods on the same lines, it is almost as easy to manœuvre a fleet at night, or even in a thick fog, as it is in broad and clear daylight.

What he had done for signals Colomb next did for tactics. Having first determined by experiment—for which he was given special facilities by the Admiralty—what are the manœuvring powers of ships propelled by steam under varying conditions of speed and helm, he proceeded to devise a system of tactics based on these data. In the sequel he prepared a new evolutionary signal-book, which was adopted by the Royal Navy, and still remains in substance the foundation of the existing system of tactical evolutions at sea. The same series of experimental studies led him to conclusions concerning the chief causes of collisions at sea; and these conclusions, though stoutly combated in many quarters at the outset, have since been generally accepted, and were ultimately embodied in the International Code of Regulations now adopted by the leading maritime nations on the recommendation of a Conference held at Washington in 1889.

After his retirement Colomb devoted himself rather to the history of naval warfare, and to the large principles disclosed by its intelligent study, than to experimental inquiries having an immediate practical aim. As in his active career he had wrought organic changes in the ordering, direction, and control of fleets, so by his historic studies, pursued after his retirement, he helped greatly to effect, if he did not exclusively initiate, an equally moment-

ous change in the popular, and even the professional, way of regarding sea-power and its conditions. He did not invent the term "sea-power,"—it is, as is shown elsewhere (SEA-POWER), of very ancient origin,—nor did he employ it until Captain Mahan had made it a household word with all. But he thoroughly grasped its conditions, and in his great work on Naval Warfare (first published in 1891) he enunciated its principles with great cogency and with keen historic insight. The central idea of his teaching was that naval supremacy is the condition precedent of all vigorous military offensive across the seas, and, conversely, that no vigorous military offensive can be undertaken across the seas until the naval force of the enemy has been accounted for—either destroyed or defeated and compelled to withdraw to the shelter of its own ports, or at least driven from the seas by the menace of a force it dare not encounter in the open. This broad and indefeasible principle he enunciated and defended in essay after essay, in lecture after lecture, until what at first was rejected as a paradox came in the end to be accepted as a commonplace. He worked quite independently of Captain Mahan, and his chief conclusions were published before Captain Mahan's works appeared. In the last edition of *Naval Warfare* he showed how, in the Cuban War, Captain Mahan had been driven by force of circumstances to adopt in practice the sound doctrine of the Command of the Sea, which in some of his works he had seemed in some measure to impugn. There was no jealousy and no rivalry between these two great writers on the philosophy of naval warfare. They worked on independent lines—Colomb perhaps with deeper and more consistent thought, but Mahan assuredly with a broader historical outlook, and with finer powers of lucid and orderly exposition.

Colomb died quite suddenly and in the full swing of his literary activity on October 13, 1899, at Steeple Court, Botley, Hants. His latest published work was a biography of his friend Sir Astley Cooper Key, and his last article was a critical examination of the tactics adopted at Trafalgar, which showed his acumen and insight at their best. He left much valuable literary material in an unfinished state at his death. He was often thought too speculative, and even too visionary, by his contemporaries of a profession which is eminently practical, and little given to speculation even on the theory of its own occupation. He was indeed essentially a pioneer, and his larger range of thought often supplied the Navy with well-considered methods, of which practical men discerned neither the rationale nor the origin. But no naval officer of his time left a deeper or more lasting impression on the thought and action of the great service he adorned.

(J. K. L.)

**Colombes,** a town in the arrondissement of St Denis, department of Seine, France, 7 miles north-north-west of Paris, near the left bank of the Seine, and on the railway from Paris to Havre. It has a 16th-century church with 12th-century tower, numerous villa residences and boarding schools, and manufactures of gelatine and starch. A castle formerly stood here, in which died Henrietta Maria, queen of Charles I. of England and daughter of Henry IV. of France. Port traffic (1899), 55,350 tons. Population (1901), 23,061. The adjacent town of BOIS COLOMBES had a population (1896) of 10,404.

**Colombia,** a country of South America extending from 12° 20′ N. lat. to the still undefined boundaries of Ecuador, Peru, and Brazil. The boundary towards Venezuela, according to the arbitration of the Spanish Government in 1891, runs from the Bay of Calaboso westwards to the mountains of Oca, then southwards along the watershed between the Magdalena river and Lake Maracaibo as far as the Rio de Oro, whence it crosses the cordillera and follows successively the rivers Oira, Arauca, Meta, Orinoco, and Atabapo. Then it passes to the Piedra del Cocuy and follows the course of the Guainia to the frontier of Brazil. The boundary dispute with Peru and Ecuador was, by treaty of 1894, submitted to the arbitration of Spain. The question of the frontier towards Costa Rica was in 1899 submitted to the president of the French Republic, who gave his award on 15th September 1900. The boundary between the two republics is formed by the spur of the cordilleras starting from Cape Mona on the Atlantic and enclosing on the north the valley of the Rio Tarire, and by the watershed between the Atlantic and Pacific up to the parallel of 9° N. lat. It then follows the watershed between the Chiriqui Viejo and the affluents of the Dolce Gulf, ending at Burica Point on the Pacific. The islands east and south of Cape Mona are Colombian, to the west and north-west Costa Rican; but seven islands at a greater distance, lying between the Mosquito coast and the isthmus of Panama, are Colombian. On the Pacific coast Colombia possesses Burica and the islands to the east; Costa Rica, those to the west.

*Area and Population.*—According to a census taken in 1871 the total population was 2,951,323, consisting of 1,434,129 males and 1,517,194 females. An official estimate published in 1881, and considered to be approximately correct for the present date, gave the following details as regards area and population:—

| Departments. | Area in Square Miles. | Population in 1881. | Population per Square Mile. |
|---|---|---|---|
| Antioquia (1884) | 22,316 | 470,000 | 21 |
| Bolivar | 21,345 | 280,000 | 13 |
| Boyacá | 33,351 | 702,000 | 21 |
| Cauca | 257,462 | 621,000 | 2·4 |
| Cundinamarca (1884) | 79,810 | 569,000 | 7 |
| Magdalena | 24,440 | 90,000 | 3·7 |
| Panama | 31,571 | 285,000 | 9 |
| Santander | 16,409 | 555,000 | 35 |
| Tolima (1884) | 18,069 | 306,000 | 17 |
| Total | 504,773 | 3,878,000 | 7·7 |

This estimate includes some 220,000 uncivilized Indians, and the population of the different territories attached to departments. A later statement, published in 1893, estimates the total population at 4,060,000, but without precise data showing where the increase occurred. The principal towns are Bogota (the capital), with 110,000 inhabitants; Medellin, with 50,000; Panama, 30,000; Cartagena, 20,000; Bucaramanga, 20,000.

No statistics of the movement of population are compiled. An official calculation in 1893 estimated the death-rate at 21 per 1000, 20 per cent. of the deaths being those of children under one year, and 30 per cent. of the total deaths those of children under five years of age. Of the total population 68·8 per cent. are engaged in agriculture; 10·6 per cent. are labourers; 8·6, mechanics; 8·4, commercial; 2·0, miners.

Spanish is spoken throughout Colombia, except among some of the tribes of Indians in the districts adjoining the Meta, Orinoco, and the affluents of these two rivers. The highlands are generally healthy, the lowlands and plains infected to some extent with malarial fever. The annual mean temperature at Bogota, 8300 feet above sea-level, is said to be 63° Fahr.

*Constitution and Government.*—The constitution of 1863 was superseded in 1886 by that now in force, which adopted a centralized organization and named the state the Republic of Colombia. The legislative power is entrusted to the Senate and the House of Representatives, together constituting the Congress, which meets at the capital every two years, on the 20th of July. The Senate consists of twenty-seven members, three from each department, who are elected for six years by the departmental assemblies (local legislatures). The House of Representatives consists of sixty-eight members—one member for every 50,000 inhabitants; they are elected for four years directly by citizens able to read and write, or who have an income of \$500 a year, or real estate worth \$1500. The executive authority is vested in the President of the Republic, who is assisted by ministers chosen by him, and a Council of State consisting of seven members. He is elected by electoral colleges for six years, and when for any reason he ceases to act, the vice-president takes his place.

*Local Government.*—Each of the nine departments is divided into provinces, and these into municipal districts, of which there are 991. The departments are under governors appointed by the President, and each has an elective assembly, meeting every two years. The municipal districts are under alcaldes, and each has an elective municipal council. The governors and alcaldes are agents both of the central and local authorities.

*Justice.*—Justice is administered by a supreme court composed of seven members, the president of the court being elected by the members for a term of four years. In each of the judicial districts there are superior tribunals, lower courts, and magistrates. The law, both civil and criminal, is written and codified. The foundation of the Colombian legal system is Spanish law, modified in certain directions to suit local conditions. Many complaints are made of the administration of justice throughout the republic, and there can be no question that legal procedure is extremely dilatory.

*Religion.*—The religion is the Roman Catholic. The ecclesiastical establishment consists of an archbishop, ten bishops, eight vicars-general, and 2170 priests of all classes, besides monks, who do not belong to the regular priesthood. The number of monks in 1894 in thirteen monasteries was 469, and the number of nuns in ten communities was 731. In 1894 the number of churches was 714, and chapels 312, in the whole republic.

*Education.*—Education, especially in the primary branches, has been much neglected, although attention has from time to time been directed to the subject. Primary education is under the control of the municipal authorities, grants in aid of the schools being given by the central Government. It is free, but not compulsory. The number of primary schools in 1898 was stated to be 2036, and the number of pupils on the rolls about 110,320. For secondary education there are thirty-four public colleges; fifteen normal schools, with 600 pupils; four technical colleges, with 800 students; two academies of music, with 300 pupils; one school of fine arts, with 160 pupils; a Salesian institute, with 200 pupils; and a national night institute for artizans, with 150 pupils. There is a national university, and four departmental universities. The national Government devotes a sum of nearly 800,000 pesos annually to educational purposes. There is a national library containing 40,000 volumes, and a museum of antiquities and natural curiosities, both situated in the capital of the republic. Seminaries for priests are maintained by their own revenues and are free from civil control.

*Defence.*—The peace footing of the army was fixed at 2158 men in the budget for the biennial period 1899–1900. The military strength, however, consists principally of a national militia comprising about 130,000 men, with 3203 officers, who can be called to serve if required. The small arm in use is the Mannlicher rifle. The police force consists of 1000 men.

*Finance.*—The actual revenue recorded in 1895 was 16,273,259 pesos; in 1896, 20,444,489 pesos; in 1897, 19,519,431 pesos; in 1898, 17,941,569 pesos. For the biennium 1897–98 the revenue was 57,461,000, and the expenditure 41,429,180 pesos, leaving a deficit of 3,968,180 pesos. The principal sources of revenue are the duties on imports and exports, these yielding 10,750,889 pesos in 1895, 13,697,823 pesos in 1896, and 13,256,353 pesos in 1897. The falling off in 1897 was stated to be in consequence of the reduction of the duties on salt, and the suppression of the export duty on coffee. Other sources of income in 1897 were—the *saladero* tax, 1,767,607 pesos; the sale of stamped paper, 733,762 pesos; and the post office and telegraphs. The war department absorbs more than one-half of the annual expenditure; but details of actual expenditure are not accessible. The budgets of revenue and expenditure are voted for periods of two years. For 1899–1900 the revenue was estimated at 34,305,000 pesos, and the expenditure at 34,000,000 pesos.

The service of the foreign debt was suspended in 1880. The amount of this obligation was then £1,913,500, bearing interest at the rate of 4½ per cent. per annum. In 1896, when the debt and arrears amounted to £3,514,442, an agreement was made to issue bonds for £2,700,000 in exchange for old bonds, arrangements being made for a reduction in the rates of interest and amortization. Of the authorized issue the sum of £2,500,000 had been emitted in 1899, but the payment of interest by Colombia ceased in 1899. The internal indebtedness consists of a consolidated debt of 6,000,000 pesos; a floating debt of 5,000,000 pesos; and the paper money in circulation, increased by recent issues to 40,000,000 pesos. The total internal obligations are, therefore, 51,000,000 pesos in round numbers.

*Production.*—Economic development has been retarded by the difficulties of transport, and by the frequent recurrence of revolutionary disturbances. The production of wheat and other bread stuffs is insufficient for local demand. The principal industry is coffee planting. The export of coffee in 1895 amounted to 21,504 tons; 1896, 28,521 tons; in 1897, 17,564 tons; in 1898, 38,480 tons. Colombian coffee shipped at the Venezuelan port of Maracaibo does not figure in the return of Colombian exports. Tobacco is exported in large quantities, amounting for 1898 to 6120 tons; cocoa and sugar are also grown—the former in sufficient quantities for export. Ivory nuts and dye-woods are collected for shipment abroad, and various [illegible]. Of india-rubber, 404 tons were exported in 1898. The rubber trees are principally found in the low-lying forest regions bordering the Orinoco river, and southwards towards the affluents of the river Amazon.

Pastoral industry extends over the whole country, but is practised on a large scale only on the great plains of the interior adjoining the rivers flowing into the Orinoco, where the number of cattle is estimated to be not far short of 3,500,000. Dried beef, *tasajo*, is prepared, and animals are driven to populous centres for sale; but the outlet is much restricted. In 1899 the scarcity of cattle in Cuba caused a demand, and a large number of live animals were exported from the port of Cartagena. Sheep, goats, and swine are raised for the home market.

The mining industry has hitherto been chiefly directed towards the search for gold and emeralds, and, to a lesser extent, silver. The production of gold and silver in three years is given as follows, in troy ounces:—

| | 1896. | 1897. | 1898. |
|---|---|---|---|
| | oz. | oz. | oz. |
| Gold . | 106,416 | 107,734 | 109,470 |
| Silver . | 3,407,610 | 5,048,257 | 5,484,725 |

In July 1899 a sudden fever for speculation in emeralds set in and lasted for some weeks. During this period stones to the value of 4,000,000 pesos were stated to have changed hands, often at prices above the values in Europe. Iron ore of good quality is abundant. The salt mines are worked as a Government monopoly, and the supply is large.

Manufacturing industry is only in its infancy. The Pradera ironworks to the north-east of Bogota have a capacity for a daily output of 30 tons of pig-iron, and this establishment also produces wrought iron, rails, sugar-mills, and castings. Manganese is found in the vicinity of these works. Breweries and distilleries have been established in the principal cities. Soap and candle factories, boot- and shoe-making, tanneries, and other small local industries are found scattered over the republic to supply the local needs of the population.

*Commerce.*—The imports consist mainly of tissues, groceries, wines and spirits, hardware, and other articles of common use or consumption, while the principal exports are coffee, gold and silver, tobacco, live-stock, hides and skins, bananas, and some medicinal products. The values of the imports and exports, expressed in sterling (gold peso = 4 sh.), for six years were as follow:—

| Years. | Imports. | Exports. | Years. | Imports. | Exports. |
|---|---|---|---|---|---|
| | £ | £ | | £ | £ |
| 1893 | 2,680,660 | 2,926,060 | 1896 | 3,389,420 | 3,719,470 |
| 1894 | 2,142,240 | 3,192,400 | 1897 | 3,627,400 | 3,364,080 |
| 1895 | 2,305,670 | 3,017,680 | 1898 | 2,216,610 | 3,831,540 |

In 1898 the imports at Panama and Colon amounted to the value of £722,468; and the exports to £212,220. The exports in 1898 from the ports of Panama, Colon, Barranquilla, Cartagena, and Santa Marta comprised coffee to the value of £1,384,184; gold dust, £595,343; silver and silver ore, £182,018; tobacco, £309,609; hides and skins, £175,684; live-stock, £192,507; bananas, £116,720; rubber, £84,822. Of the exports in 1898, the value of £1,061,175 went to the United States, £963,270 to Great Britain, £674,350 to France, £613,980 to Germany, and £200,130 to Venezuela. According to British statistics, the imports into the United Kingdom from Colombia in 1899 amounted to £574,021; and the exports of home produce from the United Kingdom to Colombia, to £668,986 of which £356,693 was for cottons. According to American statistics, the imports into the United States from Colombia in 1899 amounted to £1,067,900, of which £506,320 was for coffee; and the exports of home produce from the United States to Colombia, to £622,830.

The principal commercial centre for the direct trade of Colombia is Barranquilla, slightly more than one-half of the total passing by way of that place through the port of Sabanilla; about one-quarter of the balance goes to Cartagena, and the remainder is chiefly divided between Buenaventura, Riohacha, and Santa Marta. The transit trade by way of Panama to and from Europe and the east and west coasts of North America averages annually about 130,000 tons for the outward freights, and about 120,000 tons for those to Europe and the Atlantic ports. The import and export trade is largely in the hands of British, German, Spanish, Italian, and French merchants.

*Shipping and Communications.*—Thirty-three regular steamers visit Colombian ports monthly; of these, 15 are British, 9 American, 4 German, 3 French, 1 Spanish, and 1 Italian. The number of ships entering Colombian ports in 1897 was 1897, with a total

tonnage of 858,457 tons; the number cleared in the same year was 1850, with a tonnage of 800,710 tons. In 1898, 266 vessels of, altogether, 441,673 tons entered, and 263 of 442,777 tons cleared at Barranquilla and Sabanilla—more than half the tonnage being British. The shipping belonging to Colombian ports had, in 1898, a total tonnage of 2227 tons.

Means of transport for both passengers and freight are confined to a large extent to conveyance by mule or donkey. The so-called roads are little more than bridle tracks. The total length of the railways open to public service in 1899 was only 419 miles; but about 80 additional miles are in course of construction. These railways are in isolated sections, running as a rule from the seaboard to inland towns at different points of the coast. The Panama–Colon line has a length of 48 miles; the Cartagena–Calamar line, 65 miles. The Magdalena river forms an important artery of trade. It is navigable for 780 miles; steamers ascend to La Dorada, 590 miles from Barranquilla; tributaries supply 215 miles more of navigable river, and on these waters 42 steamers, with a total tonnage of 7330 tons, ply regularly. At present the journey from the coast to Bogota requires at least twelve days of continuous travel by rail, steamer, and mule. There are some 8600 miles of telegraph lines, with 448 stations open to the public; and a telephone system has been established in the principal towns. The republic is connected with the outside world by the cable of the Central and South American Cable Company.

The postal service is well organized; in the two years 1896–97 the letters and post-cards conveyed numbered 2,794,069; printed papers, 1,233,313; other packets, 161,217,—total pieces, 4,188,599.

*Panama Canal.*—The construction of a ship canal, 46 miles in length, across the Isthmus of Panama was in 1881 undertaken by a company which went into liquidation in 1889. A new company, formed in 1894, carried on the work, and their concession was extended to the year 1910, by which time it was estimated the canal and locks might be completed, at a cost of £20,480,000. The total sum raised for the purpose of constructing the canal was 772,545,412 francs by the old company, and 65,000,000 francs by the new company. But when the American Government took up the question of constructing an Isthmian Canal, the position of the Panama Company was necessarily involved. See the articles CANALS and LESSEPS.

*Credit and Currency.*—The law, passed in 1894, for the redemption of the inconvertible paper currency has not been carried into effect. The amount in circulation is stated to be 51,000,000 pesos, the value constantly fluctuating, to the injury of trade. In Panama the silver dollar of 25 grammes, ·835 fine, is the coinage in common use, but Peruvian silver is also current. The principal banking institutions are the Banco Nacional, the Banco de Colombia, and the Banco de Bogota, besides a number of private banks. The Banco Nacional is exclusively a State bank, and through it the paper money is put in circulation. The metric system of weights and measures is the legal system, but is not customarily in use, except at the Custom House and other Government offices. For ordinary purposes the Spanish pound, of 1·102 lb avoirdupois; the *arroba*, of 25 lb; and the *carga*, of 250 lb, are invariably employed. Corn is measured by the *fanega*. In lineal measurement the *vara* (80 centimetres) is used. The litre is the standard for liquid measure.

*Recent History.*—The term of office for which President Aquiles Parra had been elected in 1876 came to a conclusion in 1878, and in April of that year General Trujillo was inaugurated as President of the republic for the two succeeding years. His administration was marked by a strong effort to place the financial position of the Government on a more satisfactory footing, and the internal indebtedness was substantially reduced during his rule. In April 1880 Señor Rafael Nuñez acceded to the Presidency. During his term of office revolutionary disturbances occurred in the provinces of Cauca and Antioquia, but were suppressed with no great difficulty. Provision was made in 1880 for a settlement of the boundary dispute with Costa Rica, and in July of that year the federal Congress authorized the formation of a naval squadron. A movement was now set afoot in favour of a confederation of the three republics of Colombia, Ecuador, and Venezuela on the basis of the original conditions existing after the expulsion of Spanish authority, and a resolution was passed by the Chamber of Deputies to that effect. The opposition shown by Venezuela and Ecuador to this project prevented any definite result from being achieved. In April 1882 Señor Laldua became President, but, his death occurring a year later, General Otalora was nominated to exercise the executive power for the unexpired portion of the term. In 1883 the dispute in connexion with the boundary between Colombia and Venezuela was submitted by the two Governments to the arbitration of Alphonso XII., king of Spain, and a commission of five members was appointed to investigate the merits of the respective claims. The decision in this dispute was finally given by the Queen Regent of Spain on 16th March 1891. In April 1884 Señor Rafael Nuñez was again proclaimed President of the republic in his absence abroad. Pending his return the administration was left in the hands of General Campo Serrano and General Eliseo Payan. The Liberal party had been instrumental in the re-election of Nuñez, and looked for a policy in conformity with their views and political convictions. President Nuñez had no sooner returned to Colombia than the Liberals discovered that his political opinions had changed and had become strongly Conservative. Discontent at this condition of affairs soon spread. Nuñez from motives of ill-health did not openly assume the Presidential office, but from his house near Cartagena he practically directed the government of the republic. The Liberals now began to foment a series of revolutionary movements, and these led in 1885 to a civil war extending over the departments of Boyaca, Cundinamarca, Magdalena, and Panama. General Reyes and General Velez were the two principal leaders of the revolt. In order to protect the passage of the traffic across the Isthmus of Panama during these disturbed times detachments of United States marines were landed at Panama and Colon, in accordance with the terms of the concession under which the railway had been constructed. After a number of defeats the leaders of the revolt surrendered in August 1885, and on 5th September following peace was officially proclaimed. Nuñez, who had meanwhile assumed the Presidential duties, now brought about a movement in favour of a fresh Act of Constitution for Colombia, and a new law to that effect was finally approved and promulgated on 4th August 1886. Under the terms of this act the federal system of government for Colombia was abolished, the states becoming departments, the governors of these political divisions being appointed by the President of the republic. Each department has a local legislative assembly elected by the people. The National Congress is constituted of the Senate and the House of Representatives. The Senate is composed of twenty-seven members elected for six years, one-third retiring every two years, three of whom are nominated by each of the nine departments. The House of Representatives comprises members elected for four years by universal suffrage, each department forming a constituency and returning one member for every 50,000 inhabitants. The Congress convenes every two years. The Presidential term of office under the new Act was fixed at six years in place of the two years formerly prevailing. The judiciary was irremovable, and trial by jury was allowed for criminal offences. Capital punishment was re-established, and the press was made responsible for matter published. The unlicensed trade in arms and ammunition thitherto existing was prohibited. Previous to 1886 the crime of murder was only punishable by 10 years' imprisonment, a sentence which in practice was reduced to two-thirds of that term; slander and libel were formerly offences which the law had no power to restrain, and no responsibility attached to seditious publications.

After the promulgation of this new Act of Constitution President Nuñez was proclaimed as President of the republic for the term ending in 1892. He was unable, however, in consequence of ill-health, to reside at Bogota and discharge the presidential duties, and, consequently, in August 1888 Señor Cárlos Holguin was designated to act for him.

In 1892 President Nuñez was again elected to the Presidency for a term of six years, his continued ill-health, however, forcing him to place the active performance of his duties in the hands of the Vice-President, Señor Miguel Caro. In 1895 the Liberals made another attempt to seize the Government of the country, but the movement was suppressed without any very great difficulty. In this same year Nuñez died, and Vice-President Caro became the actual President, an office he had practically filled during the three previous years. In 1898 Señor M. A. Sanclemente, a strong Conservative, and supported by the Church party, was elected to the Presidency for the period ending in 1904. In October 1899 the Liberals organized another revolutionary outbreak for the purpose of trying to wrest the power from Conservatives, but this attempt had no better success than the movements of 1885 and 1895. In January 1900, however, Vice-President Marroquin seized upon the Government, imprisoned President Sanclemente (who died in prison in March 1902), and another period of disturbance began. The rebels were defeated in May in a desperate battle at Cartagena; and continuous fighting went on about Panama, where British marines had to be landed to protect foreign interests. As the year 1900 advanced, the conflict went on with varying success, but the Government troops were generally victorious, and in August Vice-President Marroquin was recognized as the acting head of the executive, with a Cabinet under General Calderon. In 1901 the rebellion continued, and severe fighting took place about Colon. Further complications arose in August, when trouble occurred between Colombia and Venezuela. On the one hand, there were grounds for believing that the Clericals and Conservatives in both countries were acting together; and, on the other, it was expected that President Castro of Venezuela would not be sorry to unite his own countrymen, and to divert their attention from internal affairs, by a war against Colombia. The Colombian revolutionary leaders had made use of the Venezuelan frontier as a base of operations, and the result was an invasion of Venezuelan territory by Colombian Government troops, an incident which at once caused a diplomatic quarrel. The United States Government in September offered its good offices, but President Castro refused them, and the state of affairs became gradually more menacing. Meanwhile both Panama and Colon were seriously threatened by the rebel forces, who in November succeeded in capturing Colon by surprise. The situation was complicated by the fact that the railway traffic on the Isthmus was in danger of interruption, and on the capture of Colon it became necessary for the American, British, and French naval authorities to land men for the protection of the railway and of foreign interests.

The chief foreign treaties entered into by Colombia in the last quarter of the 19th century were:—(1) A treaty with Great Britain, signed on 27th October 1888, for the extradition of criminals; (2) a treaty of friendship, commerce, and navigation with Italy, signed 27th October 1892; (3) two protocols with Italy, signed respectively 24th May and 25th August 1886, in connexion with the affair of the Italian subject Cerruti; (4) a consular convention with Holland, signed 20th July 1881; (5) a treaty of peace and friendship with Spain, signed 30th January 1881; (6) a convention with Spain for the reciprocal protection of intellectual property; (7) a concordat with the Vatican, signed 31st December 1887; (8) an agreement with the Vatican, signed 20th August 1892, in connexion with ecclesiastical jurisdiction; (9) an agreement with the republic of San Salvador, signed 24th December 1880, in regard to the despatch of a delegate to an international congress; (10) a treaty of peace, friendship, and commerce with Germany, signed 23rd July 1892; (11) a treaty with the republic of Costa Rica, signed in 1880, for the delimitation of the boundary; (12) the postal convention, signed at Washington, 4th July 1891; (13) a convention with Great Britain, signed 31st July 1896, in connexion with the claim of Messrs Punchard, M'Taggart, Lowther, & Co.; (14) a treaty of friendship, commerce, and navigation with Peru, signed 6th August 1898; (15) an extradition treaty with Peru, signed 6th August 1898; (16) a treaty of peace, [illegible] d defensive alliance with Venezuela, signed 21st N[illegible], and on the same date a treaty regulating the frontier commerce.

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**Colombo,** the capital and principal seaport of Ceylon, in the west coast. It has greatly changed since 1875. The formation of a commodious harbour (though the works are still in progress), and of 300 miles of railway, has made the port a very important one, mail steamers calling regularly, as well as men-of-war and mercantile marine of all nations, while the island's export traffic is concentrated in it. The demolition of the landward side of the old Dutch fort enabled new roads and buildings to be constructed; much land was reclaimed; and the banks, many commercial and steamer offices now occupy fine buildings. A new suburb has been built over with handsome bungalows beyond the Public Museum (a very fine structure) and Victoria Park. The water supply is drawn from a hill region 30 miles off. A scientific scheme of drainage is contemplated. Most of the town is lighted by gas, and certain quarters with electric light, and electric tramways have been laid over 7 miles of city roads. The packing, blending, and shipping of tea (rather than of coffee) is now the great industry, along with the preparation and packing of cocoanut oil, cocoa (chocolate) plumbago, spices, &c. 607 steamers called to coal in 1900. Population (1891), 128,870; (1901), 154,279. There is a floating population in the harbour of from 5000 to 15,000.

**Colon,** formerly known as Aspinwall, a city and port on the northern coast of Panama, in the republic of Colombia, South America, on the north-east side of the Bay of Limon, 41 miles north-west of Panama by rail. Having been burned down during the revolution of 1885, it was rebuilt on improved plans, but owing mainly to carelessness in the administration and the untidy habits of the inhabitants, chiefly West Indians from Jamaica, it is still rather unhealthy. The streets, though wide and originally well paved, are badly kept, but are lighted by electricity. The harbour is only an open bay, and therefore dangerous at certain seasons. There are four piers, affording accommodation for eight ocean steamers at one time, in addition to a number of sailing craft. The northern portion of the city, owned by the Panama Railway Company, is supplied with water from the Chagres river, but the remainder depends mainly on rain water. There are a number of important commercial houses, an aërated water factory, and a distillery. The average tonnage of vessels entering is over 500,000 annually. Colon possesses a bronze statue

of Columbus, presented by the Empress Eugénie in 1870. The population is about 10,000.

**Colon,** an important railway town of Matanzas province, Cuba, and the centre of a rich sugar-planting country. Population (1899), 7175.

**Colonne, Édouard** (properly JUDAS) (1838–——), French conductor, was born at Bordeaux on 23rd July 1838. He entered the Paris Conservatoire in 1856, and obtained there the first prizes in harmony and violin-playing in 1858 and 1863. He became a member of the orchestra at the Grand Opera in 1858, and at the foundation of Pasdeloup's Concerts Populaires was one of the first violins. The success of these concerts induced Colonne to start some on his own account. With the aid of Messrs Duquesnel and Hartmann, he founded Le Concert National. The first concert took place at the Odéon Theatre on 2nd March 1873. The following year the Concert National changed its title to that of Association Artistique, and migrated to the Théâtre du Châtelet. M. Colonne has done a great deal to popularize the works of Hector Berlioz, besides bringing forward compositions of the younger French school of music. He was "chef d'orchestre" at the Paris Grand Opera from 1891 to 1893, and conducted the first performance there of Wagner's *Die Walküre.* M. Colonne has travelled with his orchestra, and he visited London in the autumn of 1896, when he gave four concerts at the Queen's Hall.

**Colorado,** a western State of the American Union, situated between 41° and 37° N. lat. and 102° and 109° W. long., bounded on the N. by Wyoming and Nebraska, on the E. by Nebraska and Kansas, on the S. by Oklahoma and New Mexico, and on the W. by Utah. Its largest and most important development has occurred since 1875. During this period the growth of its mining, railway, manufacturing, and agricultural interests has been much greater than during all its previous history, while its educational institutions have nearly all of them been established since it was admitted to the Union, and its population has increased several-fold. Many of its towns have sprung into existence during this time, and its larger towns have changed from straggling and poorly constructed villages into important residential and manufacturing cities. Its area is 103,925 square miles, or over 66,000,000 acres. The western half of the State was part of the Mexican Cession of 1848. The south-east corner was part of the Texas Cession of 1850, and the north-western part of the Louisiana Purchase of 1803. It was organized as a Territory in 1861, and admitted as a State on 1st August 1876. At the first State election 30,000 votes were polled, the entire Republican ticket being elected, with John L. Routt (Republican) as Governor. The second Governor was F. W. Pitkin, who held office for four years, and was elected on the Republican ticket. He was followed by James B. Grant, a Democrat, who was succeeded by B. H. Eaton, a Republican. Alva Adams, a Democrat, was elected in 1887, and J. R. Cooper, a Republican, in 1890, being followed by John L. Routt. David H. Waite, a Populist, was chosen in 1893, Albert W. M'Intire, a Republican, in 1895; Alva Adams was again chosen in 1897, on a fusion ticket of Democrats and Populists, and on the same ticket Chas. S. Thomas was elected in 1899, and James B. Orman in 1901. The question of the free coinage of silver played an important part in the last three elections. Woman's suffrage prevails, having been adopted in the election of 1893 by a majority of about 5000 votes.

*Population.*—In 1876 the population was estimated at 135,000; the census of 1880 showed an increase to 194,327, that of 1890 to 412,198, and that of 1900 to 539,700. The average number of persons to the square mile was 5·2 in 1900, as compared with 3·9 in 1890. The population in 1900 was made up as follows:—295,332 (54·7 per cent.) males and 244,368 (45·3 per cent.) females, 448,545 native-born and 91,155 foreign-born, 529,046 white and 10,654 coloured (including 8570 negroes, 599 Chinese, 48 Japanese, and 1437 Indians). Out of 185,708 males 21 years of age and over, 7689 were illiterate (unable to write), including 3804 foreign-born, 448 negroes, 138 Chinese, 10 Japanese, and 246 Indians. The death-rate of the entire state in 1900, on the basis of the deaths reported to the U.S. census enumerators, was about 13·7. In 1900 there were 165 incorporated cities, towns, and villages in Colorado, of which 27 had a population of more than 2000, and of these 7 had a population of over 5000, namely, Denver, with 133,859; Pueblo, with 28,157; Colorado Springs, with 21,085; Leadville, with 12,455; Cripple Creek, with 10,147; Boulder, with 6150; and Trinidad, with 5345 inhabitants. The growth of Denver has been as follows: (1870), 4759; (1880), 35,629; (1890), 106,713; (1900), 133,859.

*Mineral Resources.*—The pioneers in the settlement of the State were attracted by its mineral resources. Gold and silver are found in 57 counties; iron, copper, lead, and zinc in 37; and aluminium in 5. The first discovery of gold was made on January 7, 1859; since then the coin value of the gold and silver produced, including the output of 1899, has been $665,039,636. The coin value of the gold product for 1899 was $26,265,487, and that of silver $29,679,706, making a total of $55,945,193. The total product for 1898 was $53,484,649. The chief gold-producing counties are Gilpin, Boulder, San Miguel, El Paso, Teller, Clear Creek, and Lake. The Cripple Creek district produced in 1900 about $1,250,000 of gold per month, and since 1891 had yielded $43,450,000. The largest silver production was in 1892, when the coin value of the product was $31,478,972. Iron ores are found in great abundance, and all materials necessary for making steel of excellent quality. The total value of the steel and iron products for 1899 was $7,681,719, in which year 134,936,223 pounds of steel rails and 215,640,332 pounds of pig iron were manufactured. Colorado stood ninth in 1898 in the list of coal-producing States. The aggregate area of coal beds is estimated at 18,100 square miles, and the accessible coal at 33,897,800,000 tons. In 1899 the total tonnage mined was 4,806,879, and 455,783 tons of coke were produced, the number of men employed being 7321. There are 35 oil wells in Fremont county, which are sunk to a depth of about 1500 feet. The oil ordinarily rises to within 400 feet of the surface, although there have been a number of flowing wells. The product increased from 76,295 barrels in 1887 to 842,000 in 1892; in 1900 it was about 500,000. It is refined, for the most part, at Florence, where there are two modern refineries. The value of lead produced in 1898 was $4,394,917; of copper, $1,831,500. The number of men employed in mining of all kinds was 30,231. Building stone of many varieties and of excellent quality is produced, valued at $2,000,000 annually. Mineral springs are found in all parts of the State. They vary in temperature from 40° to 150° F., and many possess medicinal value. The chief springs are at Manitou, Glenwood, Idaho Springs, Poncho Springs, Buena Vista, and Cañon City.

*Agriculture and Stock-Raising.*—Early experiments in farming indicated that regular crops could be secured only by means of irrigation, and in 1872 irrigation ditches were exempted from taxation. Extensive systems of canals were developed. In 1877 English capitalists constructed a canal over 150 miles in length. This was followed by a canal that cost $2,500,000. Since then extensive canals have been built in the Arkansas and Grand Valleys, the San Luis Park, and other parts of the State. In 1889 there were over 6000 miles of main irrigating ditches. In 1900 the mileage had increased to more than 15,000, and the valuation of all irrigation enterprises was $6,000,000. The amount of land under irrigation in 1883 was 416,594 acres, and in 1899, 1,975,400 acres. The average annual cost of water per acre is 79 cents. The soil is fertile in the north central section and in the river bottoms and large valleys, producing cereals, fruits, and vegetables of a superior quality. As early as 1866 the Surveyor-General estimated that of the population of 35,000 one-half were engaged in agriculture. In 1870 the agricultural production was estimated at $3,500,000, or within half a million of the bullion product. The total value of all farm, range, ranch, and orchard products in 1882 was $8,947,500, and in 1899, $45,774,251. The assessed valuation of all agricultural lands in 1900 was $19,566,124, and of grazing lands $9,901,701. The natural fruits are rare and almost worthless. In 1873 fruit trees began to be planted in various parts, and in 1882 the amount of land in orchards was 2500 acres, and the estimated value of the fruit crop $250,000; in 1898 the number of acres of fruit land was 118,752, and the value of the fruit crop $5,225,000; and there was still much open for settlement and improvement. Apples, peaches, plums, apricots, pears, cherries, and melons of exceptionally fine flavour are raised in increasingly large quantities. The most productive sections are along the Arkansas Valley, and in the western and south-western portions of

the State. Melons from Rocky Ford and peaches from Mesa county are shipped to the east, and in small quantities to Europe. The report for 1898 shows that the staple grains gave the following yield in bushels: wheat, 6,729,565, corn, 3,113,892; barley, 353,952; oats, 3,063,191; rye, 47,484. The hay product was 1,760,728 tons, and potatoes 2,564,331 bushels. The total value of these products was estimated at $17,349,251, as against $3,047,750 in 1882. It has been discovered by experiments conducted by the United States Government, through the Agricultural College, that the soil along the South Platte, the Arkansas and Grand rivers, and also in the San Luis Valley, is adapted for the cultivation of sugar beets, the average crop being 16 tons to the acre, and the proportion of saccharine matter unusually large. Sugar factories have been built at Grand Junction, Rocky Ford, and Sugar City; the first with a daily capacity of 3500 tons, and the others of 7500 tons. Stock-raising has always played an important part in the development of the State. The native grasses are especially adapted for fodder. The grama, buffalo, and bunch varieties cure on the stem and furnish nutritive food throughout the year. Before the plains were fenced, large herds drifted to the south during the winter; but sufficient hay and alfalfa are now cut to feed the cattle during the storms, which at longest are brief. As the industry has grown, laws have been enacted concerning branding, herding, and protection from disease; and a State Board of Inspectors has been formed. In 1884 the number of cattle was given as 1,005,000, and the number of sheep as 1,497,000. In 1899 the number was as follows: cattle, 754,039; sheep, 930,839; horses, 194,923; and mules, 7480. The total assessed valuation was $11,627,730, the assessment being about one-third of the market value. Wool in 1898 averaged seven pounds per fleece, the total clip yielding $840,000. The total value of cattle slaughtered in the packing houses in 1898 was $3,168,000. The value of the dairy product in the same year was $13,267,849.

*Manufactures.*—Since 1888 there has been a considerable growth of manufacturing. There are 18 smelters and reduction plants in the State, situated mainly at Denver, Leadville, Durango, and at Pueblo, where there are also blast-furnaces, a steel plant, and rolling mills. The most improved methods of treating ore are used. The cyanide process, introduced in 1890, is now one of the most important factors in the treatment of low-grade and refractory gold and silver ores. The improved dioxide cyanide process was adopted in 1895. One million barrels of flour were produced during 1899, the fifty mills having a capacity of 2,000,000 per annum. Cotton and paper manufactures are carried on in the vicinity of Denver. According to the United States' Census of 1900, there were in the State 1792 manufacturing establishments (excluding 1778 classified as hand trades, and 292 others, with a product of less than $500 each). They had a total capital of $59,515,279, an average number of 19,948 wage-earners, and products valued at $91,639,495. This sum includes the value of the gold, silver, lead, and copper smelted, which amounted to $44,625,305. Of the other products, iron and steel (valued at $6,108, 295), flouring and grist mill products (valued at $4,528,062), and foundry and machine shop products (valued at $3,986, 915), were the most important.

*Railways.*—The Denver Pacific, built from Cheyenne, reached Denver in June 1870, and the Kansas Pacific in August of the same year. Then followed the Denver and Rio Grande, to which the earlier development of the State is largely due. In 1886 the Colorado Midland started from Colorado Springs westwards, up the Ute Pass, and through the South Park to Leadville, and then over the Continental Divide to Aspen and Glenwood Springs; it has right of way over the Denver and Rio Grande line to Grand Junction, there connecting with the Rio Grande Western for Salt Lake City and Ogden, and the Pacific Coast. The Colorado and Southern, connecting Colorado with the south, has become an important system. In 1900 there were fifteen railways, with 4685 miles, in operation. The assessment on railways, tramways, telephones, and telegraphs was $35,533,586.

*Finances.*—The assessed valuation in real and personal property in 1876 was $44,130,205; in 1899 the total assessed valuation of all properties was $203,861,746; but this was regarded by the State Board as too low, and 5 per cent. increase was recommended. Taxes were levied in 1899 to the amount of $4,688,458. The total State debt in 1899 was $2,584,443. The cash in the treasury and uncollected taxes, $849,275, leaving a balance of indebtedness of $1,735,167. The total deposits in the 36 national banks on 13th February 1900, was $45,802,863.

*Education.*—Of the public lands, 3,715,555 acres were granted for the support of schools, 46,080 acres for the University, and 90,000 acres for the Agricultural College. In 1900 the number of persons of school age (5 to 20 years inclusive) was 160,531. The amount apportioned to the various school districts for 1900 was $62,577, and the total value of all school properties was $6,495,850. The salaries paid to the teachers in the public schools during 1899 and 1900 amounted to $1,423,680. Graded schools are found throughout the State, and high schools in all the larger towns. The State institutions are: the University of Colorado, at Boulder; the School of Mines, at Golden; the Agricultural College, at Fort Collins; the Normal School, at Greeley; the School for the Deaf and Blind, at Colorado Springs; the Industrial School for boys, at Golden, and for girls at Aurora. These are supported by a mill tax, and special appropriations. The State University has an annual income of $70,000, and a library of 19,000 volumes; the School of Mines, an income of $37,000; and the Normal School an income of $32,000, and a library of 10,000 volumes. The Agricultural College has an income of $65,500, of which $23,000 is from the United States Government. Experiment stations are conducted in connexion with the college at Fort Collins, Rocky Ford, and Cheyenne Wells. There are two institutions for higher education on an independent foundation. Colorado College, at Colorado Springs, is the oldest existing college in the State. Its property in equipment and endowment is $1,500,000, and it has a library of 30,000 volumes. The University of Denver, under Methodist control, is an outgrowth of the Colorado Seminary, the charter of which was granted in 1864. It has associated Law and Medical Schools. The Chamberlin Astronomical Observatory, with a 20-inch aperture telescope, is part of its equipment.

(W. F. S.)

**Colorado Springs,** capital of El Paso county, Colorado, U.S.A. It is situated near the centre of the state upon the high plains near the base of the Rocky Mountains, on Fontaine qui Bouille river, at the mouth of Monument creek, in 38° 50′ N. lat. and 104° 49′ W. long., at an altitude of 5985 feet. Its situation is fine, commanding a superb view of the mountains, whose culminating point, Pike's Peak, rises to a height of 14,108 feet, or more than 8000 feet above the city. It is entered by five railways: the Denver and Rio Grande; the Atchison, Topeka, and Santa Fé; the Colorado and Southern; the Chicago, Rock Island, and Pacific; and the Colorado Midland. It is the site of Colorado College, which in 1899 had a faculty numbering thirty-three, and was attended by 335 students. Colorado Springs was founded in 1871, upon the construction of the Denver and Rio Grande Railway, and has had a rapid growth. In its earlier years this was due to the beauty of its situation and its reputation as a health resort for consumptives. In later years the development of the gold mines at Cripple Creek has given it importance as a supply-point for this great mining camp. Population (1880), 4226; (1890), 11,140; (1900), 21,085, of whom 2300 were foreign-born and 875 negroes.

**Colossæ,** once the great city of South-West Phrygia, was situated at an altitude of 1150 feet on rising ground on the left bank of the Lycus (*Churuk Su*), a tributary of the Mæander, at the upper end of a narrow gorge 2½ miles long, through which the river runs between cliffs from 50 to 60 feet high. It stood on the great trade route from Sardis to Celænæ and Iconium, and was a large, prosperous, and populous city (Herod. vii. 30; Xenophon, *Anab.* i. 2, § 6), until its prosperity was ruined by the foundation of Laodicea in a more advantageous position. The town was celebrated for its wool, which was dyed a purple colour called *colossinus*. Colossæ was the seat of an early Christian Church, possibly founded by Epaphras, to which St Paul addressed an epistle. For some centuries it continued to prosper, but during the 7th and 8th centuries it was gradually deserted under pressure of the Arab invasions. Its place was taken by Khonæ (*Khonas*)—a strong fortress on a rugged spur of Mt. Kadmus, 3 miles to the south, which became a place of importance during the wars between the Byzantines and Turks, and was the birthplace of the historian, Nicetas Khoniates. The worship of angels alluded to by St Paul (Col. ii. 18), and condemned in the 4th century by a council at Laodicea, reappears in the later worship of St Michael, in whose honour a celebrated church, destroyed by the Seljúks in the 12th century, was built on the right bank of the Lycus (Ramsay, *Cities and Bishoprics of Phrygia*, vol. i. 1895).

# COLOURS OF ANIMALS.

## 1. Bionomics.

THE scope of this article includes the uses of colour in the struggle for existence among animals and in their sexual relationships, but not the physiological uses of coloured pigments or the discussion of pigments of uncertain meaning.

*Use of Colour for Concealment.—Cryptic Colouring* is by far the commonest use of colour in the struggle for existence. It is employed for the purpose of attack (*Aggressive Resemblance* or *Anticryptic Colouring*) as well as of defence (*Protective Resemblance* or *Procryptic Colouring*). The fact that the same method, concealment, may be used both for attack and defence has been well explained by Belt (*The Naturalist in Nicaragua*, London, 1888), who suggests as an illustration the rapidity of movement which is also made use of by both pursuer and pursued, which is similarly raised to a maximum in both by the gradual dying out of the slowest through a series of generations. Cryptic colouring is commonly associated with other aids in the struggle for life. Thus well-concealed mammals and birds, when discovered, will generally endeavour to escape by speed, and will often attempt to defend themselves actively. On the other hand, small animals which have no means of active defence, such as large numbers of insects, frequently depend upon concealment alone. Protective Resemblance is far commoner among animals than Aggressive Resemblance, in correspondence with the fact that predaceous forms are as a rule much larger and much less numerous than their prey. In the case of insectivorous Vertebrata and their prey such differences exist in an exaggerated form. Cryptic colouring, whether used for defence or attack, may be either *General* or *Special.* In *General Resemblance* the animal, in consequence of its colouring, produces the same effect as its environment, but the conditions do not require any special adaptation of shape and outline. General Resemblance is especially common among the animals inhabiting some uniformly coloured expanse of the earth's surface, such as an ocean or a desert. In the former, animals of all shapes are frequently protected by their transparent blue colour; on the latter, equally diverse forms are defended by their sandy appearance. The effect of a uniform appearance may be produced by a combination of tints in startling contrast. Thus the black and white stripes of the zebra blend together at a little distance, and "their proportion is such as exactly to match the pale tint which arid ground possesses when seen by moonlight" (Galton, *South Africa*, London, 1889). *Special Resemblance* is far commoner than General, and is the form which is usually met with on the diversified surface of the earth, on the shores, and in shallow water, as well as on the floating masses of Algæ on the surface of the ocean, such as the Sargasso Sea. In these environments the cryptic colouring of animals is usually aided by special modifications of shape, and by the instinct which leads them to assume particular attitudes. Complete stillness and the assumption of a certain attitude play an essential part in General Resemblance on land; but in Special Resemblance the attitude is often highly specialized, and perhaps more important than any other element in the complex method by which concealment is effected. In Special Resemblance the combination of colouring, shape, and attitude is such as to produce a more or less exact resemblance to some one of the objects in the environment, such as a leaf or twig, a patch of lichen, or flake of bark. In all cases the resemblance is to some object which is of no interest to the enemy or prey respectively. The animal is not hidden from view by becoming indistinguishable from its background, as in the cases of General Resemblance, but it is mistaken for some well-known object.

In seeking the interpretation of these most interesting and elaborate adaptations, attempts have been made along two lines. First, it is sought to explain the effect as a result of the direct influence of the environment upon the individual (Buffon), or by the inherited effects of effort and the use and disuse of parts (Lamarck). Second, natural selection is believed to have produced the result, and afterwards maintained it by the survival of the best concealed in each generation. The former suggestions break down when the complex nature of numerous Special Resemblances is appreciated. Thus the arrangement of colours of many kinds into an appropriate pattern requires the co-operation of a suitable shape and the rigidly exact adoption of a certain elaborate attitude. The latter is instinctive, and thus depends on the central nervous system. The cryptic effect is due to the exact co-operation of all these factors; and in the present state of science the only possible hope of an interpretation lies in the theory of natural selection, which can accumulate any and every variation which tends towards survival. A few of the chief types of methods by which concealment is effected may be briefly described. The colours of large numbers of Vertebrate animals are darkest on the back, and become gradually lighter on the sides, passing into white on the belly. Abbot H. Thayer (*The Auk*, vol. xiii., 1896) has suggested that this gradation obliterates the appearance of solidity, which is due to shadow. The colour-harmony, which is also essential to concealment, is produced because the back is of the same tint as the environment (*e.g.*, earth) bathed in the cold blue-white of the sky, while the belly, being cold blue-white bathed in shadow and yellow earth reflexions, produces the same effect. Thayer has made models (in the Natural History Museums at London, Oxford, and Cambridge) which support his interpretation in a very convincing manner. This method of neutralizing shadow for the purpose of concealment by increased lightness of tint was first suggested by E. B. Poulton in the case of a larva (*Trans. Ent. Soc. Lond.*, 1887, p. 294) and a pupa (*Trans. Ent. Soc. Lond.*, 1888, pp. 596, 597), but he did not appreciate the great importance of the principle. In an analogous method an animal in front of a background of dark shadow may have part of its body obliterated by the existence of a dark tint, the remainder resembling, *e.g.*, a part of a leaf (Müller, *Zool. Jahr. J. W. Spengel*, Jena, 1886). This method of rendering invisible any part which would interfere with the resemblance is well known in Mimicry. A common aid to concealment is the adoption by different individuals of two or more different appearances, each of which resembles some special object to which an enemy is indifferent. Thus the leaf-like butterflies (*Kallima*) present various types of colour and pattern on the under side of the wings, each of which closely resembles some well-known appearance presented by a dead leaf; and the common British Yellow Underwing Moth (*Tryphæna pronuba*) is similarly polymorphic on the upper side of its upper wings, which are exposed as it suddenly drops among dead leaves. Caterpillars and pupæ are also commonly *Dimorphic*, green and brown. Such differences as these extend the area which an enemy is compelled to search in order to make a living. In many cases the cryptic colouring changes appropriately during the course of an individual life, either seasonally, as in the ptarmigan or Alpine hare, or, according as the

individual enters a new environment in the course of its growth (such as larva, pupa, imago, &c.). In insects with more than one brood in the year, *Seasonal Dimorphism* is often seen, and the differences are sometimes appropriate to the altered condition of the environment as the seasons change. The causes of change in these and Arctic animals are insufficiently worked out: in both sets there are observations or experiments which indicate changes from within the organism, merely following the seasons and not caused by them, and other observations or experiments which prove that certain species are susceptible to the changing external influences. In certain species concealment is effected by the use of adventitious objects, which are employed as a covering. Examples of this *Allocryptic* defence are found in the tubes of the caddis worms (*Phryganea*), or the objects made use of by crabs of the genera *Hyas*, *Stenorhynchus*, &c. Such animals are concealed in any environment. If sedentary, like the former example, they are covered up with local materials; if wandering, like the latter, they have the instinct to reclothe. Allocryptic methods may also be used for aggressive purposes, as the ant-lion larva, almost buried in sand, or the large frog *Ceratophrys*, which covers its back with earth when waiting for its prey. Another form of Allocryptic defence is found in the use of the colour of the food in the digestive organs showing through the transparent body, and in certain cases the adventitious colour may be dissolved in the blood or secreted in superficial cells of the body: thus certain insects make use of the chlorophyll of their food (Poulton, *Proc. Roy. Soc.* vol. liv. p. 417). The most perfect Cryptic powers are possessed by those animals in which the individuals can change their colours into any tint which would be appropriate to a normal environment. This power is widely prevalent in Fish, and also occurs in Amphibia and Reptilia (the chameleon affording a well-known example). Analogous powers exist in certain Crustacea and Cephalopoda. All these rapid changes of colour are due to changes in shape or position of superficial pigment cells controlled by the nervous system. That the latter is itself stimulated by light through the medium of the eye and optic nerve has been proved in many cases. Animals with a short life-history passed in a single environment, which, however, may be very different in the case of different individuals, may have a different form of *Variable Cryptic Colouring*, namely, the power of adapting their colour once for all (many pupæ), or once or twice (many larvæ). In these cases the effect appears to be produced through the nervous system, although the stimulus of light probably acts on the skin and not through the eyes. Particoloured surfaces do not produce particoloured pupæ, probably because the antagonistic stimuli neutralize each other in the central nervous system which then disposes the superficial colours so that a neutral or intermediate effect is produced over the whole surface (Poulton, *Trans. Ent. Soc. Lond.*, 1892, p. 293). Cryptic colouring may incidentally produce superficial resemblances between animals; thus desert forms concealed in the same way may gain a likeness to each other, and in the same way Special Resemblances, *e.g.*, to lichen, bark, grasses, pine-needles, &c., may sometimes lead to a tolerably close similarity between the animals which are thus concealed. Such likeness may be called *Syncryptic* or *Common Protective* (or *Aggressive*) *Resemblance*, and it is to be distinguished from Mimicry and Common Warning Colours, in which the likeness is not incidental but an end in itself. Syncryptic Resemblances have much in common with those incidentally caused by functional adaptation, such as the mole-like forms produced in the burrowing Insectivora, Rodentia, and Marsupialia. Such likeness may be called *Syntechnic Resemblance*, incidentally produced by dynamic similarity, just as Syncryptic Resemblance is produced by static similarity.

*Use of Colour for Warning and Signalling.*—The use of colour for the purpose of warning is the exact opposite of the one which has been just described, its object being to render the animal conspicuous to its enemies, so that it can be easily seen, well remembered, and avoided in future. Warning colours are associated with some quality or weapon which renders the possessor unpleasant or dangerous, such as unpalatability, an evil odour, a sting, the poison-fang, &c. The object being to warn an enemy off, these colours are also called *Aposematic*. Recognition markings, on the other hand, are *Episematic*, assisting the individuals of the same species to keep together when their safety depends upon numbers, or easily to follow each other to a place of safety, the young and inexperienced benefiting by the example of the older. Episematic characters are far less common than Aposematic, and these than Cryptic; although, as regards the latter comparison, the opposite impression is generally produced from the very fact that concealment is so successfully attained. *Warning* or *Aposematic Colours*, together with the qualities they indicate, depend, as a rule, for their very existence upon the abundance of palatable food supplied by the animals with Cryptic colouring. Unpalatability, or even the possession of a sting, is not sufficient defence unless there is enough food of another kind to be obtained at the same time and place (Poulton, *Proc. Zool. Soc.*, 1887, p. 191). Hence insects with Warning Colours are not seen in temperate countries except at the time when insect life as a whole is most abundant; and in warmer countries, with well-marked wet and dry seasons, it will probably be found that Warning Colours are proportionately less developed in the latter. In many species of African butterflies belonging to the genus *Junonia* (including *Precis*) the wet-season broods are distinguished by the more or less conspicuous under sides of the wings, those of the dry season being highly cryptic. Warning Colours are, like Cryptic, assisted by special adaptations of the body-form, and especially by movements which assist to render the colour as conspicuous as possible. On this account animals with Warning Colours generally move or fly slowly, and it is the rule in butterflies that the Warning patterns are similar on both upper and under sides of the wings. Many animals, when attacked or disturbed, "sham death" (as it is commonly but wrongly described), falling motionless to the ground. In the case of well-concealed animals this instinct gives them a second chance of escape in the earth or among the leaves, &c., when they have been once detected; animals with Warning Colours are, on the other hand, enabled to assume a position in which their characters are displayed to the full (Portschinski, *Lepidopterorum Rossiæ Biologia*, St. Petersburg, 1890, plate i. figs. 16, 17). In both cases a definite attitude is assumed, which is not that of death. Other warning characters exist in addition to colouring: thus sound is made use of by the disturbed Rattle-snake and the Indian *Echis*, &c. Large birds, when attacked, often adopt a threatening attitude, accompanied by a terrifying sound. The Cobra warns an intruder chiefly by attitude and the dilation of the flattened neck, the effect being heightened in some species by the "spectacles." In such cases we often see the combination of *Cryptic* and *Sematic* methods, the animal being concealed until disturbed, when it instantly assumes an Aposematic attitude. The advantage to the animal itself is clear: a poisonous snake gains nothing by killing an animal it cannot eat; while the poison does not cause immediate death, and the enemy would have time to injure or destroy the snake. In the case of small unpalatable animals with Warning Colours the enemies would

only first become aware of the unpleasant quality by tasting and often destroying their prey; but the species would gain by the experience thus conveyed, even though the individual might suffer. An insect-eating animal does not come into the world with knowledge: it has to be educated by experience, and Warning Colours enable this education as to what to avoid to be gained by a small instead of a large waste of life. Furthermore, great tenacity of life is usually possessed by animals with Warning Colours. The tissues of Aposematic insects generally possess great elasticity and power of resistance, so that large numbers of individuals can recover after very severe treatment.

The brilliant Warning Colours of many caterpillars attracted the attention of Darwin when he was thinking over his hypothesis of sexual selection, and he wrote to Wallace on the subject (Darwin, *Life and Letters*, London, 1887, vol. iii. p. 93). Wallace, in reply, suggested their interpretation as Warning Colours, a suggestion since verified by experiment (*Proc. Ent. Soc. Lond.*, 1867, p. lxxx; *Trans. Ent. Soc. Lond.*, 1869, pp. 21 and 27). Although animals with Warning Colours are probably but little attacked by the ordinary enemies of their class, they have special enemies which keep the numbers down to the average. Thus the cuckoo appears to be an insectivorous bird which will freely devour conspicuously coloured unpalatable larvæ. The effect of the Warning Colours of caterpillars is often intensified by gregarious habits. Another Aposematic use of colours and structures is to divert attention from the vital parts, and thus give the animal attacked an extra chance of escape. The large, conspicuous, easily torn wings of butterflies and moths act in this way, as is found by the abundance of individuals which may be captured with notches bitten symmetrically out of both wings when they were in contact. The eyespots and "tails" so common on the hinder part of the hind wing, and the conspicuous apex so frequently seen on the fore wing, probably have this meaning. Their position corresponds to the parts which are most often found to be notched. In some cases (*e.g.*, many *Lycœnidœ*) the "tail" and eye-spot combine to suggest the appearance of a head with antennæ at the posterior end of the butterfly, the deception being aided by movements of the hind wings. The flat-topped "tussocks" of hair on many caterpillars look like conspicuous fleshy projections of the body, and they are held prominently when the larva is attacked. If seized, the "tussock" comes out, and the enemy is greatly inconvenienced by the fine branched hairs. The tails of lizards, which easily break off, are to be similarly explained, the attention of the pursuer being probably still further diverted by the extremely active movements of the amputated member. Certain crabs similarly throw off their claws when attacked, and the claws continue to snap most actively. The tail of the dormouse, which easily comes off, and the extremely bushy tail of the squirrel, are probably of use in the same manner. Animals with Warning Colours often tend to resemble each other superficially. This fact was first pointed out by H. W. Bates in his paper on the Theory of Mimicry (*Trans. Linn. Soc.* vol. xxiii., 1862, p. 495). He showed that the conspicuous, presumably unpalatable, tropical American butterflies, belonging to very different groups, which are mimicked by others, also tend to resemble each other, the likeness being often remarkably exact. These resemblances were not explained by his theory of Mimicry, and he could only suppose that they had been produced by the direct influence of a common environment. The problem was solved in 1879 by Fritz Müller (see *Proc. Ent. Soc. Lond.*, 1879, p. xx), who suggested that life is saved by this resemblance between Warning Colours, inasmuch as the education of young inexperienced enemies is facilitated. Each species which falls into a group with Common Warning (*Synaposematic*) Colours contributes to save the lives of the other members. It is sufficiently obvious that the amount of learning and remembering, and consequently of injury and loss of life involved in the process, are reduced when many species in one place possess the same Aposematic colouring, instead of each exhibiting a different "danger-signal." These resemblances are often described as "Mullerian Mimicry," as distinguished from true or "Batesian Mimicry" described in the next section. Similar Synaposematic resemblances between the specially protected groups of butterflies were afterwards shown to exist in tropical Asia, the East Indian Islands, and Polynesia by F. Moore (*Proc. Zool. Soc.*, 1883, p. 201), and in Africa by E. B. Poulton (*Report Brit. Assoc.*, 1897, p. 688). R. Meldola (*Ann. and Mag. Nat. Hist.* x., 1882, p. 417) first pointed out and explained in the same manner the remarkable general uniformity of colour and pattern which runs through so many species of each of the distasteful groups of butterflies; while, still later, Poulton (*Proc. Zool. Soc.*, 1887, p. 191) similarly extended the interpretation to the Synaposematic resemblances between animals of all kinds in the same country. Thus, for example, longitudinal or circular bands of the same strongly contrasted colours are found in species of many groups with distant affinities.

Certain animals, especially the Crustacea, make use of the special defence and Warning Colours of other animals. Thus the English Hermit-crab, *Pagurus bernhardus*, commonly carries the Sea-anemone, *Sagartia parasitica*, on its shell; while another English species, *Pagurus prideauxii*, inhabits a shell which is invariably clothed by the flattened *Adamsia palliata*.

The white patch near the tail which is frequently seen in the gregarious Ungulates, and is often rendered conspicuous by adjacent black markings, probably assists the individuals in keeping together; and appearances with probably the same interpretation are found in many birds. The white upturned tail of the rabbit is probably of use in enabling the individuals to follow each other readily. The difference between a typical Aposematic character appealing to enemies, and Episematic intended for other individuals of the same species, is well seen when we compare such examples as (1) the huge banner-like white tail, conspicuously contrasted with the black or black and white body, by which the slow-moving skunk warns enemies of its power of emitting an intolerably offensive odour; (2) the small upturned white tail of the rabbit, only seen when it is likely to be of use and when the owner is moving, and, if pursued, very rapidly moving, towards safety.

*Mimicry, or Pseudo-sematic Colours.*—The fact that animals with distant affinities may more or less closely resemble each other was observed long before the existing explanation was possible. Its recognition is implied in a number of insect names with the termination *-formis*, usually given to species of various Orders which more or less closely resemble the stinging Hymenoptera. The usefulness of the resemblance was suggested in Kirby and Spence's *Introduction to Entomology*, London, 1817, vol. ii. p. 223. H. W. Bates (*Trans. Linn. Soc.* vol. xxiii. 1862, p. 495) first proposed an explanation of Mimicry based on the theory of Natural Selection. He supposed that every step in the formation and gradual improvement of the likeness occurred in consequence of its usefulness in the struggle for life. The subject is of additional interest, inasmuch as it was one of the first attempts to apply the theory of Natural Selection to a large class of phenomena up to that time well known but unexplained. Numerous

examples of Mimicry among tropical American butterflies were discussed by Bates in his paper; and in 1866 A. R. Wallace extended the hypothesis to the butterflies of the tropical East (*Trans. Linn. Soc.* vol. xxv., 1866, p. 19); Roland Trimen (*Trans. Linn. Soc.* vol. xxvi., 1870, p. 497) to those of Africa in 1870. The term Mimicry is used in various senses. It is often extended, as indeed it was by Bates, to include all the superficial resemblances between animals and any part of their environment. Wallace, however, separated the Cryptic Resemblances already described, and the majority of naturalists have followed this convenient arrangement. In Cryptic Resemblance an animal resembles some object of no interest to its enemy (or prey), and in so doing is concealed; in Mimicry an animal resembles some other animal which is specially disliked by its enemy, or some object which is specially attractive to its prey, and in so doing becomes conspicuous. Some naturalists have considered Mimicry to include all superficial likenesses between animals, but such a classification would group together resemblances which have widely different uses. (1) The resemblance of a mollusc to the coral on which it lives, or an external parasite to the hair or skin of its host, would be *Procryptic*; (2) that between moths which resemble lichen, *Syncryptic*; (3) between distasteful insects, *Synaposematic*; (4) between the Insectivor mole and the Rodent mole-rat, *Syntechnic*; (5) the essential element in Mimicry is that it is a false warning (Pseud-aposematic) or false recognition (Pseud-episematic) character. Some have considered that Mimicry indicates resemblance to a *moving object*; but apart from the non-mimetic likenesses between animals classified above, there are ordinary Cryptic Resemblances to drifting leaves, swaying bits of twig, &c., while truly Mimetic Resemblances are often specially adapted for the attitude of rest. Many use the term Mimicry to include *Synaposematic* as well as *Pseudo-sematic Resemblances*, calling the former "Müllerian," the latter "Batesian," Mimicry. The objection to this grouping is that it takes little account of the deceptive element which is essential in Mimicry. In Synaposematic colouring the warning is genuine, in Pseud-aposematic it is a sham. The term Mimicry has led to much misunderstanding from the fact that in ordinary speech it implies deliberate imitation. The production of Mimicry in an individual animal has no more to do with consciousness or "taking thought" than any of the other processes of growth. Protective Mimicry is here defined as an advantageous and superficial resemblance of one animal to another, which latter is specially defended so as to be disliked or feared by the majority of enemies of the groups to which both belong—a resemblance which appeals to the sense of sight, sometimes to that of hearing, and rarely to smell, but does not extend to deep-seated characters except when the superficial likeness is affected by them. *Mutatis mutandis* this definition will apply to Aggressive (Pseud-episematic) Resemblance. The conditions under which Mimicry occurs have been stated by Wallace:—"(1) that the imitative species occur in the same area and occupy the same station as the imitated; (2) that the imitators are always the more defenceless; (3) that the imitators are always less numerous in individuals; (4) that the imitators differ from the bulk of their allies; (5) that the imitation, however minute, is *external* and *visible* only, never extending to internal characters or to such as do not affect the external appearance." It is obvious that conditions 2 and 3 do not hold in the case of Müllerian Mimicry. Mimicry has been explained, independently of Natural Selection, by the supposition that it is the common expression of the direct action of common causes, such as climate, food, &c.; also by the supposition of independent lines of evolution leading to the same result without any selective action in consequence of advantage in the struggle; also by the operation of Sexual Selection.

It is proposed, in conclusion, to give an account of the broad aspects of Mimicry, and attempt a brief discussion of the theories of origin of each class of facts (see Poulton, *Linn. Soc. Journ. Zool.*, 1898, p. 558). It will be found that in many cases the argument here made use of applies equally to the origin of Cryptic and Sematic Colours. The relationship between these classes has been explained: Mimicry is, as Wallace has stated (*Darwinism*, London, 1889), merely "an exceptional form of protective resemblance." Now, protective (cryptic) resemblance cannot be explained on any of the lines suggested above, except natural selection; even sexual selection fails, because cryptic resemblance is especially common in the immature stages of insect life. But it would be unreasonable to explain Mimetic Resemblance by one set of principles and Cryptic by another and totally different set. Again, it may be plausible to explain the mimicry of one butterfly for another on one of the suggested lines, but the resemblance of a fly or moth to a wasp is by no means so easy, and here selection would be generally conceded; yet the appeal to antagonistic principles to explain such closely related cases would only be justified by much direct evidence. Furthermore, the mimetic resemblances between butterflies are not haphazard, but the models almost invariably belong only to certain sub-families, the *Danainæ* and *Acraeinæ* in all the warmer parts of the world, and, in tropical America, the *Ithomiinæ* and *Heliconinæ* as well. These groups have the characteristics of Aposematic species, and no theory but natural selection explains their invariable occurrence as models wherever they exist. It is impossible to suggest, except by natural selection, any explanation of the fact that mimetic resemblances are confined to changes which produce or strengthen a superficial likeness. Very deep-seated changes are generally involved, inasmuch as the appropriate instincts as to attitude, &c., are as important as colour and marking. The same conclusion is reached when we analyse the nature of mimetic resemblance and realize how complex it really is, being made up of *colours*, both pigmentary and structural, *pattern*, *form*, *attitude*, and *movement*. A plausible interpretation of colour may be wildly improbable when applied to some other element, and there is *no* explanation except natural selection which can explain all these elements. The appeal to the direct action of local conditions in common often breaks down upon the slightest investigation, the difference in habits between mimic and model in the same locality causing the most complete divergence in their conditions of life. Thus many insects produced from burrowing larvæ mimic those whose larvæ live in the open. Mimetic resemblance is far commoner in the female than in the male, a fact readily explicable by selection, as suggested by Wallace, for the female is compelled to fly more slowly and to expose itself while laying eggs, and hence a resemblance to the slow-flying freely exposed models is especially advantageous. The facts that mimetic species occur in the same locality, fly at the same time of the year as their models, and are day-flying species even though they may belong to nocturnal groups, are also more or less difficult to explain except on the theory of natural selection, and so also is the fact that mimetic resemblance is produced in the most varied manner. A spider resembles its model, an ant, by a modification of its body-form into a superficial resemblance, and by holding one pair of legs to represent antennæ; certain bugs (Hemiptera) and beetles have also gained a shape unusual in their respective groups, a shape which superficially resembles an ant; a Locustid (*Myrmecophana*) has the shape of an ant painted, as it were, on its body, all other parts resembling the back-

ground and invisible; a Membracid (Homoptera) is entirely unlike an ant, but is concealed by an ant-like shield. When we further realize that in this and other examples of Mimicry "the likeness is almost always detailed and remarkable, however it is attained, while the methods differ absolutely," we recognize that natural selection is the only possible explanation hitherto suggested. In the cases of Aggressive Mimicry an animal resembles some object which is attractive to its prey. Examples are found in the flower-like species of Mantis, which attract the insects on which they feed. Such cases are generally described as possessing "*alluring colours*," and are regarded as examples of *Aggressive* (*Anticryptic*) *Resemblance*, but their logical position is here.

*Colours displayed in Courtship, Secondary Sexual Characters, Epigamic Colours.*—Darwin suggested the explanation of these appearances in his theory of *Sexual Selection* (*The Descent of Man*, London, 1874). The rivalry of the males for the possession of the females he believed to be decided by the preference of the latter for those individuals with especially bright colours, highly developed plumes, beautiful song, &c. Wallace does not accept the theory, but believes that natural selection, either directly or indirectly, accounts for all the facts. Probably the majority of naturalists follow Darwin in this respect. The subject is most difficult, and the interpretation of a great proportion of the examples in a high degree uncertain, so that a very brief account is here expedient. That selection of some kind has been operative is indicated by the diversity of the elements into which the effects can be analysed. The most complete set of observations on Epigamic display was made by George W. and Elizabeth G. Peckham upon spiders of the family *Attidæ* (*Nat. Hist. Soc. of Wisconsin*, vol. i., 1889). These observations afforded the authors "conclusive evidence that the females pay close attention to the love-dances of the males, and also that they have not only the power, but the will, to exercise a choice among the suitors for their favour." Epigamic characters are often concealed except during courtship; they are found almost exclusively in species which are diurnal or semi-diurnal in their habits, and are excluded from those parts of the body which move too rapidly to be seen. They are very commonly directly associated with the nervous system; and in certain fish, and probably in other animals, an analogous heightening of effect accompanies nervous excitement other than sexual, such as that due to fighting or feeding. Although there is Epigamic display in species with sexes alike, it is usually most marked in those with secondary sexual characters specially developed in the male. These are an exception to the rule in heredity, in that their appearance is normally restricted to a single sex, although in many of the higher animals they have been proved to be latent in the other, and may appear after the essential organs of sex have been removed or become functionless. This is also the case in the Aculeate Hymenoptera when the reproductive organs have been destroyed by the parasite (*Stylops*). Cunningham has recently argued (*Sexual Dimorphism in the Animal Kingdom*, London, 1900) that secondary sexual characters have been produced by direct stimulation due to contests, &c., in the breeding period, and have gradually become hereditary, a hypothesis involving the assumption that acquired characters are transmitted. Wallace suggests that they are in part to be explained as "Recognition Characters," in part as an indication of surplus vital activity in the male.

AUTHORITIES.—The following works may also be consulted:—EIMER. *Orthogenesis der Schmetterlinge.* Leipzig, 1898.—POULTON. *The Colours of Animals.* London, 1890.—BEDDARD. *Animal Coloration.* London, 1892.—HAASE. *Researches on Mimicry* (translation). London, 1896.—WALLACE. *Natural Selection and Tropical Nature.* London 1895. *Darwinism.* London, 1897. Many of the memoirs and volumes quoted in the text also contain further references. (E. B. P.)

II. CHEMISTRY.

The coloration of the *surface* of animals is caused either by *pigments*, or by a certain *structure* of the surface by means of which the light falling on it, or reflected through its superficial transparent layers, undergoes diffraction or other optical change. Or it may be the result of a combination of these two causes. It plays an important part in the relationship of the animal to its environment, in concealment, in mimicry, and so on; the presence of a pigment in the integument may also serve a more direct physiological purpose, such as a respiratory function. The coloration of birds' feathers, of the skin of many fishes, of many insects, is partially at least due to structure and the action of the peculiar pigmented cells known as "chromatophores" (which Garstang defines as pigmented cells specialized for the discharge of the chromatic function) and is much better marked when these have for their background a "reflecting layer" such as is provided by guanin, a substance closely related to uric acid. Such a mechanism is seen to greatest advantage in fishes. Among these, guanin may be present in a finely granular form, causing the light falling on it to be scattered, thus producing a white effect; or it may be present in a peculiar crystalline form, the crystals being known as "iridocytes"; or in a layer of closely apposed needles forming a silvery sheet or mirror. In the iris of some fishes the golden red colour is produced by the light reflected from such a layer of guanin needles having to pass through a thin layer of a reddish pigment, known as a "lipochrome." Again, in some lepidopterous insects a white or a yellow appearance is produced by the deposition of uric acid or a nearly allied substance on the surface of the wings. In many animals, but especially among invertebrates, colouring matters or pigments play an important rôle in surface coloration; in some cases such coloration may be of benefit to the animal, but in others the integument simply serves as an organ for the excretion of waste pigmentary substances. Pigments (1) may be of direct physiological importance; (2) they may be excretory; or (3) they may be introduced into the body of the animal with the food.

Of the many pigments which have been described up to the present time, very few have been subjected to elementary chemical analysis, owing to the great difficulties attending their isolation. An extremely small amount of pigment will give rise to a great amount of coloration, and the pigments are generally accompanied by impurities of various kinds which cling to them with great tenacity, so that when one has been thoroughly cleansed, very little of it remains for ultimate analysis. Most of these substances have been detected by means of the spectroscope, their absorption bands serving for their recognition, but mere identity of spectrum does not necessarily mean chemical identity, and a few chemical tests have also to be applied before a conclusion can be drawn. The absorption bands are referred to certain definite parts of the spectrum, such as the Fraunhofer lines, or they may be given in wave-lengths. For this purpose the readings of the spectroscope are reduced to wave-lengths by means of interpolation curves; or if Zeiss's microspectroscope be used, the position of bands in wave-lengths (denoted by the Greek letter $\lambda$) may be read directly. Examples of the absorption bands yielded by colouring matters will be found in *Ency. Brit.* vol. xx. p. 483.

Hæmoglobin, the red colouring matter of vertebrate blood, $C_{758}H_{1203}N_{195}S_3FeO_{218}$, and its derivatives hæmatin, $C_{32}H_{30}N_4FeO_3$, and hæmatoporphyrin, $C_{16}H_{18}N_2O_3$, are

colouring matters about which we possess definite chemical knowledge, as they have been isolated, purified, and analysed. Most of the bile pigments of mammals have likewise been isolated and studied chemically, and all of these are fully described in the text-books of physiology and physiological chemistry. Hæmoglobin, though physiologically of great importance in the respiratory process of vertebrate animals, is yet seldom used for surface pigmentation, except in the face of white races of man or in other parts in monkeys, &c. In some worms the transparent skin allows the hæmoglobin of the blood to be seen through the integument, and in certain fishes also the hæmoglobin is visible through the integument. It is a curious and noteworthy fact that in some invertebrate animals in which no hæmoglobin occurs, we meet with its derivatives. Thus hæmatin is found in the so-called bile of slugs, snails, the limpet, and the crayfish. In sea-anemones there is a pigment which yields some of the decomposition-products of hæmoglobin, and associated with this is a green pigment apparently identical with biliverdin ($C_{16}H_{18}N_2O_4$), a green bile pigment. Again, hæmatoporphyrin is found in the integuments of star-fishes and slugs, and occurs in the "dorsal streak" of the earth-worm (*Lumbricus terrestris*), and perhaps in other species. Hæmatoporphyrin and biliverdin also occur in the egg-shells of certain birds, but in this case they are derived from hæmoglobin. Hæmoglobin is said to be found as low down in the animal kingdom as the Echinoderms, *e.g.*, in *Ophiactis virens*, and *Thyonella gemmata*. It also occurs in the blood of *Planorbis corneus*, and in the pharyngeal muscles of other mollusca.

A great number of other pigments have been described; for example, in the muscles and tissues of animals, both vertebrate and invertebrate, are the histohæmatins, of which a special muscle pigment, myohæmatin, is one. In vertebrates the latter is generally accompanied by hæmoglobin, but in invertebrates—with the exception of the pharyngeal muscles of the mollusca—it occurs alone. Although closely related to hæmoglobin or its derivative hæmochromogen, the histohæmatins are yet totally distinct, and they are found in animals where not a trace of hæmoglobin can be detected. Another interesting pigment is turacin, which contains about 7 per cent. of nitrogen, found by Professor Church in the feathers of the Cape lory and other plantain-eaters, from which it can be extracted by water containing a trace of ammonia. It has been isolated, purified, and analysed by Professor Church. From it may be obtained turacoporphyrin, which is identical with hæmatoporphyrin, and gives the band in the ultra-violet which Soret and subsequently Gamgee have found to be characteristic of hæmoglobin and its compounds. Turacin itself gives a peculiar two-banded spectrum, and contains about 7 per cent. of copper in its molecule. Another copper-containing pigment is hæmocyanin, which in the oxidized state gives a blue colour to the blood of various mollusca and arthropoda. Like hæmoglobin, it acts as an oxygen-carrier in respiration, but it takes no part in surface coloration.

A class of pigments widely distributed among plants and animals are the lipochromes. As their name denotes, they are allied to fat and generally accompany it, being soluble in fat solvents. They play an important part in surface coloration, and may be greenish, yellow, or red in colour. They contain no nitrogen. As an example of a lipochrome which has been isolated, crystallized, and purified, we may mention carotin, which has recently been found in green leaves. Chlorophyll, which is so often associated with a lipochrome, has been found in some Infusoria, and in *Hydra* and *Spongilla*, &c. In some cases it is probably formed by the animal; in other cases it may be due to symbiotic algæ, while in the gastric gland of many Mollusca, Crustacea, and Echinodermata, it is derived from food-chlorophyll. Here it is known as entero-chlorophyll. The black pigments which occur among both vertebrate and invertebrate animals often have only one attribute in common, viz., blackness, for among the discordant results of analysis one thing is certain, viz., that the melanins from vertebrate animals are not identical with those from invertebrate animals. The melanosis or blackening of insect blood, for instance, is due to the oxidation of a chromogen, the pigment produced being known as a uranidine. In some sponges a somewhat similar pigment has been noticed. Other pigments have been described, such as actiniochrome, echinochrome, pentacrinin, antedonin, polyperythrin (which appears to be a hæmatoporphyrin), the floridines, spongioporphyrin, &c., which need no mention here; all these pigments can only be distinguished by means of the spectroscope.

Most of the pigments are preceded by colourless substances known as "chromogens," which by the action of the oxygen of the air and by other agencies become changed into the corresponding pigments. In some cases the pigments are built up in the tissues of an animal, in others they appear to be derived more or less directly from the food. Derivatives of chlorophyll and lipochromes especially, seem to be taken up from the intestine, probably by the agency of leucocytes, in which they may occur in combination with, or dissolved by, fatty matters and excreted by the integument. In worms especially, the skin seems to excrete many effete substances, pigments included. No direct connexion has been traced between the chlorophyll eaten with the food and the hæmoglobin of blood and muscle. Attention may, however, be drawn to the work of Dr Schunck, who has shown that a substance closely resembling hæmatoporphyrin can be prepared from chlorophyll; this is known as phylloporphyrin. Not only does the *visible* spectrum of this substance resemble that of hæmatoporphyrin, but the *invisible* ultra-violet also, as recently shown by Mr C. A. Schunck.

The reader may refer to Schäfer's *Text-Book of Physiology* (1898) for Gamgee's article "On Hæmoglobin, and its Compounds"; to the writer's papers in the *Phil. Trans.* and *Proc. Roy. Soc.* from 1881 onwards, and also *Quart. Journ. Micros. Science* and *Journ. of Physiol.*; to Krukenberg's *Vergleichende physiologische Studien* from 1879 onwards, and to his *Vorträge.* Miss Newbigin has collected in *Colour in Nature* (1898) most of the recent literature of this subject. Dr Schunck's papers will be found under the heading "Contribution to the Chemistry of Chlorophyll" in *Proc. Roy. Soc.* from 1885 onwards; and Mr C. A. Schunck's paper in *Proc. Roy. Soc.* vol. lxiii. (C. A. MACM.)

**Columbia,** capital of Boone county, Missouri, U.S.A., situated in 38° 57′ N. lat. and 92° 19′ W. long., in the central part of the state, on the Wabash Railway, at an altitude of 783 feet. It is the site of the State University, and of Christian and Stephens Female Colleges. Population (1880), 3326; (1890), 4000; (1900), 5651.

**Columbia,** a borough of Lancaster county, Pennsylvania, U.S.A., situated on the east bank of Susquehanna river, in the south-eastern part of the state, on branches of the Pennsylvania and the Philadelphia and Reading Railways, at an altitude of 251 feet. It has extensive manufactures, principally of iron. Population (1880), 8312; (1890), 10,599; (1900), 12,316.

**Columbia,** capital of Richland county, South Carolina, U.S.A., and of the state, situated in 34° 00′ N. lat. and 80° 57′ W. long. on the east bank of Congaree river, at the junction of the Saluda and Broad, near the centre of the state, at an altitude of 244 feet.

Five railways enter it, namely, the Atlantic Coast Line, the Southern, the South Carolina and Georgia, the Florida Central and Peninsula, and the Columbia, Newberry, and Laurens. It is the seat of South Carolina College, which in 1898 had twelve professors and 188 students. Population (1880), 10,036; (1890), 15353; (1900), 21,108.

**Columbia,** capital of Maury county, Tennessee, U.S.A., situated on Duck river, in the central part of the state, at an altitude of 646 feet. It has two railways, the Louisville and Nashville and the Nashville, Chattanooga, and St Louis. Population (1880), 3400; (1890), 5370; (1900), 6052.

**Columbia, District of.** See WASHINGTON.

**Columbia University,** in the city of New York, U.S.A., includes both a college and a university in the strict sense of the word as used in the United States. It comprises the faculties of law, medicine, philosophy, political science, pure science, and applied science. It is the successor of the corporation known as "The Governors of King's College, in the Province of New York," founded in 1754 by royal charter. In the educational system is also included Barnard College for Women, a separate corporation founded in 1889, and a teachers' college, also a separate corporation. In 1897 the university moved from the centre of the city northwards to Morningside Heights, which overlook the Hudson from an altitude of 150 feet. The Medical School (the College of Physicians and Surgeons) remains in its old location opposite Roosevelt Hospital. The entire plant of the university represents a cost of about $9,500,000. In the year ending 30th June 1900 the expenditures for educational purposes were $942,460, leaving a deficiency of $17,328, which was met by a special guarantee fund. In 1901 there were registered in the college for men (Columbia) 475 students, and in the college for women (Barnard) 293 students, making a total of 768 undergraduates. The total of non-professional graduate students was 412. The scientific schools contained 539 students, the law school 422 students, the medical school 775 students, the teachers' college 498 students—making a total of 2234 professional students. The total number of students in the university was thus 3830 (including 417 summer session students). In addition to these there were 29 auditors and 679 members of extension courses, making a grand total of 4538. The number of teachers of all grades for the same year was 375. The library, which numbers about 300,000 volumes, is thoroughly modern, and is selected with special reference to scholarly uses. The university is growing in all departments. (See also UNIVERSITIES and EDUCATION.) (S. L*.)

**Columbus,** capital of Muscogee county, Georgia, U.S.A., situated on the western boundary of the state, at an altitude of 260 feet, on Chattahoochee river, which is navigable to this point. Just above the city the river crosses the fall line, producing falls and rapids which furnish excellent water-power. This has been turned to account in extensive cotton manufactures. Three railways enter the city, the Southern, the Central of Georgia, and the Georgia and Alabama. Population (1880), 10,123; (1890), 17,303; (1900), 17,614.

**Columbus,** capital of Bartholomew county, Indiana, U.S.A., situated on the east fork of White river, a little south of the centre of the state, at an altitude of 629 feet. It is at the intersection of lines of the Pittsburg, Cincinnati, Chicago, and St Louis and the Cleveland, Cincinnati, Chicago, and St Louis Railways. The centre of population of the United States was in 1900 very near this place. Population (1880), 4813; (1890), 6719; (1900), 8130.

**Columbus,** capital of Lowndes county, Mississippi, U.S.A., at the intersection of the Southern and the Mobile and Ohio Railways, on the Tombigbee river. It contains large cotton mills. Population (1890), 4559; (1900, with limits enlarged), 6484, including 3366 negroes.

**Columbus,** capital of Franklin county, Ohio, U.S.A., and of the state of Ohio. The site was purposely selected in 1813 near the centre of the state, in 39° 57′ N. lat. and 82° 59′ W. long., at an altitude of 743 feet, the elevation of the lines at the Union Station. It is a railway centre of the first importance. Fourteen different lines of railway, belonging to eight companies, enter the fine new Union Station in the heart of the city, thence radiating in all directions. The manufactures employed in 1890 a capital of $16,178,703, with 13,421 hands and an output of $22,887,586. The principal manufacture was that of carriages and waggons, valued at $3,199,287. Foundry and machine-shop products were second, with a value of $2,139,185. Then followed the manufacture of steam cars, the product of which was valued at $1,670,078. The Ohio State University, situated here, had in 1898 a faculty of 95 professors, and was attended by 1150 students, one-fifth of whom were women. Its property was valued at $2,600,000, and its income at $292,000. It has schools of law, medicine, dentistry, pharmacy, and veterinary surgery. Capital University, a Lutheran institution, also here, had in 1898 a faculty of 10 teachers and 113 students. The death-rate in 1899 was but 10·83 per thousand; this is less than half the average of American cities, and little more than half that of the Union. The assessed valuation of property, real and personal, was, in 1899, $64,344,990. The income from all sources was $2,612,301, the expenditure $2,570,038, and the net debt $6,059,146. The tax rate per $1000 was $27.50. Population (1880), 51,647; (1890), 88,150; (1900), 125,560; death-rate (1900), 15·8.

**Combaconum,** or Kumbakonam, a city of British India, in the Tanjore district of Madras, in the delta of the Kaveri; with a railway station on the South Indian Railway, 194 miles from Madras. In 1881 it had a population of 50,098, and in 1891 of 54,307, of whom nearly one-fifth were Brahmans. In 1901 the population was 59,688, showing an increase of 10 per cent. The municipal income in 1897–98 was Rs.80,480. It contains a Government college, two high schools, four printing-presses, and a reading-room.

**Combinatorial Analysis.**—The Combinatorial Analysis, as it was understood up to the end of the 18th century, was of limited scope and restricted application. P. Nicholson, in his *Essays on the Combinatorial Analysis*, published in 1818, states that "the Combinatorial Analysis is a branch of mathematics which teaches us to ascertain and exhibit all the possible ways in which a given number of things may be associated and mixed together; so that we may be certain that we have not missed any collection or arrangement of these things that has not been enumerated." Writers on the subject seemed to recognize fully that it was in need of cultivation, that it was of much service in facilitating algebraical operations of all kinds, and that it was the fundamental method of investigation in the theory of Probabilities. Some idea of its scope may be gathered from a statement of the parts of algebra to which it was commonly applied, viz., the expansion of a multinomial, the product of two or more multinomials, the quotient of one multinomial by another, the reversion and conversion of series, the theory of indeterminate equations, &c. Some of the elementary theorems and various particular problems appear in the works of the

***Historical introduction.***

earliest algebraists, but the true pioneer of modern researches seems to have been Abraham Demoivre, who first published in 1697 (*Phil. Trans. R. S.*) the law of the general coefficient in the expansion of the series $a+bx+cx^2+dx^3+\ldots$ raised to any power. (See also *Miscellanea Analytica*, Bk. iv. chap. ii. prob. iv.) His work on Probabilities would naturally lead him to consider questions of this nature. An important work at the time it was published was the *De Partitione Numerorum* of Euler, in which the consideration of the reciprocal of the product $(1-xz)(1-x^2z)(1-x^3z)\ldots$ establishes a fundamental connexion between arithmetic and algebra, arithmetical addition being made to depend upon algebraical multiplication, and a close bond is secured between the theories of discontinuous and continuous quantities. The multiplication of the two powers $x^a$, $x^b$, viz., $x^a \times x^b = x^{a+b}$ showed Euler that he could convert arithmetical addition into algebraical multiplication, and in the paper referred to he gives the complete formal solution of the main problems of the partition of numbers. He did not obtain general expressions for the coefficients which arose in the expansion of his generating functions, but he gave the actual values to a high order of the coefficients which arise from the generating functions corresponding to various conditions of partitionment. Other writers who have contributed to the solution of special problems are James Bernouilli, Boscovitch, Hindenburgh, Emerson, Woodhouse, Simpson, and Barlow. Problems of combination were generally undertaken as they became necessary for the advancement of some particular part of mathematical science: it was not recognized that the theory of combinations is in reality a science by itself, well worth studying for its own sake irrespective of applications to other parts of analysis. There was a total absence of orderly development, and until the first third of the 19th century had passed, Euler's classical paper remained alike the chief result and the only scientific method of combinatorial analysis.

In 1846 Jacobi studied the partitions of numbers by means of certain identities involving infinite series that are met with in the theory of Elliptic Functions. The method employed is essentially that of Euler. Interest in England was aroused, in the first instance, by De Morgan in 1846, who, in a letter to Henry Warburton, suggested that combinatorial analysis stood in great need of development, and alluded to the theory of partitions. Warburton, to some extent under the guidance of De Morgan, prosecuted researches by the aid of a new instrument, viz., the theory of finite differences. This was a distinct advance, and he was able to obtain expressions for the coefficients in partition series in some of the simplest cases (*Trans. Camb. Phil. Soc.*, 1849). This paper inspired a valuable paper by Sir John Herschel (*Phil. Trans. Roy. Soc.*, 1850), who, by introducing the idea and notation of the circulating function, was able to present results in advance of those of Warburton. The new idea involved a calculus of the imaginary roots of unity. Shortly afterwards, in 1855, the subject was attacked simultaneously by Cayley and Sylvester, and their combined efforts resulted in the practical solution of the problem that we have to-day. The former added the idea of the prime circulator, and the latter applied Cauchy's theory of Residues to the subject, and invented the arithmetical entity termed a "denumerant." The next distinct advance was made by Sylvester, Franklin, Durfee, and others, about the year 1882 (*Amer. Journ. Math.* vol. v.) by the employment of a graphical method. The results obtained were not only valuable in themselves, but also threw considerable light upon the theory of algebraic series. So far it will be seen that researches had for their object the discussion of the partition of numbers. Other branches of combinatorial analysis were, from any general point of view, absolutely neglected. In 1888 MacMahon investigated the general problem of distribution, of which the partition of a number is a particular case. He introduced the method of symmetric functions and the method of differential operators, applying both methods to the two important subdivisions, the theory of composition and the theory of partition. He introduced the notion of the separation of a partition, and extended all the results so as to include multipartite as well as unipartite numbers. He showed how to introduce zero and negative numbers, unipartite and multipartite, into the general theory; he extended Sylvester's graphical method to three dimensions; and finally, 1898, he invented the "Partition Analysis" and applied it to the solution of novel questions in arithmetic and algebra. An important paper by G. B. Mathews, which reduces the problem of compound partition to that of simple partition, should also be noticed. This is the problem which was known to Euler and his contemporaries as "the Problem of the Virgins," or "the Rule of Ceres"; it is only now, nearly 200 years later, that it has been solved.

*Fundamental Problem.*

The most important problem of combinatorial analysis is connected with the distribution of objects into classes. A number $n$ may be regarded as enumerating $n$ similar objects; it is then said to be unipartite. On the other hand, if the objects be not all similar they cannot be effectively enumerated by a single integer; we require a succession of integers. If the objects be $p$ in number of one kind, $q$ of a second kind, $r$ of a third, &c., the enumeration is given by the succession $pqr\ldots$ which is termed a multipartite number, and written

$$\overline{pqr\cdots},$$

where $p+q+r+\ldots=n$. If the order of magnitude of the numbers $p, q, r, \ldots$ is immaterial, it is usual to write them in descending order of magnitude, and the succession may then be termed a partition of the number $n$, and is written $(pqr\ldots)$. The succession of integers thus has a twofold signification: (i.) as a multipartite number it may enumerate objects of different kinds; (ii.) it may be viewed as a partitionment into separate parts of a unipartite number. We may say either that the objects are represented by the multipartite number $\overline{pqr\ldots}$, or that they are defined by the partition $(pqr\ldots)$ of the unipartite number $n$. Similarly the classes into which they are distributed may be $m$ in number all similar; or they may be $p_1$ of one kind, $q_1$ of a second, $r_1$ of a third, &c., where $p_1+q_1+r_1+\ldots=m$. We may thus denote the classes either by the multipartite numbers $\overline{p_1q_1r_1\cdots}$, or by the partition $(p_1q_1r_1\ldots)$ of the unipartite number $m$. The distributions to be considered are such that any number of objects may be in any one class subject to the restriction that no class is empty. Two cases arise. If the order of the objects in a particular class is immaterial the class is termed a parcel; if the order is material the class is termed a group. The distribution into parcels is alone considered here, and the main problem is the enumeration of the distributions of objects defined by the partition $(pqr\ldots)$ of the number $n$ into parcels defined by the partition $(p_1q_1r_1\ldots)$ of the number $m$. (See "Symmetric Functions and the Theory of Distributions," *Proc. London Mathematical Society*, vol. xix.) Three particular cases are of great importance. Case I. is the "one-to-one distribution," in which the number of parcels is equal to the number of objects, and one object is distributed in each parcel. Case II. is that in which the parcels are all different, being defined by the partition $(1111\ldots)$, con-

veniently written $(1^m)$; this is the theory of the compositions of unipartite and multipartite numbers. Case III. is that in which the parcels are all similar, being defined by the partition $(m)$; this is the theory of the partitions of unipartite and multipartite numbers. Previous to discussing these in detail, it is necessary to describe the method of symmetric functions which will be largely utilized.

Let $\alpha, \beta, \gamma, \ldots$ be the roots of the equation

$$x^n - a_1 x^{n-1} + a_2 x^{n-2} - \ldots = 0.$$

***The Distribution Function.*** The symmetric function $\Sigma\alpha^p\beta^q\gamma^r \ldots$, where $p+q+r+\ldots=n$ is, in the partition notation, written $(pqr\ldots)$. Let $A_{(pqr\ldots),(p_1q_1r_1\ldots)}$ denote the number of ways of distributing the $n$ objects defined by the partition $(pqr\ldots)$ into the $m$ parcels defined by the partition $(p_1q_1r_1\ldots)$. The expression

$$\Sigma A_{(pqr\ldots),(p_1q_1r_1\ldots)} \cdot (pqr\ldots),$$

where the numbers $p_1, q_1, r_1 \ldots$ are fixed and assumed to be in descending order of magnitude, the summation being for every partition $(pqr\ldots)$ of the number $n$, is defined to be the distribution function of the objects defined by $(pqr\ldots)$ into the parcels defined by $(p_1q_1r_1\ldots)$. It gives a complete enumeration of $n$ objects of whatever species into parcels of the given species.

1. *One-to-One Distribution. Parcels* m *in number* (*i.e.* m=n).—

***Case I.*** Let $h_s$ be the homogeneous product-sum of degree $s$ of the quantities $\alpha, \beta, \gamma, \ldots$ so that

$$(1-\alpha x \,.\, 1-\beta x \,.\, 1-\gamma x \,.\, \ldots)^{-1} = 1 + h_1x + h_2x^2 + h_3x^3 + \ldots$$
$$h_1 = \Sigma\alpha = (1)$$
$$h_2 = \Sigma\alpha^2 + \Sigma\alpha\beta = (2) + (1^2)$$
$$h_3 = \Sigma\alpha^3 + \Sigma\alpha^2\beta + \Sigma\alpha\beta\gamma = (3) + (21) + (1^3).$$
$$\cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot$$

Form the product $h_{p_1}h_{q_1}h_{r_1}\ldots$

Any term in $h_{p_1}$ may be regarded as derived from $p_1$ objects distributed into $p_1$ similar parcels, one object in each parcel, since the order of occurrence of the letters $\alpha, \beta, \gamma, \ldots$ in any term is immaterial. Moreover, every selection of $p_1$ letters from the letters in $\alpha^p\beta^q\gamma^r\ldots$ will occur in some term of $h_{p_1}$, every further selection of $q_1$ letters will occur in some term of $h_{q_1}$, and so on. Therefore in the product $h_{p_1}h_{q_1}h_{r_1}\ldots$ the term $\alpha^p\beta^q\gamma^r\ldots$, and therefore also the symmetric function $(pqr\ldots)$ will occur as many times as it is possible to distribute objects defined by $(pqr\ldots)$ into parcels defined by $(p_1q_1r_1\ldots)$ one object in each parcel. Hence

$$\Sigma A_{(pqr\ldots),(p_1q_1r_1\ldots)} \cdot (pqr\ldots) = h_{p_1}h_{q_1}h_{r_1}\ldots$$

This theorem is of algebraic importance; for consider the simple particular case of the distribution of objects (43) into parcels (52), and represent objects and parcels by small and capital letters respectively. One distribution is shown by the scheme

A A A A A B B
*a a a a b b b*

wherein an object denoted by a small letter is placed in a parcel denoted by the capital letter immediately above it. We may interchange small and capital letters and derive from it a distribution of objects (52) into parcels (43); viz. :—

A A A A B B B
*a a a a a b b*

The process is clearly of general application, and establishes a one-to-one correspondence between the distributions of objects $(pqr\ldots)$ into parcels $(p_1q_1r_1\ldots)$ and the distributions of objects $(p_1q_1r_1\ldots)$ into parcels $(pqr\ldots)$. It is in fact, in Case I., an intuitive observation that we may either consider an object placed in or attached to a parcel, or a parcel placed in or attached to an object. Analytically we have

*Theorem.*—"The coefficient of symmetric function $(pqr\ldots)$ in the development of the product $h_{p_1}h_{q_1}h_{r_1}\ldots$ is equal to the coefficient of symmetric function $(p_1q_1r_1\ldots)$ in the development of the product $h_ph_qh_r\ldots$."

The problem of Case I. may be considered when the distributions are subject to various restrictions. If the restriction be to the effect that an aggregate of similar parcels is not to contain more than one object of a kind, we have clearly to deal with the elementary symmetric functions $a_1, a_2, a_3, \ldots$ or $(1), (1^2), (1^3), \ldots$ in lieu of the quantities $h_1, h_2, h_3, \ldots$ The distribution function has then the value $a_{p_1}a_{q_1}a_{r_1}\ldots$ or $(1^{p_1})(1^{q_1})(1^{r_1})\ldots$, and by interchange of object and parcel we arrive at the well-known theorem of symmetry in symmetric functions, which states that the coefficient of symmetric function $(pqr\ldots)$ in the development of the product $a_{p_1}a_{q_1}a_{r_1}\ldots$ in a series of monomial symmetric functions, is equal to the coefficient of the function $(p_1q_1r_1\ldots)$ in the similar development of the product $a_pa_qa_r\ldots$

The general result of Case I. may be further analysed with important consequences.

Write
$$X_1 = (1)x_1,$$
$$X_2 = (2)x_2 + (1^2)x_1^2,$$
$$X_3 = (3)x_3 + (21)x_2x_1 + (1^3)x_1^3$$
$$\cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot$$

and generally $\quad X_s = \Sigma(\lambda\mu\nu\ldots)x_\lambda x_\mu x_\nu\ldots$

the summation being in regard to every partition of $s$. Consider the result of the multiplication—

$$X_{p_1}X_{q_1}X_{r_1}\ldots = \Sigma P x_{s_1}^{\sigma_1}x_{s_2}^{\sigma_2}x_{s_3}^{\sigma_3}\ldots$$

To determine the nature of the symmetric function P a few definitions are necessary.

*Definition I.*—Of a number $n$ take any partition $(\lambda_1\lambda_2\lambda_3\ldots\lambda_s)$ and separate it into component partitions thus :—

$$(\lambda_1\lambda_2)(\lambda_3\lambda_4\lambda_5)(\lambda_6)\ldots$$

in any manner. This may be termed a *separation* of the partition, the numbers occurring in the separation being identical with those which occur in the partition. In the theory of symmetric functions the separation denotes the product of symmetric functions—

$$\Sigma\alpha^{\lambda_1}\beta^{\lambda_2}\Sigma\alpha^{\lambda_3}\beta^{\lambda_4}\gamma^{\lambda_5}\Sigma\alpha^{\lambda_6}\ldots$$

The portions $(\lambda_1\lambda_2)$, $(\lambda_3\lambda_4\lambda_5)$, $(\lambda_6)$, . . are termed *separates*, and if $\lambda_1+\lambda_2=p_1$, $\lambda_3+\lambda_4+\lambda_5=q_1$, $\lambda_6=r_1, \ldots$ be in descending order of magnitude, the usual arrangement, the separation is said to have a *species* denoted by the partition $(p_1q_1r_1\ldots)$ of the number $n$.

*Definition II.*—If in any distribution of $n$ objects into $n$ parcels (one object in each parcel), we write down a number $\xi$, whenever we observe $\xi$ similar objects in similar parcels we will obtain a succession of numbers $\xi_1, \xi_2, \xi_3, \ldots$, where $(\xi_1\xi_2\xi_3\ldots)$ is some partition of $n$. The distribution is then said to have a *specification* denoted by the partition $(\xi_1\xi_2\xi_3\ldots)$.

Now it is clear that P consists of an aggregate of terms, each of which, to a numerical factor *près*, is a separation of the partition $(s_1^{\sigma_1}s_2^{\sigma_2}s_3^{\sigma_3}\ldots)$ of species $(p_1q_1r_1\ldots)$. Further, P is the distribution function of objects into parcels denoted by $(p_1q_1r_1\ldots)$, subject to the restriction that the distributions have each of them the specification denoted by the partition $(s_1^{\sigma_1}s_2^{\sigma_2}s_3^{\sigma_3}\ldots)$. Employing a more general notation we may write

$$X_{p_1}^{\pi_1}X_{p_2}^{\pi_2}X_{p_3}^{\pi_3}\ldots = \Sigma P x_{s_1}^{\sigma_1}x_{s_2}^{\sigma_2}x_{s_3}^{\sigma_3}\ldots$$

and then P is the distribution function of objects into parcels $(p_1^{\pi_1}p_2^{\pi_2}p_3^{\pi_3}\ldots)$, the distributions being such as have the specification $(s_1^{\sigma_1}s_2^{\sigma_2}s_3^{\sigma_3}\ldots)$. Multiplying out P so as to exhibit it as a sum of monomials, we get a result—

$$X_{p_1}^{\pi_1}X_{p_2}^{\pi_2}X_{p_3}^{\pi_3}\ldots = \Sigma\Sigma\theta(\lambda_1^{l_1}\lambda_2^{l_2}\lambda_3^{l_3}\ldots)x_{s_1}^{\sigma_1}x_{s_2}^{\sigma_2}x_{s_3}^{\sigma_3}\ldots$$

indicating that for distributions of specification $(s_1^{\sigma_1}s_2^{\sigma_2}s_3^{\sigma_3}\ldots)$ there are $\theta$ ways of distributing $n$ objects denoted by $(\lambda_1^{l_1}\lambda_2^{l_2}\lambda_3^{l_3}\ldots)$ amongst $n$ parcels denoted by $(p_1^{\pi_1}p_2^{\pi_2}p_3^{\pi_3}\ldots)$, one object in each parcel. Now observe that as before we may interchange parcel and object, and that this operation leaves the specification of the distributions unchanged. Hence the number of distributions must be the same, and if

$$X_{p_1}^{\pi_1}X_{p_2}^{\pi_2}X_{p_3}^{\pi_3}\ldots = \ldots + \theta(\lambda_1^{l_1}\lambda_2^{l_2}\lambda_3^{l_3}\ldots)x_{s_1}^{\sigma_1}x_{s_2}^{\sigma_2}x_{s_3}^{\sigma_3}\ldots + \ldots$$

then also

$$X_{\lambda_1}^{l_1}X_{\lambda_2}^{l_2}X_{\lambda_3}^{l_3}\ldots = \ldots + \theta(p_1^{\pi_1}p_2^{\pi_2}p_3^{\pi_3}\ldots)x_{s_1}^{\sigma_1}x_{s_2}^{\sigma_2}x_{s_3}^{\sigma_3}\ldots + \ldots$$

This extensive theorem of algebraic reciprocity includes many known theorems of symmetry in the theory of Symmetric Functions.

The whole of the theory has been extended to include symmetric functions symbolized by partitions which contain as well zero and negative parts.

2. *The Compositions of Multipartite Numbers. Parcels denoted by* $(1^m)$.—There are here no similarities between the parcels.

*Case II.* Let $(\pi_1\ \pi_2\ \pi_3 \dots)$ be a partition of $m$

$(p_1^{\pi_1}p_2^{\pi_2}p_3^{\pi_3}\dots)$ a partition of $n$.

Of the whole number of distributions of the $n$ objects, there will be a certain number such that $\pi_1$ parcels each contain $p_1$ objects, and in general $\pi_s$ parcels each contain $p_s$ objects where $s=1, 2, 3, \dots$. Consider the product $h_{p_1}^{\pi_1}h_{p_2}^{\pi_2}h_{p_3}^{\pi_3}\dots$ which can be permuted in $\frac{m!}{\pi_1!\pi_2!\pi_3!\dots}$ ways. For each of these ways $h_{p_1}^{\pi_1}h_{p_2}^{\pi_2}h_{p_3}^{\pi_3}$.. will be a distribution function for distributions of the specified type. Hence, regarding all the permutations, the distribution function is

$$\frac{m!}{\pi_1!\pi_2!\pi_3!\dots}h_{p_1}^{\pi_1}h_{p_2}^{\pi_2}h_{p_3}^{\pi_3}\dots$$

and regarding, as well, all the partitions of $n$ into exactly $m$ parts, the desired distribution function is

$$\Sigma\frac{m!}{\pi_1!\pi_2!\pi_3!\dots}h_{p_1}^{\pi_1}h_{p_2}^{\pi_2}h_{p_3}^{\pi_3}\dots \qquad [\Sigma\pi=m,\ \Sigma\pi p=n],$$

that is, it is the coefficient of $x^n$ in $(h_1x+h_2x^2+h_3x^3+\dots)^m$. The value of $A_{(p_1^{\pi_1}p_2^{\pi_2}p_3^{\pi_3}\dots),\ (1^m)}$ is the coefficient of $(p_1^{\pi_1}p_2^{\pi_2}p_3^{\pi_3}\dots)x^n$ in the development of the above expression, and is easily shown to have the value

$$\binom{p_1+m-1}{p_1}^{\pi_1}\binom{p_2+m-1}{p_2}^{\pi_2}\binom{p_3+m-1}{p_3}^{\pi_3}\dots$$
$$-\binom{m}{1}\binom{p_1+m-2}{p_1}^{\pi_1}\binom{p_2+m-2}{p_2}^{\pi_2}\binom{p_3+m-2}{p_3}^{\pi_3}\dots$$
$$+\binom{m}{2}\binom{p_1+m-3}{p_1}^{\pi_1}\binom{p_2+m-3}{p_2}^{\pi_2}\binom{p_3+m-3}{p_3}^{\pi_3}\dots$$
$$-\ \dots \text{to } m \text{ terms.}$$

Observe that when $p_1=p_2=p_3=\dots=\pi_1=\pi_2=\pi_3=\dots=1$ this expression reduces to the $m$th divided difference of $0^n$. The expression gives the compositions of the multipartite number $\overline{p_1^{\pi_1}p_2^{\pi_2}p_3^{\pi_3}\dots}$ into $m$ parts. Summing the distribution function from $m=1$ to $m=\infty$ and putting $x=1$, as we may without detriment, we find that the totality of the compositions is given by $\frac{h_1+h_2+h_3+\dots}{1-h_1-h_2-h_3-\dots}$ which may be given the form $\frac{a_1-a_2+a_3-\dots}{1-2(a_1-a_2+a_3-\dots)}$. Adding $\frac{1}{2}$ we bring this to the still more convenient form

$$\frac{1}{2}\frac{1}{1-2(a_1-a_2+a_3-\dots)}.$$

Let $F(p_1^{\pi_1}p_2^{\pi_2}p_3^{\pi_3}\dots)$ denote the total number of compositions of the multipartite $\overline{p_1^{\pi_1}p_2^{\pi_2}p_3^{\pi_3}\dots}$. Then $\frac{1}{2}\frac{1}{1-2a}=\frac{1}{2}+\Sigma F(p)a^p$, and thence $F(p)=2^{p-1}$. Again $\frac{1}{2}\frac{1}{1-2(a+\beta-a\beta)}=\frac{1}{2}+\Sigma F(p_1p_2)a^{p_1}\beta^{p_2}$, and expanding the left-hand side we easily find

$$F(p_1p_2)=2^{p_1+p_2-1}\frac{(p_1+p_2)!}{0!\,p_1!\,p_2!}-2^{p_1+p_2-2}\frac{(p_1+p_2-1)!}{1!\,(p_1-1)!\,(p_2-1)!}$$
$$+2^{p_1+p_2-3}\frac{(p_1+p_2-2)!}{2!\,(p_1-2)!\,(p_2-2)!}-\dots.$$

We have found that the number of compositions of the multipartite $\overline{p_1p_2p_3\dots p_s}$ is equal to the coefficient of symmetric function $(p_1p_2p_3\dots p_s)$ *or* of the single term $a_1^{p_1}a_2^{p_2}a_3^{p_3}\dots a_s^{p_s}$ in the development according to ascending powers of the algebraic fraction

$$\frac{1}{2}\cdot\frac{1}{1-2(\Sigma a_1-\Sigma a_1a_2+\Sigma a_1a_2a_3-\dots+(-)^{s+1}a_1a_2a_3\dots a_s}.$$

This result can be thrown into another suggestive form, for it can be proved that that portion of the expanded fraction

$$\frac{1}{2}\cdot\frac{1}{\{1-t_1(2a_1+a_2+\dots+a_s)\}\{1-t_2(2a_1+2a_2+\dots+a_s)\}\dots\{1-t_s(2a_1+2a_2+\dots+2a_s)\}},$$

which is composed entirely of powers of

$$t_1a_1,\ t_2a_2,\ t_3a_3,\ \dots\ t_sa_s$$

has the expression

$$\frac{1}{2}\cdot\frac{1}{1-2(\Sigma t_1a_1-\Sigma t_1t_2a_1a_2+\Sigma t_1t_2t_3a_1a_2a_3-\dots+(-)^{s+1}t_1t_2\dots t_sa_1a_2\dots a_s)},$$

and therefore the coefficient of $a_1^{p_1}a_2^{p_1}\dots a_s^{p_s}$ in the latter fraction, when $t_1$, $t_2$, &c., are put equal to unity, is equal to the coefficient of the same term in the product

$$\frac{1}{2}(2a_1+a_2+\dots+a_s)^{p_1}(2a_1+2a_2+\dots+a_s)^{p_2}\dots(2a_1+2a_2+\dots+2a_s)^{p_s}.$$

This result gives a direct connexion between the number of compositions and the permutations of the letters in the product $a_1^{p_1}a_2^{p_2}\dots a_s^{p_s}$. Selecting any permutation, suppose that the letter $a_r$ occurs $q_r$ times in the last $p_r+p_{r+1}+\dots+p_s$ places of the permutation; the coefficient in question may be represented by $\frac{1}{2}\Sigma 2^{q_1+q_2+\dots+q_s}$, the summation being for every permutation, and since $q_1=p_1$ this may be written

$$2^{p_1-1}\Sigma 2^{q_2+q_3+\dots+q_s}.$$

*Ex. Gr.*—For the bipartite $\overline{22}$, $p_1=p_2=2$, and we have the following scheme:—

$$\begin{array}{cc|cc r}
a_1 & a_1 & a_2 & a_2 & q_2=2 \\
a_1 & a_2 & a_1 & a_2 & =1 \\
a_1 & a_2 & a_2 & a_1 & =1 \\
a_2 & a_1 & a_1 & a_2 & =1 \\
a_2 & a_1 & a_2 & a_1 & =1 \\
a_2 & a_2 & a_1 & a_1 & =0
\end{array}$$

Hence $F(22)=2(2^2+2+2+2+2+2^0)=26.$

We may regard the fraction

$$\frac{1}{\frac{1}{2}\cdot\{1-t_1(2a_1+a_2+\dots+a_s)\}\{1-t_2(2a_1+2a_2+\dots+a_s)\}\dots\{1-t_s(2a_1+2a_2+\dots+2a_s)\}}$$

as a redundant generating function, the enumeration of the compositions being given by the coefficient of

$$(t_1a_1)^{p_1}(t_2a_2)^{p_2}\dots(t_sa_s)^{p_s}.$$

The transformation of the pure generating function into a factorized redundant form supplies the key to the solution of a large number of questions in the theory of ordinary permutations, as will be seen later.

[The transformation of the last section involves a comprehensive theory of Permutations, which it is convenient to discuss shortly here. ***The Theory of Permutations.***

If $X_1, X_2, X_3, \dots X_n$ be linear functions given by the matricular relation

$$(X_1, X_2, \dots X_n)=\left(\begin{array}{cccc} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \cdot & \cdot & \dots & \cdot \\ \cdot & \cdot & \dots & \cdot \\ a_{n1} & a_{n2} & \dots & a_{nn}\end{array}\right)(x_1, x_2, \dots x_n)$$

that portion of the algebraic fraction,

$$\frac{1}{(1-s_1X_1)(1-s_2X_2)\dots(1-s_nX_n)},$$

which is a function of the products $s_1x_1, s_2x_2, s_3x_3 \dots s_nx_n$ only is

$$\frac{1}{|(1-a_{11}s_1x_1)(1-a_{22}s_2x_2)(1-a_{33}s_3x_3)\dots(1-a_{nn}s_nx_n)|}$$

where the denominator is in a symbolic form and denotes on expansion

$$1-\Sigma|a_{11}|s_1x_1+\Sigma|a_{11}a_{22}|s_1s_2x_1x_2-\dots+(-)^n|a_{11}a_{22}a_{33}\dots a_{nn}|s_1s_2\dots s_nx_1x_2\dots x_n,$$

where $|a_{11}|, |a_{11}a_{22}|, \dots |a_{11}a_{22}\dots a_{nn}|$ denote the several co-axial minors of the determinant

$$|a_{11}a_{22}\dots a_{nn}|$$

of the matrix. (For the proof of this theorem see MacMahon, "A certain Class of Generating Functions in the Theory of Numbers," *Phil. Trans. R. S.* vol. clxxxv. A, 1894). It follows that the coefficient of

$$x_1^{\xi_1}x_2^{\xi_2}\dots x_n^{\xi_n}$$

in the product

$$(a_{11}x_1+a_{12}x_2+\dots+a_{1n}x_n)^{\xi_1}(a_{21}x_1+a_{22}x_2+\dots+a_{2n}x_n)^{\xi_2}\dots(a_{n1}x_1+a_{n2}x_2+\dots+a_{nn}x_n)^{\xi_n}$$

is equal to the coefficient of the same term in the expansion ascending-wise of the fraction

$$\frac{1}{1-\Sigma|a_{11}|x_1+\Sigma|a_{11}a_{22}|x_1x_2-\dots+(-)^n|a_{11}a_{22}\dots a_{nn}|x_1x_2\dots x_n}.$$

If the elements of the determinant be all of them equal to unity, we obtain the functions which enumerate the unrestricted permutations of the letters in

$$x_1^{\xi_1}x_2^{\xi_2}\dots x_n^{\xi_n},$$

viz.,

$$(x_1+x_2+\dots+x_n)^{\xi_1+\xi_2+\dots+\xi_n}$$

and

$$\frac{1}{1-(x_1+x_2+\dots+x_n)}.$$

Suppose that we wish to find the generating function for the enumeration of those permutations of the letters in $x_1^{\xi_1}x_2^{\xi_2}\ldots x_n^{\xi_n}$ which are such that no letter $x_s$ is in a position originally occupied by an $x_s$ for all values of $s$. This is a generalization of the "Problème des rencontres" or of "derangements." We have merely to put

$$a_{11}=a_{22}=a_{33}=\ldots=a_{nn}=0$$

and the remaining elements equal to unity. The generating product is

$$(x_2+x_3+\ldots+x_n)^{\xi_1}(x_1+x_3+\ldots+x_n)^{\xi_2}\ldots(x_1+x_2+\ldots+x_{n-1})^{\xi_n},$$

and to obtain the condensed form we have to evaluate the co-axial minors of the invertebrate determinant—

$$\begin{vmatrix} 0 & 1 & 1 & \ldots & 1 \\ 1 & 0 & 1 & \ldots & 1 \\ 1 & 1 & 0 & \ldots & 1 \\ \cdot & \cdot & \cdot & \ldots & \cdot \\ 1 & 1 & 1 & \ldots & 0 \end{vmatrix}$$

The minors of the 1st, 2nd, 3rd ... $n$th orders have respectively the values

$$\begin{array}{c} 0 \\ -1 \\ +2 \\ \vdots \\ (-)^{n-1}(n-1), \end{array}$$

therefore the generating function is

$$\frac{1}{1-\Sigma x_1x_2-2\Sigma x_1x_2x_3-\ldots-s\Sigma x_1x_2\ldots x_{s+1}-\ldots-(n-1)x_1x_2\ldots x_n}$$

or writing

$$(x-x_1)(x-x_2)\ldots(x-x_n)=x^n-a_1x^{n-1}+a_2x^{n-2}-\ldots$$

this is

$$\frac{1}{1-a_2-2a_3-3a_4-\ldots-(n-1)a_n}$$

Again, consider the general problem of "derangements." We have to find the number of permutations such that exactly $m$ of the letters are in places they originally occupied. We have the particular redundant product

$$(ax_1+x_2+\ldots+x_n)^{\xi_1}(x_1+ax_2+\ldots+x_n)^{\xi_2}\ldots(x_1+x_2+\ldots+ax_n)^{\xi_n},$$

in which the sought number is the coefficient of $a^m x_1^{\xi_1}x_2^{\xi_2}\ldots x_n^{\xi_n}$. The true generating function is derived from the determinant

$$\begin{vmatrix} a & 1 & 1 & 1 & . & . & . \\ 1 & a & 1 & 1 & . & . & . \\ 1 & 1 & a & 1 & . & . & . \\ 1 & 1 & 1 & a & . & . & . \\ . & . & . & . & & & \\ . & . & . & . & & & \end{vmatrix}$$

and has the form

$$\frac{1}{1-a\Sigma x_1+(a-1)(a+1)\Sigma x_1x_2-\ldots+(-)^n(a-1)^{n-1}(a+n-1)x_1x_2\ldots x_n}.$$

It is clear that a large class of problems in permutations can be solved in a similar manner, viz., by giving special values to the elements of the determinant of the matrix. The redundant product leads uniquely to the real generating function, but the latter has generally more than one representation as a redundant product, in the cases in which it is representable at all. For the existence of a redundant form, the coefficients of $x_1$, $x_2$, ... $x_1x_2$, ... in the denominator of the real generating function must satisfy $2^n-n^2+n-2$ conditions, and assuming this to be the case, a redundant form can be constructed which involves $n-1$ undetermined quantities. We are thus able to pass from any particular redundant generating function to one equivalent to it, but involving $n-1$ undetermined quantities. Assuming these quantities at pleasure we obtain a number of different algebraic products, each of which may have its own meaning in arithmetic, and thus the number of arithmetical correspondences obtainable is subject to no finite limit (cf. MacMahon, *loc. cit.*, pp. 125 *et seq.*)]

3. *The Theory of Partitions. Parcels defined by* (m).—When an **Case III.** ordinary unipartite number $n$ is broken up into other numbers, and the order of occurrence of the numbers is immaterial, the collection of numbers is termed a partition of the number $n$. It is usual to arrange the numbers comprised in the collection, termed the parts of the partition, in descending order of magnitude, and to indicate repetitions of the same part by the use of exponents. Thus (32111), a partition of 8, is written ($321^3$). Euler's pioneering work in the subject rests on the observation that the algebraic multiplication

$$x^a\times x^b\times x^c\times\ldots=x^{a+b+c+}\ldots$$

is equivalent to the arithmetical addition of the exponents $a$, $b$, $c$, ... He showed that the number of ways of composing $n$ with $p$ integers drawn from the series $a$, $b$, $c$, ..., repeated or not, is equal to the coefficient of $\zeta^p x^n$ in the ascending expansion of the fraction

$$\frac{1}{1-\zeta x^a\,.\,1-\zeta x^b\,.\,1-\zeta x^c\,.\,\ldots},$$

which he termed the generating function of the partitions in question.

If the partitions are to be composed of $p$, or fewer parts, it is merely necessary to multiply this fraction by $\frac{1}{1-\zeta}$. Similarly, if the parts are to be unrepeated, the generating function is the algebraic product

$$(1+\zeta x^a)(1+\zeta x^b)(1+\zeta x^c)\ldots,$$

if each part may occur at most twice,

$$(1+\zeta x^a+\zeta^2x^{2a})(1+\zeta x^b+\zeta^2x^{2b})(1+\zeta x^c+\zeta^2x^{2c})\ldots,$$

and generally if each part may occur at most $k-1$ times it is

$$\frac{1-\zeta^kx^{ka}}{1-\zeta x^a}\cdot\frac{1-\zeta^kx^{kb}}{1-\zeta x^b}\cdot\frac{1-\zeta^kx^{kc}}{1-\zeta x^c}\cdot\ldots$$

It is thus easy to form generating functions for the partitions of numbers into parts subject to various restrictions. If there be no restriction in regard to the numbers of the parts, the generating function is

$$\frac{1}{1-x^a\,.\,1-x^b\,.\,1-x^c\,.\,\ldots}$$

and the problems of finding the partitions of a number $n$, and of determining their number, are the same as those of solving and enumerating the solutions of the indeterminate equation in positive integers

$$ax+by+cz+\ldots=n.$$

Euler considered also the question of enumerating the solutions of the indeterminate simultaneous equation in positive integers

$$\begin{array}{l} ax+by+cz+\ldots=n \\ a'x+b'y+c'z+\ldots=n' \\ a''x+b''y+c''z+\ldots=n'' \\ \cdot\quad\cdot\quad\cdot\quad\cdot \end{array}$$

which was called by him and those of his time the "Problem of the Virgins." The enumeration is given by the coefficient of $x^ny^{n'}z^{n''}\ldots$ in the expansion of the fraction

$$\frac{1}{(1-x^ay^bz^c\ldots)(1-x^{a'}y^{b'}z^{c'}\ldots)(1-x^{a''}y^{b''}z^{c''}\ldots)\ldots}$$

which enumerates the partitions of the multipartite number $\overline{nn'n''\ldots}$ into the parts

$$\overline{abc\ldots},\ \overline{a'b'c'\ldots},\ \overline{a''b''c''}\ldots\ldots$$

Sylvester has determined an analytical expression for the coefficient of $x^n$ in the expansion of

$$\frac{1}{(1-x^a)(1-x^b)\ldots(1-x^l)}.$$

To explain this we have two lemmas:—

*Lemma* 1.—The coefficient of $\frac{1}{x}$, *i.e.*, after Cauchy, the residue in the ascending expansion of $(1-e^x)^{-i}$ is $-1$. For when $i$ is unity, it is obviously the case, and

$$\begin{aligned}(1-e^x)^{-i-1}&=(1-e^x)^{-i}+e^x(1-e^x)^{-i-1}\\&=(1-e^x)^{-i}+\frac{d}{dx}(1-e^x)^{-i}\,.\,\frac{1}{i}.\end{aligned}$$

Here the residue of $\frac{d}{dx}(1-e^x)^{-i}\frac{1}{i}$ is zero, and therefore the residue of $(1-e^x)^{-i}$, is unchanged when $i$ is increased by unity, and is, therefore, always $-1$ for all values of $i$.

*Lemma* 2.—The constant term in any proper algebraical fraction developed in ascending powers of its variable is the same as the residue, with changed sign, of the sum of the fractions obtained by substituting in the given fraction, in lieu of the variable, its exponential multiplied in succession by each of its values (zero excepted, if there be such), which makes the given fraction infinite. For write the proper algebraical fraction

$$Fx=\Sigma\Sigma\frac{c_{\lambda,\mu}}{(a_\mu-x)^\lambda}+\Sigma\frac{\gamma_\lambda}{x^\lambda}.$$

The constant term is $\Sigma\Sigma \dfrac{c_{\lambda,\mu}}{\alpha_\mu^\lambda}$.

Let $\alpha_\nu$ be a value of $x$ which makes the fraction infinite. The residue of

$$\Sigma\Sigma\Sigma \frac{c_{\lambda,\mu}}{(\alpha_\mu - \alpha_\nu e^x)^\lambda} + \Sigma \frac{\gamma_\lambda}{\alpha_\nu^\lambda e^{\lambda x}}$$

is equal to the residue of

$$\Sigma\Sigma\Sigma \frac{c_{\lambda,\mu}}{(\alpha_\mu - \alpha_\nu e^x)^\lambda},$$

and when $\nu = \mu$, the residue vanishes so that we have to consider

$$\Sigma\Sigma \frac{c_{\lambda,\mu}}{\alpha_\mu^\lambda (1-e^x)^\lambda},$$

and the residue of this is, by the first lemma,

$$-\Sigma\Sigma \frac{c_{\lambda,\mu}}{\alpha_\mu^\lambda},$$

which proves the lemma.

Take $Fx = \dfrac{1}{x^n(1-x^a)(1-x^b)\dots(1-x^l)} = \dfrac{fx}{x^n}$, since the sought number is its constant term.

Let $\rho$ be a root of unity which makes $fx$ infinite when substituted for $x$. The function of which we have to take the residue is

$$\Sigma \rho^{-n} e^{nx} f(\rho e^{-x})$$

$$= \Sigma \frac{\rho^{-n} e^{nx}}{(1-\rho^a e^{-ax})(1-\rho^b e^{-bx})\dots(1-\rho^l e^{-lx})}.$$

We may divide the calculation up into sections by considering separately that portion of the summation which involves the primitive $q$th roots of unity, $q$ being a divisor of one of the numbers $a, b, \dots l$. Thus the $q$th *wave* is

$$\Sigma \frac{\rho_q^{-n} e^{nx}}{(1-\rho_q^a e^{-ax})(1-\rho_q^b e^{-bx})\dots(1-\rho_q^l e^{-lx})}$$

which, putting $\dfrac{1}{\rho_q}$ for $\rho_q$ and $\nu = n + \frac{1}{2}(a+b+\dots+l)$, may be written

$$\Sigma \frac{\rho_q^\nu e^{\nu x}}{\left(\rho_q^{\frac{1}{2}a} e^{\frac{1}{2}ax} - \rho_q^{-\frac{1}{2}a} e^{-\frac{1}{2}ax}\right)\left(\rho_q^{\frac{1}{2}b} e^{\frac{1}{2}bx} - \rho_q^{-\frac{1}{2}b} e^{-\frac{1}{2}bx}\right)\dots\left(\rho_q^{\frac{1}{2}l} e^{\frac{1}{2}lx} - \rho_q^{-\frac{1}{2}l} e^{-\frac{1}{2}lx}\right)},$$

and the calculation in simple cases is practicable.

Thus Sylvester finds for the coefficient of $x^n$ in

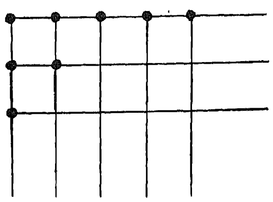
$$\frac{1}{1-x \,.\, 1-x^2 \,.\, 1-x^3}$$

the expression $\quad \dfrac{\nu^2}{12} - \dfrac{7}{72} - \dfrac{1}{8}(-)^\nu + \dfrac{1}{9}(\rho_3^\nu + \rho_3^{-\nu})$

where $\nu = n + 3$.

**Sylvester's graphical Method.**

Sylvester, Franklin, Durfee, Ely, and others, have evolved a Constructive Theory of Partitions, the object of which is the contemplation of the partitions themselves, and the evolution of their properties from a study of their inherent characters. It is concerned for the most part with the partition of a number into parts drawn from the natural series of numbers 1, 2, 3 .... Any partition, say (521) of the number 8, is represented by nodes placed in order at the points of a rectangular lattice,



when the partition is given by the enumeration of the nodes by lines. If we enumerate by columns we obtain another partition of 8, viz., $(321^3)$, which is termed the conjugate of the former. The fact of conjugacy was first pointed out by Ferrers. If the original partition is one of a number $n$ in $i$ parts, of which the largest is $j$, the conjugate is one into $j$ parts, of which the largest is $i$, and we obtain the theorem:—"The number of partitions of any number into $\begin{matrix}i \text{ parts} \\ i \text{ parts or fewer}\end{matrix}$ and having the largest part $\begin{matrix}\text{equal to } j \\ \text{equal or less than } j,\end{matrix}$ remains the same when the numbers $i$ and $j$ are interchanged."

The study of this representation on a lattice (termed by Sylvester the "graph") yields many theorems similar to that just given, and, moreover, throws considerable light upon the expansion of algebraic series.

The theorem of reciprocity just established shows that the number of partitions of $n$ into $j$ parts or fewer, is the same as the number of ways of composing $n$ with the integers 1, 2, 3, .. $j$. Hence we can expand $\dfrac{1}{1-a \,.\, 1-ax \,.\, 1-ax^2 \,.\, 1-ax^3 \dots \textit{ad inf.}}$ in ascending powers of $a$; for the coefficient of $a^j x^n$ in the expansion is the number of ways of composing $n$ with $j$ or fewer parts, and this we have seen in the coefficients of $x^n$ in the ascending expansion of $\dfrac{1}{1-x \,.\, 1-x^2 \dots 1-x^j}$. Therefore

$$\frac{1}{1-a \,.\, 1-ax \,.\, 1-ax^2 \dots} = 1 + \frac{a}{1-x} + \frac{a^2}{1-x \,.\, 1-x^2} + \dots$$
$$+ \frac{a^j}{1-x \,.\, 1-x^2 \dots 1-x^j} + \dots$$

The coefficient of $a^j x^n$ in the expansion of

$$\frac{1}{1-a \,.\, 1-ax \,.\, 1-ax^2 \,.\dots 1-ax^i}$$

denotes the number of ways of composing $n$ with $j$ or fewer parts, none of which are greater than $i$. The expansion is known to be

$$\Sigma \frac{1-x^{j+1} \,.\, 1-x^{j+2} \dots 1-x^{j+i}}{1-x \,.\, 1-x^2 \dots 1-x^i} a^j.$$

It has been established by the constructive method by F. Franklin (*Amer. Jour. of Math.* vol. v. p. 254), and shows that the generating function for the partitions in question is

$$\frac{1-x^{j+1} \,.\, 1-x^{j+2} \dots 1-x^{j+i}}{1-x \,.\, 1-x^2 \dots 1-x^i},$$

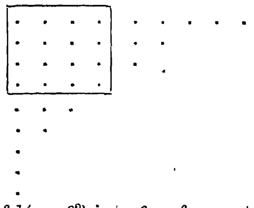
which, observe, is unaltered by interchange of $i$ and $j$.

Franklin has also similarly established the identity of Euler—

$$(1-x)(1-x^2)(1-x^3)\dots \textit{ad inf.} = \sum_{j=+\infty}^{j=-\infty} (-)^j x^{\frac{1}{2}(3j^2+j)},$$

known as the "pentagonal number theorem," which on interpretation shows that the number of ways of partitioning $n$ into an even number of unrepeated parts is equal to that into an uneven number, except when $n$ has the pentagonal form $\frac{1}{2}(3j^2+j)$, $j$ positive or negative, when the difference between the numbers of the partitions is $(-)^j$.

To illustrate an important dissection of the graph we will consider those graphs which read the same by columns as by lines; these are called self-conjugate. Such a graph may be obviously dissected into a square, containing say $\theta^2$ nodes, and into two graphs, one lateral and one subjacent, the latter being the conjugate of the former. The former graph is limited to contain not more than $\theta$ parts, but is subject to no other condition. Hence the number of self-conjugate partitions of $n$ which are associated with a square of $\theta^2$ nodes, is clearly equal to the number of partitions of $\frac{1}{2}(n-\theta^2)$ into $\theta$ or few parts, *i.e.*, it is the coefficient of $x^{\frac{1}{2}(n-\theta^2)}$ in



$$\frac{1}{1-x \,.\, 1-x^2 \,.\, 1-x^3 \dots 1-x^\theta},$$

or of $x^n$ in $\quad \dfrac{x^{\theta^2}}{1-x^2 \,.\, 1-x^4 \,.\, 1-x^6 \dots 1-x^{2\theta}},$

and the whole generating function is

$$1 + \sum_{\theta=1}^{\theta=\infty} \frac{x^{\theta^2}}{1-x^2 \,.\, 1-x^4 \,.\, 1-x^6 \dots 1-x^{2\theta}}.$$

Now the graph is also composed of $\theta$ angles of nodes, each angle containing an uneven number of nodes; hence the partition is transformable into one containing $\theta$ unequal uneven numbers. In the case depicted this partition is (17, 9, 5, 1). Hence the number of the partitions based upon a square of $\theta^2$ nodes is the coefficient

coverer is often added as 1895 C (Perrine). Comets are definitely designated as 1899 I., 1899 II., 1899 III., &c., the numerals I., II., III., &c., indicating the order in which the various comets of the year pass their perihelion points (comet 1895 C = comet 1895 IV.). Periodic comets are also often called by the name of their discoverers, as Winnecke's comet (= 1892 IV., or 1886 VI.); or, again, the name of the first discoverer is sometimes replaced by the name of an astronomer who has made extended calculations upon the comet's orbit. Comet 1819 IV. is no longer Pons's comet, but Encke's, for this reason.

In the following table the first column contains a current number for reference; the second, the date A.D. (new style after 1580), in Paris mean time, and the number of the comet in its year, as I., II., &c.; the third, the argument of perihelion or, $\pi - \Omega$, where $\pi$ = longitude of perihelion; the fourth, longitude of the ascending node of the comet's orbit, $\Omega$; the fifth, the inclination of the orbit; the sixth, the perihelion distance of the comet in terms of the earth's mean distance = 1·000; the seventh, the comet's semi-major axis; the eighth, the periodic time in years; the ninth, the eccentricity; and the tenth, the name by which the comet is commonly known. The data in this form record every appearance of known periodic comets, whose periods are less than one hundred years. The data for Nos. 1–111 are from Winlock's Tables in *Publ. Ast. Soc. Pac.* vol. viii. p. 141; the data for Nos. 112–122 have been furnished by C. D. Perrine.

*Table of the Approximate Elements at each Return of all known Periodic Comets whose Periods are less than One Hundred Years.*

| No. | Time of Perihelion Passage. T. | $\pi - \Omega$ $\omega$ | Longitude Ascending Node. $\Omega$ | Inclination. $i$ | Perihelion Distance. $q$ | Semi-Major Axis. $a$ | Period. $U$ | Eccentricity. $e$ | Comet of |
|---|---|---|---|---|---|---|---|---|---|
| | A.D. O.S. | ° | ° | ° | | | | | |
| 1 | 1378, Nov. 8·8 | 107·8 | 47·3 | 162·1 | 0·583 | ... | ... | ... | Halley. |
| 2 | 1456, June 8·2 | 104·8 | 43·8 | 162·4 | 0·580 | 17·97 | 75·0 | 0·968 | ,, |
| 3 | 1531, Aug. 25·8 | 104·3 | 45·5 | 163·0 | 0·580 | 17·79 | 75·0 | 0·967 | ,, |
| | N.S. | | | | | | | | |
| 4 | 1607, Oct. 26·7 | 107·0 | 48·7 | 162·8 | 0·588 | 17·87 | 75·5 | 0·967 | ,, |
| 5 | 1678, Aug. 18·3 | 159·5 | 163·3 | 2·9 | 1·145 | 3·070 | 5·38 | 0·627 | Lahire. |
| 6 | 1682, Sept. 14·8 | 109·3 | 51·2 | 162·3 | 0·583 | 18·17 | 77·5 | 0·968 | Halley. |
| 7 | 1743 I., Jan. 8·2 | 6·4 | 86·9 | 1 9 | 0·862 | 3·10 | 6·73 | 0·721 | Grischow. |
| 8 | 1759 I., Mar. 12·6 | 110·6 | 53·8 | 162·4 | 0·585 | 18·09 | 76·9 | 0·968 | Halley. |
| 9 | 1766 II., April 27·0 | 177·0 | 74·2 | 8·0 | 0·399 | 2·934 | 5·025 | 0·864 | Helfenzrieder. |
| 10 | 1770 I., Aug. 13·5 | 224·3 | 132 0 | 1·6 | 0 674 | 3·163 | 5·626 | 0·786 | Messier. |
| 11 | 1772, Feb. 16·7 | 213·0 | 257·3 | 17·1 | 0·986 | 3·58 | 6·77 | 0·725 | Biela. |
| 12 | 1783, Nov. 19·9 | 354·6 | 55·7 | 45·1 | 1·459 | 3·260 | 5·888 | 0·552 | Pigott. |
| 13 | 1786 I., Jan. 30·9 | 182·5 | 334·1 | 13·6 | 0·335 | 2·208 | 3·281 | 0·848 | Encke. |
| 14 | 1790 II., Jan. 30·9 | 207·1 | 268·6 | 54·1 | 1·044 | 5·78 | 13·90 | 0·819 | Tuttle. |
| 15 | 1795, Dec. 21·4 | 182·0 | 334·7 | 13·7 | 0·334 | 2·213 | 3·292 | 0·849 | Encke. |
| 16 | 1805, Nov. 21·5 | 182·5 | 334·3 | 13·6 | 0·340 | 2·213 | 3·292 | 0·846 | ,, |
| 17 | 1806 I., Jan. 2·0 | 218·2 | 251·3 | 13·6 | 0·907 | 3·567 | 6·737 | 0·746 | Biela. |
| 18 | 1812, Sept. 15·3 | 199·3 | 253·0 | 74·0 | 0·777 | 17·5 | 73· | 0·956 | Pons. |
| 19 | 1815, April 26·0 | 65·6 | 83·5 | 44·5 | 1·213 | 17·63 | 74· | 0·931 | Olbers. |
| 20 | 1819 I., Jan. 28·0 | 182·4 | 334·6 | 13·6 | 0·335 | 2·214 | 3·295 | 0·849 | Encke. |
| 21 | 1819 III., July 18·9 | 161·5 | 113·2 | 10·7 | 0·774 | 3·160 | 5·618 | 0·755 | Winnecke. |
| 22 | 1819 IV., Nov. 20·3 | 350·1 | 77·2 | 9·0 | 0·893 | 2·849 | 4·810 | 0·687 | Blanpain. |
| 23 | 1822 II., May 24·0 | 182·8 | 334·4 | 13·3 | 0·346 | 2·224 | 3·318 | 0·845 | Encke. |
| 24 | 1825 III., Sept. 16·3 | 182·8 | 334·5 | 13·4 | 0·345 | 2·223 | 3·315 | 0·845 | ,, |
| 25 | 1826 I., Mar. 18·4 | 218·3 | 251·5 | 13·6 | 0·903 | 3·561 | 6·720 | 0·747 | Biela. |
| 26 | 1829 Jan. 9·7 | 182·8 | 334·5 | 13·3 | 0·346 | 2·224 | 3·316 | 0·845 | Encke. |
| 27 | 1832 I., May 4·0 | 182·8 | 334·5 | 13·4 | 0·343 | 2·222 | 3·312 | 0·845 | ,, |
| 28 | 1832 III., Nov. 26·1 | 221·8 | 248·3 | 13·2 | 0·879 | 3·537 | 6·652 | 0·751 | Biela. |
| 29 | 1835 II., Aug. 26·4 | 182·8 | 334·6 | 13·4 | 0·344 | 2·223 | 3·314 | 0·845 | Encke. |
| 30 | 1835 III., Nov. 15·9 | 110·6 | 55·2 | 162·2 | 0·587 | 17·99 | 76·29 | 0·967 | Halley. |
| 31 | 1838, Dec. 19·0 | 182·8 | 334·6 | 13·4 | 0·344 | 2·222 | 3·313 | 0·845 | Encke. |
| 32 | 1842 I., April 12·0 | 182·8 | 334·7 | 13·3 | 0·345 | 2·223 | 3·314 | 0·845 | ,, |
| 33 | 1843 III., Oct. 17·1 | 200·1 | 209·5 | 11·4 | 1·693 | 3·812 | 7·442 | 0·556 | Faye. |
| 34 | 1844 I., Sept. 2·5 | 278·7 | 63·8 | 2·9 | 1·186 | 3·100 | 5·459 | 0·617 | De Vico. |
| 35 | 1845 IV., Aug. 9·6 | 183·4 | 334·3 | 13·1 | 0·338 | 2·216 | 3·300 | 0·847 | Encke. |
| 36 | 1846 II., Feb. 11·0 | 223·1 | 245·9 | 12·6 | 0·856 | 3·520 | 6·603 | 0·757 | Biela (A). |
| 37 | 1846 II., Feb. 11·1 | 223·1 | 245·9 | 12·6 | 0·856 | 3·519 | 6·601 | 0·757 | Biela (B). |
| 38 | 1846 III., Feb. 25·4 | 13·8 | 102·7 | 30·9 | 0·650 | 3·142 | 5·569 | 0·793 | Brorsen. |
| 39 | 1846 IV., Mar. 5·6 | 12·9 | 77·6 | 85·1 | 0·664 | 17·90 | 75·7 | 0·963 | De Vico. |
| 40 | 1846 VI., June 1·1 | 339·6 | 260·4 | 30·7 | 1·529 | 5·635 | 13·38 | 0·729 | C. H. F. Peters. |
| 41 | 1847 V., Sept. 9·5 | 129·3 | 309·8 | 19·1 | 0·488 | 18·7 | 81·1 | 0·974 | Brorsen. |
| 42 | 1848 II., Nov. 26·1 | 183·4 | 334·4 | 13·1 | 0·337 | 2·215 | 3·296 | 0·848 | Encke. |
| 43 | 1851 I., April 1·9 | 200·2 | 209·5 | 11·4 | 1·700 | 3·819 | 7·462 | 0·555 | Faye. |
| 44 | 1851 II., July 8·7 | 174·5 | 148·4 | 13·9 | 1·173 | 3·444 | 6·390 | 0·659 | D'Arrest. |
| 45 | 1852 I., March 14·7 | 183·5 | 334·4 | 13·1 | 0·337 | 2·215 | 3·297 | 0·848 | Encke. |
| 46 | 1852 III., Sept. 23·7 | 223·3 | 245·9 | 12·6 | 0·861 | 3·526 | 6·621 | 0·756 | Biela (A). |
| 47 | 1852 III., Sept. 23·1 | 223·3 | 245·9 | 12·6 | 0·861 | 3·525 | 6·619 | 0·756 | Biela (B). |
| 48 | 1852 IV., Oct. 12·8 | 57·1 | 346·2 | 40·9 | 1·250 | 15·44 | 60·7 | 0·919 | Westphal. |
| 49 | 1855 III., July 1·2 | 183·4 | 334·4 | 13·1 | 0·337 | 2·215 | 3·295 | 0·848 | Encke. |
| 50 | 1857 II., March 29·3 | 14·0 | 101·8 | 29·8 | 0·621 | 3·130 | 5·538 | 0·802 | Brorsen. |
| 51 | 1857 VII., Nov. 28·2 | 174·6 | 148·5 | 13·9 | 1·170 | 3·440 | 6·380 | 0·660 | D'Arrest. |
| 52 | 1858 I., Feb. 23·5 | 206·8 | 269·1 | 54·4 | 1·025 | 5·736 | 13·74 | 0·821 | Tuttle. |
| 53 | 1858 II., May 2·0 | 162·1 | 113·5 | 10·8 | 0·769 | 3·317 | 5·555 | 0·755 | Winnecke. |
| 54 | 1858 III., May 3·0 | 25·7 | 175·1 | 19·5 | 1·149 | 3·523 | 6·609 | 0·674 | Tuttle. |
| 55 | 1858 V., Sept. 12·9 | 200·2 | 209·7 | 11·4 | 1·694 | 3·813 | 7·445 | 0·556 | Faye. |
| 56 | 1858 VIII., Oct. 18·4 | 183·5 | 334·5 | 13·1 | 0·341 | 2·218 | 3·304 | 0·846 | Encke. |
| 57 | 1862 I., Feb. 6·3 | 183·5 | 334·5 | 13·1 | 0·340 | 2·217 | 3·302 | 0·847 | ,, |
| 58 | 1865 II., May 27·9 | 183·5 | 334·5 | 13·1 | 0·341 | 2·218 | 3·304 | 0·846 | ,, |
| 59 | 1866 I., Jan. 11·1 | 171·0 | 231·4 | 162·7 | 0·977 | 10·32 | 33·18 | 0·905 | Tempel. |
| 60 | 1866 II., Feb. 14·0 | 200·2 | 209·7 | 11·4 | 1·682 | 3·802 | 7·413 | 0·558 | Faye. |

*Table of the Approximate Elements—continued.*

| No. | Time of Perihelion Passage. T. | $\pi - \Omega$ ω | Longitude Ascending Node. Ω | Inclination. $i$ | Perihelion Distance $q$ | Semi-Major Axis. $a$ | Period $U$ | Eccentricity. $e$ | Comet of |
|---|---|---|---|---|---|---|---|---|---|
| | A.D. N.S. | ° | ° | ° | | | | | |
| 61 | 1867 I., Jan. 20·2 | 357·5 | 78·5 | 18·2 | 1·577 | 11·71 | 40·09 | 0·865 | Stephan. |
| 62 | 1867 II., May 23·9 | 135·0 | 101·2 | 6·4 | 1·563 | 3·189 | 5·695 | 0·510 | Tempel (I.). |
| 63 | 1868 I., April 17·4 | 14·8 | 101·2 | 29·4 | 0·597 | 3·109 | 5·482 | 0·808 | Brorsen. |
| 64 | 1868 III., Sept. 14·6 | 183·7 | 334·5 | 13·1 | 0·334 | 2·212 | 3·289 | 0 849 | Encke. |
| 65 | 1869 I., June 29·9 | 162·4 | 113·6 | 10·8 | 0 781 | 3·150 | 5·592 | 0·752 | Winnecke. |
| 66 | 1869 III., Nov. 18·8 | 106·2 | 296·8 | 5·4 | 1·063 | 3·109 | 5·483 | 0·658 | Tempel-Swift. |
| 67 | 1870 III., Sept. 22·7 | 172·3 | 146·4 | 15·7 | 1·280 | 3·507 | 6·57 | 0·635 | D'Arrest. |
| 68 | 1871 III., Dec. 1·8 | 206·8 | 259·3 | 54·3 | 1·030 | 9·757 | 13·811 | 0·821 | Tuttle. |
| 69 | 1871 V., Dec. 28·8 | 183·6 | 334·6 | 13·1 | 0·333 | 2·210 | 3·285 | 0·849 | Encke. |
| 70 | 1873 I., May 9·8 | 159·3 | 78·7 | 9·8 | 1·771 | 3·296 | 5·984 | 0·463 | Tempel (I ). |
| 71 | 1873 II., June 25·2 | 185·2 | 120·9 | 12·8 | 1·344 | 3·004 | 5·207 | 0·553 | Tempel (II.). |
| 72 | 1873 III., July 18·5 | 200·4 | 209·6 | 11·4 | 1·683 | 3·801 | 7·412 | 0·557 | Faye. |
| 73 | 1873 VI., Oct. 10·5 | 14·8 | 101·2 | 29·4 | 0·594 | 3·106 | 5·475 | 0·809 | Brorsen. |
| 74 | 1875 I., March 12·1 | 165·1 | 111·6 | 11·3 | 0·829 | 3·201 | 5·726 | 0·741 | Winnecke. |
| 75 | 1875 II., April 13·0 | 183·7 | 334·6 | 13·1 | 0·333 | 2·211 | 3·287 | 0·849 | Encke. |
| 76 | 1877 IV., May 10·5 | 173·0 | 146·2 | 15·7 | 1·318 | 3·541 | 6·664 | 0·628 | D'Arrest. |
| 77 | 1878 II., July 26·2 | 183·7 | 334·7 | 13·1 | 0·333 | 2·212 | 3·285 | 0·849 | Encke. |
| 78 | 1878 III., Sept. 7·3 | 185·1 | 121·0 | 12·8 | 1·340 | 3·001 | 5·202 | 0·554 | Tempel (II.). |
| 79 | 1879 I., March 30·5 | 14·9 | 101·3 | 29·4 | 0·590 | 3·101 | 5·470 | 0·810 | Brorsen. |
| 80 | 1879 III., May 7·1 | 159·5 | 78·8 | 9·8 | 1·771 | 3·295 | 5·982 | 0·463 | Tempel (I.). |
| 81 | 1880 IV., Nov. 8·0 | 106·2 | 296·9 | 5·4 | 1·067 | 3·113 | 5 493 | 0·657 | Tempel-Swift. |
| 82 | 1881 I., Jan. 22·7 | 201·2 | 209·6 | 11·3 | 1·738 | 3·854 | 7·566 | 0·549 | Faye. |
| 83 | 1881 V., Sept. 13·3 | 312·5 | 65·9 | 6·9 | 0·725 | 4·226 | 8·687 | 0·828 | Denning. |
| 84 | 1881 VII., Nov. 15·3 | 183·9 | 334·6 | 12·9 | 0·343 | 2·221 | 3·310 | 0·845 | Encke. |
| 85 | 1884 I., Jan. 25·7 | 199·2 | 254·1 | 74·0 | 0·776 | 17·2 | 71·56 | 0·955 | Pons-Brooks. |
| 86 | 1884 II., Aug. 16·5 | 301·0 | 5·1 | 5·5 | 1·279 | 3·078 | 5·400 | 0·584 | Barnard. |
| 87 | 1884 III., Nov. 17·8 | 172·7 | 206·3 | 25·3 | 1·571 | 3·580 | 6·774 | 0·561 | Wolf. |
| 88 | 1885 I., March 7·6 | 183·9 | 334·6 | 12·9 | 0·342 | 2·220 | 3 307 | 0·846 | Encke. |
| 89 | 1885 IV., Sept. 11·1 | 206·8 | 269·7 | 54·3 | 1·024 | 5·742 | 13·76 | 0·822 | Tuttle. |
| 90 | 1886 IV. June 6·7 | 176·8 | 53·5 | 12·7 | 1·327 | 3·152 | 5·595 | 0·579 | Brooks. |
| 91 | 1886 VI., Sept. 4·4 | 172·0 | 104·1 | 14·5 | 0·885 | 3·234 | 5·816 | 0·726 | Winnecke. |
| 92 | 1886 VII., Nov. 22·4 | 315·1 | 52·5 | 3·0 | 0·998 | 3·536 | 6·648 | 0·718 | Finlay. |
| 93 | 1887 V., Oct. 8·5 | 65·3 | 84·5 | 44·6 | 1·199 | 17·41 | 72·65 | 0·931 | Olbers. |
| 94 | 1888 II., June 28·0 | 184·0 | 334·6 | 12·9 | 0·343 | 2·220 | 3·308 | 0·845 | Encke. |
| 95 | 1888 IV., Aug. 19·9 | 201·2 | 209·6 | 11·3 | 1·738 | 3·854 | 7·566 | 0·549 | Faye. |
| 96 | 1889 V., Sept. 30·3 | 343·6 | 18·0 | 6·1 | 1·950 | 3·684 | 7·072 | 0 471 | Brooks. |
| 97 | 1889 VI., Nov. 29·5 | 69·7 | 330·6 | 10·2 | 1·354 | 4·176 | 8·534 | 0·676 | Swift. |
| 98 | 1890 V., Sept. 17·5 | 173·0 | 146·3 | 15·7 | 1·324 | 3·551 | 6·691 | 0·627 | D'Arrest. |
| 99 | 1890 VII., Oct. 26·5 | 328·2 | 45·1 | 12·9 | 1·970 | 3·448 | 6·402 | 0·471 | Spitaler. |
| 100 | 1891 II., Sept. 3·4 | 172·8 | 206·4 | 25·2 | 1·593 | 3·597 | 6·821 | 0·557 | Wolf. |
| 101 | 1891 III., Oct. 18·0 | 184·0 | 334·7 | 12·9 | 0·340 | 2·218 | 3·303 | 0·846 | Encke. |
| 102 | 1891 V., Nov. 15·0 | 106·7 | 296·5 | 5·4 | 1·087 | 3·129 | 5·534 | 0·653 | Tempel-Swift. |
| 103 | 1892 III., June 13·2 | 14·2 | 331·7 | 20·8 | 2·139 | 3·626 | 6·904 | 0·410 | Holmes. |
| 104 | 1892 IV., June 30·9 | 172·1 | 104·1 | 14·5 | 0·887 | 3·235 | 5·818 | 0·726 | Winnecke. |
| 105 | 1892 V., Dec. 11·1 | 170·3 | 206·7 | 31·2 | 1·428 | 3·384 | 6·226 | 0·578 | Barnard. |
| 106 | 1893 III., July 12·2 | 315·5 | 52·5 | 3·0 | 0·989 | 3·526 | 6·622 | 0·720 | Finlay. |
| 107 | 1894 I., Feb. 9·5 | 46·3 | 84·4 | 5·5 | 1·148 | 3·804 | 7·42 | 0·698 | Denning. |
| 108 | 1894 III., April 23·2 | 185·6 | 121·2 | 12·7 | 1·351 | 3·008 | 5·218 | 0·551 | Tempel (II.). |
| 109 | 1894 IV., Oct. 12·2 | 296·6 | 48·7 | 3·0 | 1·392 | 3·252 | 5·863 | 0·572 | De Vico-Swift. |
| 110 | 1895 I., Feb. 4·7 | 184·0 | 334·7 | 12·9 | 0·341 | 2·218 | 3·303 | 0·846 | Encke. |
| 111 | 1895 II., Aug. 20·9 | 167·8 | 170·3 | 3·0 | 1·296 | 3·680 | 7·059 | 0·648 | Swift. |
| 112 | 1896 II., March 19·3 | 201·2 | 209·8 | 11·3 | 1·738 | 3·854 | 7·566 | 0·549 | Faye. |
| 113 | 1896 V., Oct. 26·0 | 139·5 | 192·1 | 11·6 | 1·482 | 3·500 | 6·549 | 0·585 | Giacobini. |
| 114 | 1896 VI., Nov. 4·2 | 343·8 | 18·0 | 6·1 | 1·959 | 3·693 | 7·097 | 0·469 | Brooks (1889 V.). |
| 115 | 1896 VII., Nov. 24·6 | 163·9 | 246·6 | 13·6 | 1·110 | 3·462 | 6·441 | 0·679 | Perrine. |
| 116 | 1897 II., May 24·0 | 173·1 | 146·4 | 15·7 | 1·324 | 3·551 | 6·675 | 0·627 | D'Arrest. |
| 117 | 1898 II., March 20·4 | 173·4 | 100·9 | 17·0 | 0·924 | 3·240 | 5·719 | 0·715 | Winnecke. |
| 118 | 1898 III., May 27·8 | 184·0 | 334·8 | 12·9 | 0·341 | 2·218 | 3·303 | 0·846 | Encke. |
| 119 | 1898 IV., July 4·6 | 172·9 | 206·4 | 25·2 | 1·604 | 3·597 | 6·821 | 0·557 | Wolf. |
| 120 | 1899 II., April 28·1 | 14·1 | 331·7 | 20·8 | 2·139 | 3·615 | 6·874 | 0·411 | Holmes (1892 III.). |
| 121 | 1899 III., May 4·5 | 206·7 | 269·8 | 54·5 | 1·024 | 5·742 | 13·664 | 0·822 | Tuttle (discovered by photography). |
| 122 | 1899 IV., July 28·5 | 185·6 | 121·0 | 12·6 | 1·351 | 5·28 | 5·281 | 0·542 | Tempel (II.). |

During the decade 1890-1900 our knowledge of cometic orbits was greatly increased by a systematic effort to provide computers for the orbits of comets whose elements require revision. Reports on this matter are printed by Dr Kreutz, at intervals, in the *V. J. S.* of the *Astronomische Gesellschaft*. All the computations relating to periodic comets are in thoroughly competent hands. The orbit of Wolf's comet, for example, is so well determined by its calculator (Pastor Thraen) that at its last return observation agreed with computation exactly within the limits of accuracy set by five-place logarithms. The non-periodic comets appearing since 1700 are nearly all in the hands of computers; only nineteen comets of the 18th and twenty-eight of the 19th century were unassigned at the date of Dr Kreutz's report in 1898.

The most important periodic comets are given in the following table :—

| Name | Period in years | Remarks. |
|---|---|---|
| Encke . . . | 3·303 | Regularly returning since 1786, last observed in 1901. Its brightness in 1891 was about the same as in 1858. Sudden changes of brilliancy were observed at some of its returns (1865 and 1898 for example). Computers—Backlund, Ivanow. |
| Tempel (II) . . | 5·218 | Last observed 1899. Computer—Schulhoff. |
| Barnard . . | 5·400 | Last observed 1884. |
| Brorsen . . | 5·456 | Last observed 1879. See the remarks under Denning's comet below. |
| Tempel - L. Swift . | 5·534 | Last observed 1891. Computer—Bossert. |
| Winnecke . . | 5·818 | Last observed 1898. Computers Von Haerdtl and Hillebrand. |
| De Vico - E. Swift | 5·863 | Last observed 1894. It is the comet 1844 I. (De Vico). Computer—Chandler. |
| Brooks . . . | 5·595 | Last observed 1886. |
| Tempel (I.) . . | 5·98 | Observed in 1867, 1873, and 1879; subject to large perturbations by Jupiter 1879–85, and not since seen. Computer—Gautier. |
| Barnard . . | 6·226 | Last observed 1892. Computer—Coniel. |
| Spitaler . . | 6·402 | Last observed 1890. Computer—Spitaler. |
| Perrine . . | 6·441 | Discovered 1896. Computers—Ristenpart, Hadley. |
| Giacobini . . | 6·549 | Discovered 1896. |
| Biela (I. and II.) . | 6·6 | Discovered 1772; seen 1805, 1826, and 1832. In 1846 it divided into two parts, which were widely separated at its return of 1852. It has not since been observed. |
| Finlay . . . | 6·622 | Last observed 1893 (second return). Computer—Schulhoff. |
| D'Arrest . . | 6·691 | Observed in 1851, 1857, 1870, 1877, 1890, 1897. Computer—Leveau. |
| Wolf . . . | 6·821 | Regularly returning; last observed 1898. Computer—Thraen. |
| Giacobini . . | 6·86 | Last observed 1896. Its orbit somewhat resembles that of comet Faye. Computer—Pokrowsky. |
| Holmes . . | 6·904 | Last observed 1899 within its calculated place by 28 s. in R. A., 5′ in Dec. Its calculated period required a correction of 0·3 of a day only. This comet was, in 1892, subject to changes of brightness suggesting internal changes. The question arises why so bright a comet was not earlier discovered. Its orbit is more nearly circular than that of any other comet, and lies wholly between the orbits of Mars and Jupiter, in the region of asteroids therefore. Its spectrum shows only a trace of one bright line. Computer—Zwiers. |
| Swift . . . | 7·059 | Last observed 1895. It is not unlikely to be a return of Lexell's comet of 1770. |
| Brooks . . . | 7·097 | Last observed 1896. Its spectrum was continuous. It was at first supposed to be a return of Lexell's comet, but the researches of Dr C. L. Poor make the identity unlikely. |
| Denning (II) . | 7·42 | Last observed 1894. Its orbit lies within 0·16 of Jupiter's orbit, and near that point crosses the orbit of Brorsen's comet. The two comets were near the point of intersection in 1881 (though Jupiter was not then near) which *may* account for the disappearance of Brorsen's comet since its return in 1879. |
| Faye . . . | 7·566 | Last observed 1896. |
| Swift . . . | 8·534 | Last observed 1889. Computer—Coniel. |
| Denning (I.) . | 8·867 | Last observed 1881. |
| Tuttle . . . | 13·76 | Last observed 1899. Computer—Rahts. |
| Tempel . . . | 33·18 | Last observed 1866. |
| Stephan . . | 40·09 | Last observed 1867. |
| Westphal . . | 60·7 | Last observed 1852. |
| Pons-Brooks . . | 71·48 | Observed in 1812 and 1884. |
| Olbers . . | 72·63 | Observed in 1815 and 1887. |
| De Vico . . | 75·7 | Last observed 1846. |
| Halley . . . | 76·37 | Regularly returning. The next appearance is 1910. |

In the course of the ten years 1890–99 thirty-seven unexpected comets were discovered (four on photographic plates, the others after search with visual telescopes) besides a number of expected (periodic) comets. During the years 1782 to 1841 eighty-seven comets of both classes were observed, or 1·45 per year, while from 1842 to 1897 there were 241 comets, or 4·30 per year. The difference in the average numbers probably represents nothing more than the increased attention paid to cometary discovery in late years. For example, ten comets were discovered during 1898, three of them being known periodic comets. In the year 1840 a gold medal was founded by Christian VIII., king of Denmark, to be given to discoverers of telescopic comets, but after his death the award was discontinued. The comet medal (bronze) of the Astronomical Society of the Pacific was founded by Hon. Joseph A. Donohoe in the year 1890, and is presented to the discoverer of every unexpected comet on the report of a committee of the society. A list of the awards constitutes, therefore, a history of recent cometary discoveries.

*List of Unexpected Comets discovered since 1st January 1890.*

| *Discovered on* | *Discovered by* | *At* |
|---|---|---|
| March 19, 1890 | W. R. Brooks | Geneva, N.Y. |
| July 18, 1890 | Jerome Coggia | Marseilles, France |
| July 23, 1890 | W. F. Denning | Bristol, England |
| Nov. 15, 1890 | T. Zona | Palermo, Italy |
| Nov. 16, 1890 | R. Spitaler | Vienna, Austria |
| March 29, 1891 | E. E. Barnard | Lick Observatory, Cal. |
| October 3, 1891 | E. E. Barnard | ,, ,, ,, |
| March 6, 1892 | Lewis Swift | Rochester, N.Y. |
| March 18, 1892 | W. F. Denning | Bristol, England |
| August 28, 1892 | W. R. Brooks | Geneva, N.Y. |
| October 12, 1892 | E. E. Barnard | Lick Observatory, Cal.[1] |
| Nov. 6, 1892 | Edwin Holmes | London, England |
| Nov. 19, 1892 | W. R. Brooks | Geneva, N.Y. |
| April 16, 1893 | J. M. Schaeberle | Lick Observatory, Cal.[2] |
| October 16, 1893 | W. R. Brooks | Geneva, N.Y. |
| March 26, 1894 | W. F. Denning | Bristol, England |
| April 2, 1894 | W. F. Gale | Paddington, N.S.W. |
| Nov. 20, 1894 | E. D. Swift | Lowe Observatory, Cal. |
| August 20, 1895 | Lewis Swift | ,, ,, ,, |
| Nov. 17, 1895 | C. D. Perrine | Lick ,, ,, |
| Nov. 21, 1895 | W. R. Brooks | Geneva, N.Y. |
| Feb. 15, 1896 | C. D. Perrine | Lick Observatory, Cal. |
| April 13, 1896 | Lewis Swift | Lowe ,, ,, |
| August 31, 1896 | W. E. Sperra | Randolph, Ohio |
| Sept. 4, 1896 | E. Giacobini | Nice, France |
| Nov. 2, 1896 | C. D. Perrine | Lick Observatory, Cal. |
| Dec. 8, 1896 | C. D. Perrine | ,, ,, ,, |
| October 16, 1897 | C. D. Perrine | ,, ,, ,, |
| March 20, 1898 | C. D. Perrine | ,, ,, ,, |
| June 11, 1898 | E. F. Coddington | ,, ,, ,,[3] |
| June 14, 1898 | C. D. Perrine | ,, ,, ,, |
| June 18, 1898 | E. Giacobini | Nice, France |
| Sept. 13, 1898 | C. D. Perrine | Lick Observatory, Cal. |
| October 20, 1898 | W. R. Brooks | Geneva, N.Y.[4] |
| Nov. 14, 1898 | F. L. Chase | New Haven, Conn.[5] |
| March 3, 1899 | Lewis Swift | Lowe Observatory, Cal. |
| Sept. 29, 1899 | E. Giacobini | Nice, France |

A few of the remarkable comets of the years 1888–1900 are here briefly described. Comet 1888 I. exhibited peculiar variations in its head like those which distinguished the comets 1882 II. and 1884 I. Two (or according to one observer three) nuclei were enclosed in a nebulous sheath, as in 1882 II. On 21st May, two months after perihelion passage, the head suddenly became about two stellar magnitudes brighter, and two jets were ejected from it, both much brighter than the main

[1] This is the first comet discovered by photography.
[2] This comet was discovered on the photographs of the total solar eclipse taken by the Lick Observatory eclipse expedition to Chile.
[3] Discovered by photography.
[4] The orbit of this comet resembles that of Schaeberle's comet of 1881.
[5] Discovered by photography.

tail. The causes of such changes must be sought for within the comet as, in all likelihood, they were not the direct result of solar action. Several other comets have shown like variations. Comet 1889 I. is remarkable for the long period (971 days) during which it was under observation. It was observed at four oppositions to the sun, the last observation being 1st May 1891. At this time its distance from the earth was 7·40; from the sun, 8·22, which is not very different from the distance of Saturn = 9·54. The bright comet of 1811 was not observed beyond 4·53 from the sun, and the great comet of 1882 was lost at 5·16. Comet 1892 I. was photographed at various observatories, and the photographs show that its tail was of a very complex character and subject to great variations. W. H. Pickering (*Annals H. C. O.* vol. xxxii.) concludes that the variations were periodic, and that the whole comet rotated in a period of about four days on an axis through the head, coinciding with the general direction of the tail. The motion of condensations in the tail led him to the conclusion that the total repulsive force of the sun was 39·51 times the force of gravity. Professor Campbell, at the Lick Observatory, notes a diminution in the wave-length of the green band of the spectrum after perihelion passage. The changes in Holmes's periodic comet of 1892 have already been referred to. The periodic comet 1889 V. (Brooks) was discovered on 6th July. It passed perihelion on 30th September. On 1st August Professor Barnard, at the Lick Observatory, discovered two companion comets near by, and later two more. It has been suggested that the companion comets were separated from the main body by the attraction of Jupiter about May 1886, when the comet and planet were in proximity. The periodic comet (Tempel-Swift) came within 0·13 of Jupiter in 1880 (earth's distance from the sun = 1), and it is worthy of remark that at its return in 1891 it was reported by some observers to have a companion comet. Comet 1892 V. was the first one (except the eclipse comet of 1882) to be discovered by photography (by Professor Barnard at the Lick Observatory). The first comets photographed were those of 1881 (H. Draper); 1881 (Janssen); 1882 (Gill). All comets sufficiently bright are now studied to great advantage by photography. The next bright comet that is favourably situated will yield important discoveries, which are foreshadowed by the results of Professor Hussey of the Lick Observatory on the bright comet 1893 II. (see *Publications of the Astronomical Society of the Pacific*, vol. vii., 1895, pp. 161–185). Professor Hussey's photographs show marked changes in the nucleus, coma, and tail. The comet sent off a series of condensations or nebulous masses whose motions were determined to be between 40 and 60 miles per second. The photographs obtained by Professor Barnard of the Lick Observatory of the comet 1893 IV. also show extraordinary variations in the quantity of matter ejected by the head to form the tail, and in the direction of its motion (see *Knowledge*, February and May 1894). (E. S. H.)

**Comilla,** or Kumilla, a town of British India, headquarters of Tippera district in Bengal, situated on the river Gumti, with a station on the Assam-Bengal Railway, 96 miles from the coast terminus at Chittagong. Population (1881), 13,372; (1891), 14,680. The town has many large tanks; an English church, built in 1875; a high school; the Elliott artisan school; four printing-presses, one of which issues a vernacular newspaper; and a public library.

**Comiso,** a town of the province of Syracuse, Sicily, Italy, 90 miles by rail west by south from Syracuse, on the line to Licata. It has a fine spring, the fabled "bath of Diana," and limestone quarries. The people make pottery. Population, 19,333.

**Commentry,** a town of France, in the arrondissement of Montluçon, department of Allier, 42 miles south-west of Moulins by rail. It gives its name to a coal-field, the output of which in 1899 amounted to 778,417 tons (metric); over 4000 persons are employed in connexion with the mines. There are very important foundries and forges. Population (1881), 9394; (1896), 9197; (1901), 11,165.

**Commercial Treaties.**—A commercial treaty is a contract between States relative to trade. It is a bilateral act whereby definite arrangements are entered into by each contracting party towards the other—not mere concessions. As regards technical distinctions, an "agreement," an "exchange of notes," or a "convention" properly applies to one specific subject; whereas a "treaty" usually comprises several matters, whether commercial or political.

In ancient times foreign intercourse, trade, and navigation were in many instances regulated by international arrangements. The text is extant of treaties of commerce and navigation concluded between Carthage and Rome in 509 and 348 B.C. Aristotle mentions that nations were connected by commercial treaties; and other classical writers advert to these engagements. Under the Roman Empire the matters thus dealt with became regulated by law, or by usages sometimes styled laws. When the territories of the empire were contracted, and the imperial authority was weakened, some kind of international agreements again became necessary. At Constantinople in the 10th century treaties cited by Gibbon protected "the person, effects, and privileges of the Russian merchant"; and, in Western Europe, intercourse, trade, and navigation were carried on, at first tacitly by usage derived from Roman times, or under verbal permission given to merchants by the ruler to whose court they resorted. Afterwards, security in these transactions was afforded by means of formal documents, such as royal letters, charters, laws, and other instruments possessing the force of Government measures. Instances affecting English commercial relations are the letter of Charlemagne in 796, the Brabant Charter of 1305, and the Russian Ukase of 1569. Mediæval treaties of truce or peace often contained a clause permitting in general terms the renewal of personal and commercial communication as it subsisted before the war. This custom is still followed. But these mediæval arrangements were precarious: they were often of temporary duration, and were usually only effective during the lifetime of the contracting sovereigns.

Passing over trade agreements affecting the Eastern Empire, the modern commercial treaty system came into existence in the 12th century. Genoa, Pisa, and Venice were then well organized communities, and were in keen rivalry. Whenever their position in a foreign country was strong, a trading centre was established, and few or no specific engagements were made on their part. But in serious competition or difficulty another course was adopted: a formal agreement was concluded for the better security of their commerce and navigation. The arrangements of 1140 between Venice and Sicily; the Genoese conventions of 1149 with Valencia, of 1161 with Morocco, and of 1181 with the Balearic Islands; the Pisan conventions of 1173 with Sultan Saladin, and of 1184 with the Balearic Islands, were the earliest Western commercial treaties. Such definite arrangements, although still of a personal character, were soon perceived to be preferable to general provisions in a treaty of truce or peace. They afforded also greater security than privileges enjoyed under usage; or under grants of various kinds, whether local or royal. The policy thus inaugurated was adopted gradually throughout Europe. The first treaties relative to the trade of the Netherlands were between Brabant and Holland in 1203, Holland and Utrecht in 1204, and Brabant and Cologne in 1251. Early northern commercial treaties are those between Riga and Smolensk 1229, and between Lübeck and Sweden 1269. The first commercial relations between the Hanse Towns and foreign countries were arrangements made by guilds of merchants, not by public authorities as a governing body. For a long period the treaty system did not entirely supersede conditions of intercourse between nations dependent on permission.

The earliest English Commercial Treaty is that with Norway in 1217. It provides "ut mercatores et homines qui sunt de potestate vestra liberè et sine impedimento terram nostram adire possint, et homines et mercatores nostri similiter vestram." These stipulations are in due treaty form. The next early English treaties are —with Flanders, 1274 and 1314; Portugal, 1308, 1352, and 1386; Baltic Cities, 1319 and 1388; Biscay and Castile, 1351; Burgundy,

1417 and 1496; France, 1471, 1497, and 1510; Florence, 1490. The commercial treaty policy in England was carried out systematically under Henry IV. and Henry VII. It was continued under James I. to extend to Scotland English trading privileges. The results attained in the 17th century were—regularity in treaty arrangements; their durable instead of personal nature; the conversion of permissive into perfect rights; questions as to contraband and neutral trade stated in definite terms. Treaties were at first limited to exclusive and distinct engagements between the contracting States; each treaty differing more or less in its terms from other similar compacts. Afterwards by extending to a third nation privileges granted to particular countries, the *most favoured nation article* began to be framed. Cromwell continued the commercial treaty policy in order to obtain a formal recognition of the Commonwealth from foreign Powers. His treaty of 1654 with Sweden contains the first reciprocal English most favoured nation clause. Article IV. provides that the people, subjects, and inhabitants of either confederate "shall have and possess in the countries, lands, dominions, and kingdoms of the other as full and ample privileges, and as many exemptions, immunities, and liberties, as any foreigner doth or shall possess in the dominions and kingdoms of the said confederate." The Government of the Restoration replaced and enlarged the Protectorate arrangements by fresh agreements. The general policy of the Commonwealth was maintained, with further provisions on behalf of Colonial Trade. In the new treaty of 1661 with Sweden, the privileges secured were those which "any foreigner whatsoever doth or shall enjoy in the said dominions and kingdoms on both sides."

In contemporary treaties France obtained from Spain (1659) that French subjects should enjoy the same liberties as had been granted to the English; and England obtained from Denmark (1661) that the English should not pay more or greater customs than the people of the United Provinces and other foreigners, the Swedes only excepted. The colonial and navigation policy of the 17th century, and the proceedings of Louis XIV., provoked animosities and retaliatory tariffs. During the war of the Spanish Succession the Methuen Treaty of 1703 was concluded. Portugal removed prohibitions against the importation of British woollens; Great Britain engaged that Portuguese wines should pay one-third less duty than the rate levied on French wines. At the Peace of Utrecht in 1713 political and commercial treaties were concluded. England agreed to remove prohibitions on the importation of French goods, and to grant most favoured nation treatment in relation to goods and merchandise of the like nature from any other country in Europe; the French general tariff of September 18, 1664, was to be again put in force for English trade. The English provision was at variance with the Methuen Treaty. A violent controversy arose as to the relative importance in 1713 of Anglo-Portuguese or Anglo-French trade. In the end the House of Commons, by a majority of 9, rejected the Bill to give effect to the commercial treaty of 1713; and trade with France remained on an unsatisfactory footing until 1786. The other commercial treaties of Utrecht were very complete in their provisions, equal to those of the present time; and contained most favoured nation articles—England secured in 1715 reduction of duties on woollens imported into the Austrian Netherlands; and trading privileges in Spanish America. Moderate import duties for woollens were obtained in Russia by the Commercial treaty of 1766. In the meanwhile the Bourbon family compact of August 15, 1761, assured national treatment for the subjects of France, Spain, and the Two Sicilies, and for their trade in the European territories of the other two States; and most favoured nation treatment as regards any special terms granted to any foreign country. The first commercial treaties concluded by the United States with European countries contained most favoured nation clauses: this policy has been continued by the United States, but the wording of the clause has often varied.

In 1786 France began to effect tariff reform by means of commercial treaties. The first was with Great Britain, and it terminated the long-continued tariff warfare. But the wars of the French Revolution swept away these reforms, and brought about a renewal of hostile tariffs. Prohibitions and differential duties were renewed, and prevailed on the Continent until the sixth decade of the 19th century. In 1860 a Government existed in France sufficiently strong and liberal to revert to the policy of 1786. The bases of the Anglo-French treaty of 1860, beyond its most favoured nation provisions, were in France a general transition from prohibition or high customs duties to a moderate tariff; in the United Kingdom abandonment of all protective imposts, and reduction of duties maintained for fiscal purposes to the lowest rates compatible with these exigencies. Other European countries were obliged to obtain for their trade the benefit of the conventional tariff thus established in France, as an alternative to the high rates inscribed in the general tariff. A series of commercial treaties was accordingly concluded by different European States between 1861 and 1866, which effected further reductions of customs duties in the several countries which came within this treaty system. In 1871 the Republican Government sought to terminate the treaties of the Empire. The British negotiators nevertheless obtained the relinquishment of the attempt to levy protective duties under the guise of compensation for imposts on raw materials; the duration of the treaty of 1860 was prolonged; and stipulations better worded than those before in force were agreed to for shipping and most favoured nation treatment. In 1882, however, France terminated her existing European tariff treaties. Belgium and some other countries concluded fresh treaties, less liberal than those of the system of 1860, yet much better than anterior arrangements. Great Britain did not formally accept these higher duties; the treaty of February 28, 1882, with France, which secures most favoured nation treatment in other matters, provides that customs duties shall be "henceforth regulated by the internal legislation of each of the two States." In 1892 France also fell out of international tariff arrangements; and adopted the system of double columns of customs duties—one, of lower rates, to be applied to the goods of all nations receiving most favoured treatment; and the other, of higher rates, for countries not on this footing. Germany then took up the treaty tariff policy; and between 1891–94 concluded commercial treaties of twelve years' duration with Austria-Hungary, Belgium, Italy, the Netherlands, Russia, and Switzerland, to favour and develop her trade with those countries. An important series of commercial arrangements was concluded between 1884–1900 respecting the territories and spheres of interest of European powers in western, central, and eastern Africa. In these regions exclusive privileges are not claimed; most favoured nation treatment is recognized, and there is a disposition to extend national treatment to all Europeans and their trade.

The Turkish *Capitulations* are grants made by successive Sultans to Christian nations, conferring rights and privileges in favour of their subjects resident or trading in the Ottoman dominions. In the first instance capitulations were granted specially to each Christian State, beginning with the Genoese in 1453, which entered into pacific relations with Turkey. Afterwards new capitulations were obtained which summed up in one document earlier concessions, and added to them in general terms whatever had been conceded to one or more other States; a stipulation which became a most favoured nation article. The English final capitulations are of this nature; they are dated 1675, and have been confirmed by treaties of subsequent date "now and for ever."

Capitulations signify that which is arranged under distinct headings; the Turkish phrase is "ahid nameh," whereas a treaty is "mouahedé"—the latter does, and the former does not, signify a reciprocal engagement. Thus, although the Turkish capitulations are not in themselves treaties, yet by subsequent confirmation they have acquired the force of commercial treaties, of perpetual duration as regards substance and principles, while details, such as rates of customs duties, may, by mutual consent, be varied from time to time.

The *most favoured nation* article already referred to concedes to the State in the treaty with which it is concluded whatever advantages in the matters comprised within its stipulations have been allowed to any foreign or third State. It does not in itself directly confer any particular rights, but sums up the whole of the rights in the matters therein mentioned which have been or may be granted to foreign countries. The value of the privileges under this article accordingly varies with the conditions as to these rights in each State which concedes this treatment.

The article is drafted in different form:

(1) That contracting States A. and B. agree to extend to each other whatever rights and privileges they concede to countries C. and D., or to C. and D. and any other country. The object in this instance is to ensure specifically to B. and A. whatever advantages C. and D. may possess. A recent instance is Article XI. of the treaty of May 10, 1871, between France and Germany, which binds them respectively to extend to each other whatever advantages they grant to Austria, Belgium, Great Britain, the Netherlands, Russia, and Switzerland.

(2) The present general formula: A. and B. agree to extend to each other whatever advantages they concede to any third country; and engage that no other or higher duties shall be levied on the importation into A. and B. respectively of goods the produce or manufacture of B. and A. than are levied on the like goods the produce or manufacture of any third country the most favoured in this respect. There is a similar clause in regard to exportation.

(3) The conditional or reciprocity formula, often used in the 18th and in the early part of the 19th century, namely, that whenever A. and B. make special concessions in return for corresponding concessions, B. and A. respectively are either excluded from participation therein, or must make some additional equivalent concession in order to participate in those advantages.

It may further be observed that the word "like" relates to the goods themselves, to their material or quality, not to conditions of manufacture, mode of conveyance, or anything beyond the fact of their precise description; small local facilities allowed to traffic between conterminous land districts are not at variance with this article.

*Colonies.*—The application of commercial treaties to colonies depends upon the wording of each treaty. The earlier colonial policy of European States was to subordinate colonial interests to those of the mother country, to reserve colonial trade for the mother country, and to abstain from engagements contrary to these general rules. France, Portugal, and Spain have adhered in principle to this policy. Germany and Holland have been more liberal. The self-government enjoyed by the larger British colonies has led since 1886 to the insertion of an article in British commercial and other treaties whereby the assent of each of these colonies, and likewise of India, is reserved before they apply to each of these possessions. And further, the fact that certain other British colonies are now within the sphere of commercial intercourse controlled by the United States, has since 1891 induced the British Government to enter into special agreements on behalf of colonies for whose products the United States is now the chief market. As regards the most favoured nation article, it is to be remembered that the mother country and colonies are not foreign countries with respect to each other. The most favoured nation article, therefore, does not preclude special arrangements between the mother country and colonies, nor between colonies.

*Termination.*—Commercial treaties are usually concluded for a term of years, and either lapse at the end of this period, or are terminable then, or subsequently, if either State gives the required notice. When a portion of a country establishes its independence, for example the several American Republics, according to present usage foreign trade is placed on a uniform most favoured nation footing, and fresh treaties are entered into to regulate the commercial relations of the new communities. In the case of former Turkish provinces, the capitulations remain in force in principle until they are replaced by new engagements. If one State is absorbed into another, for instance Texas into the United States, or when territory passes by conquest, for instance Alsace to Germany, the commercial treaties of the new supreme Government take effect. In administered territories, Bosnia and Cyprus for instance, and in protected territories, it depends on the policy of the administering power how far the previous fiscal system shall remain in force. When the separate Italian States were united into the Kingdom of Italy in 1861, the commercial engagements of Sardinia superseded those of the other States, but fresh treaties were concluded by the new kingdom to place international relations on a regular footing. When the German Empire was established under the king of Prussia in 1871, the commercial engagements of any State which were at variance with a Zollverein treaty were superseded by that treaty.

The present scope of commercial treaties is well expressed by Monsieur Calvo in his work on International Law. They provide for the importation, exportation, transit, transhipment, and bonding of merchandise; customs tariffs; navigation charges; quarantine; the admission of vessels to roadsteads, ports, and docks; coasting trade; the admission of consuls and their rights; fisheries; they determine the local position of the subjects of each State in the other country in regard to residence, property, payment of taxes or exemptions, and military service; nationality; and a most favoured nation clause. They usually contain a termination, and sometimes a colonial Article. Some of the matters enumerated by Monsieur Calvo—consular privileges, fisheries, and nationality—are now dealt with by separate conventions. Contraband and neutral trade are not included as frequently as they were in the 18th century.

The preceding statement shows that commercial treaties afford to foreigners, personally, legal rights, and relief from technical disabilities: they afford security to trade and navigation, and regulate other matters comprised in their provisions. In Europe the general principles established by the series of treaties 1860–66 hold good, namely, the substitution of uniform rates of customs duties for prohibitions or differential rates. The disadvantages urged are that these treaties involve Government interference and bargaining, whereas each State should act independently as its interests require, that they are opposed to free trade, and restrict the fiscal freedom of the legislature. It may be observed that these objections imply some confusion of ideas. All contracts may be designated bargains, and some of the details of commercial treaties in Monsieur Calvo's enumeration enter directly into the functions of government; moreover, countries cannot remain isolated. Tariff arrangements are, however, open to controversy. Without discussing the Methuen Treaty (notice was given by the Portuguese Government in 1835 that it should be no longer operative), it may be admitted that its policy would not now be adopted. If, however, two countries agree by simultaneous action to adopt fixed rates of duty, this agreement is favourable to commerce, and it is not apparent how it is contrary to free trade principles. If the Legislature is restricted from imposing prohibitions or differential duties, this restriction is not injurious; and when maximum rates of duty are settled, this restriction cannot do harm if its duration is for a limited period; security in business transactions is provided by such tariff arrangements.

Our conclusions are—

(1) that under the varying jurisprudence of nations commercial treaties are adopted by common consent;

(2) that their provisions depend upon the general and fiscal policy of each State;

(3) that tariff arrangements, if judiciously settled, benefit trade;

(4) that prohibitions, and discriminating or differential duties, are injurious to trade; and to international relations;

(5) that the most favoured nation clause leads to equality of

1417 and 1496; France, 1471, 1497, and 1510; Florence, 1490. The commercial treaty policy in England was carried out systematically under Henry IV. and Henry VII. It was continued under James I. to extend to Scotland English trading privileges. The results attained in the 17th century were—regularity in treaty arrangements; their durable instead of personal nature; the conversion of permissive into perfect rights; questions as to contraband and neutral trade stated in definite terms. Treaties were at first limited to exclusive and distinct engagements between the contracting States; each treaty differing more or less in its terms from other similar compacts. Afterwards by extending to a third nation privileges granted to particular countries, the *most favoured nation article* began to be framed. Cromwell continued the commercial treaty policy in order to obtain a formal recognition of the Commonwealth by foreign Powers. His treaty of 1654 with Sweden contains the first reciprocal English most favoured nation clause. Article IV. provides that the people, subjects, and inhabitants of either confederate "shall have and possess in the countries, lands, dominions, and kingdoms of the other as full and ample privileges, and as many exemptions, immunities, and liberties, as any foreigner doth or shall possess in the dominions and kingdoms of the said confederate." The Government of the Restoration replaced and enlarged the Protectorate arrangements by fresh agreements. The general policy of the Commonwealth was maintained, with further provisions on behalf of Colonial Trade. In the new treaty of 1661 with Sweden, the privileges secured were those which "any foreigner whatsoever doth or shall enjoy in the said dominions and kingdoms on both sides."

In contemporary treaties France obtained from Spain (1659) that French subjects should enjoy the same liberties as had been granted to the English; and England obtained from Denmark (1661) that the English should not pay more or greater customs than the people of the United Provinces and other foreigners, the Swedes only excepted. The colonial and navigation policy of the 17th century, and the proceedings of Louis XIV., provoked animosities and retaliatory tariffs. During the war of the Spanish Succession the Methuen Treaty of 1703 was concluded. Portugal removed prohibitions against the importation of British woollens; Great Britain engaged that Portuguese wines should pay one-third less duty than the rate levied on French wines. At the Peace of Utrecht in 1713 political and commercial treaties were concluded. England agreed to remove prohibitions on the importation of French goods, and to grant most favoured nation treatment in relation to goods and merchandise of the like nature from any other country in Europe; the French general tariff of September 18, 1664, was to be again put in force for English trade. The English provision was at variance with the Methuen Treaty. A violent controversy arose as to the relative importance in 1713 of Anglo-Portuguese or Anglo-French trade. In the end the House of Commons, by a majority of 9, rejected the Bill to give effect to the commercial treaty of 1713; and trade with France remained on an unsatisfactory footing until 1786. The other commercial treaties of Utrecht were very complete in their provisions, equal to those of the present time; and contained most favoured nation articles—England secured in 1715 reduction of duties on woollens imported into the Austrian Netherlands; and trading privileges in Spanish America. Moderate import duties for woollens were obtained in Russia by the Commercial treaty of 1766. In the meanwhile the Bourbon family compact of August 15, 1761, assured national treatment for the subjects of France, Spain, and the Two Sicilies, and for their trade in the European territories of the other two States; and most favoured nation treatment as regards any special terms granted to any foreign country. The first commercial treaties concluded by the United States with European countries contained most favoured nation clauses: this policy has been continued by the United States, but the wording of the clause has often varied.

In 1786 France began to effect tariff reform by means of commercial treaties. The first was with Great Britain, and it terminated the long-continued tariff warfare. But the wars of the French Revolution swept away these reforms, and brought about a renewal of hostile tariffs. Prohibitions and differential duties were renewed, and prevailed on the Continent until the sixth decade of the 19th century. In 1860 a Government existed in France sufficiently strong and liberal to revert to the policy of 1786. The bases of the Anglo-French treaty of 1860, beyond its most favoured nation provisions, were in France a general transition from prohibition or high customs duties to a moderate tariff; in the United Kingdom abandonment of all protective imposts, and reduction of duties maintained for fiscal purposes to the lowest rates compatible with these exigencies. Other European countries were obliged to obtain for their trade the benefit of the conventional tariff thus established in France, as an alternative to the high rates inscribed in the general tariff. A series of commercial treaties was accordingly concluded by different European States between 1861 and 1866, which effected further reductions of customs duties in the several countries which came within this treaty system. In 1871 the Republican Government sought to terminate the treaties of the Empire. The British negotiators nevertheless obtained the relinquishment of the attempt to levy protective duties under the guise of compensation for imposts on raw materials; the duration of the treaty of 1860 was prolonged; and stipulations better worded than those before in force were agreed to for shipping and most favoured nation treatment. In 1882, however, France terminated her existing European tariff treaties. Belgium and some other countries concluded fresh treaties, less liberal than those of the system of 1860, yet much better than anterior arrangements. Great Britain did not formally accept these higher duties; the treaty of February 28, 1882, with France, which secures most favoured nation treatment in other matters, provides that customs duties shall be "henceforth regulated by the internal legislation of each of the two States." In 1892 France also fell out of international tariff arrangements; and adopted the system of double columns of customs duties—one, of lower rates, to be applied to the goods of all nations receiving most favoured treatment; and the other, of higher rates, for countries not on this footing. Germany then took up the treaty tariff policy; and between 1891–94 concluded commercial treaties of twelve years' duration with Austria-Hungary, Belgium, Italy, the Netherlands, Russia, and Switzerland, to favour and develop her trade with those countries. An important series of commercial arrangements was concluded between 1884–1900 respecting the territories and spheres of interest of European powers in western, central, and eastern Africa. In these regions exclusive privileges are not claimed; most favoured nation treatment is recognized, and there is a disposition to extend national treatment to all Europeans and their trade.

The Turkish *Capitulations* are grants made by successive Sultans to Christian nations, conferring rights and privileges in favour of their subjects resident or trading in the Ottoman dominions. In the first instance capitulations were granted specially to each Christian State, beginning with the Genoese in 1453, which entered into pacific relations with Turkey. Afterwards new capitulations were obtained which summed up in one document earlier concessions, and added to them in general terms whatever had been conceded to one or more other States; a stipulation which became a most favoured nation article. The English final capitulations are of this nature; they are dated 1675, and have been confirmed by treaties of subsequent date "now and for ever."

Capitulations signify that which is arranged under distinct headings; the Turkish phrase is "ahid nameh," whereas a treaty is "mouahedé"—the latter does, and the former does not, signify a reciprocal engagement. Thus, although the Turkish capitulations are not in themselves treaties, yet by subsequent confirmation they have acquired the force of commercial treaties, of perpetual duration as regards substance and principles, while details, such as rates of customs duties, may, by mutual consent, be varied from time to time.

The *most favoured nation* article already referred to concedes to the State in the treaty with which it is concluded whatever advantages in the matters comprised within its stipulations have been allowed to any foreign or third State. It does not in itself directly confer any particular rights, but sums up the whole of the rights in the matters therein mentioned which have been or may be granted to foreign countries. The value of the privileges under this article accordingly varies with the conditions as to these rights in each State which concedes this treatment.

The article is drafted in different form:

(1) That contracting States A. and B. agree to extend to each other whatever rights and privileges they concede to countries C. and D., or to C. and D. and any other country. The object in this instance is to ensure specifically to B. and A. whatever advantages C. and D. may possess. A recent instance is Article XI. of the treaty of May 10, 1871, between France and Germany, which binds them respectively to extend to each other whatever advantages they grant to Austria, Belgium, Great Britain, the Netherlands, Russia, and Switzerland.

(2) The present general formula: A. and B. agree to extend to each other whatever advantages they concede to any third country; and engage that no other or higher duties shall be levied on the importation into A. and B. respectively of goods the produce or manufacture of B. and A. than are levied on the like goods the produce or manufacture of any third country the most favoured in this respect. There is a similar clause in regard to exportation.

(3) The conditional or reciprocity formula, often used in the 18th and in the early part of the 19th century, namely, that whenever A. and B. make special concessions in return for corresponding concessions, B. and A. respectively are either excluded from participation therein, or must make some additional equivalent concession in order to participate in those advantages.

It may further be observed that the word "like" relates to the goods themselves, to their material or quality, not to conditions of manufacture, mode of conveyance, or anything beyond the fact of their precise description; small local facilities allowed to traffic between conterminous land districts are not at variance with this article.

*Colonies.*—The application of commercial treaties to colonies depends upon the wording of each treaty. The earlier colonial policy of European States was to subordinate colonial interests to those of the mother country, to reserve colonial trade for the mother country, and to abstain from engagements contrary to these general rules. France, Portugal, and Spain have adhered in principle to this policy. Germany and Holland have been more liberal. The self-government enjoyed by the larger British colonies has led since 1886 to the insertion of an article in British commercial and other treaties whereby the assent of each of these colonies, and likewise of India, is reserved before they apply to each of these possessions. And further, the fact that certain other British colonies are now within the sphere of commercial intercourse controlled by the United States, has since 1891 induced the British Government to enter into special agreements on behalf of colonies for whose products the United States is now the chief market. As regards the most favoured nation article, it is to be remembered that the mother country and colonies are not foreign countries with respect to each other. The most favoured nation article, therefore, does not preclude special arrangements between the mother country and colonies, nor between colonies.

*Termination.*—Commercial treaties are usually concluded for a term of years, and either lapse at the end of this period, or are terminable then, or subsequently, if either State gives the required notice. When a portion of a country establishes its independence, for example the several American Republics, according to present usage foreign trade is placed on a uniform most favoured nation footing, and fresh treaties are entered into to regulate the commercial relations of the new communities. In the case of former Turkish provinces, the capitulations remain in force in principle until they are replaced by new engagements. If one State is absorbed into another, for instance Texas into the United States, or when territory passes by conquest, for instance Alsace to Germany, the commercial treaties of the new supreme Government take effect. In administered territories, Bosnia and Cyprus for instance, and in protected territories, it depends on the policy of the administering power how far the previous fiscal system shall remain in force. When the separate Italian States were united into the Kingdom of Italy in 1861, the commercial engagements of Sardinia superseded those of the other States, but fresh treaties were concluded by the new kingdom to place international relations on a regular footing. When the German Empire was established under the king of Prussia in 1871, the commercial engagements of any State which were at variance with a Zollverein treaty were superseded by that treaty.

The present scope of commercial treaties is well expressed by Monsieur Calvo in his work on International Law. They provide for the importation, exportation, transit, transhipment, and bonding of merchandise; customs tariffs; navigation charges; quarantine; the admission of vessels to roadsteads, ports, and docks; coasting trade; the admission of consuls and their rights; fisheries; they determine the local position of the subjects of each State in the other country in regard to residence, property, payment of taxes or exemptions, and military service; nationality; and a most favoured nation clause. They usually contain a termination, and sometimes a colonial Article. Some of the matters enumerated by Monsieur Calvo—consular privileges, fisheries, and nationality—are now dealt with by separate conventions. Contraband and neutral trade are not included as frequently as they were in the 18th century.

The preceding statement shows that commercial treaties afford to foreigners, personally, legal rights, and relief from technical disabilities: they afford security to trade and navigation, and regulate other matters comprised in their provisions. In Europe the general principles established by the series of treaties 1860–66 hold good, namely, the substitution of uniform rates of customs duties for prohibitions or differential rates. The disadvantages urged are that these treaties involve Government interference and bargaining, whereas each State should act independently as its interests require, that they are opposed to free trade, and restrict the fiscal freedom of the legislature. It may be observed that these objections imply some confusion of ideas. All contracts may be designated bargains, and some of the details of commercial treaties in Monsieur Calvo's enumeration enter directly into the functions of government; moreover, countries cannot remain isolated. Tariff arrangements are, however, open to controversy. Without discussing the Methuen Treaty (notice was given by the Portuguese Government in 1835 that it should be no longer operative), it may be admitted that its policy would not now be adopted. If, however, two countries agree by simultaneous action to adopt fixed rates of duty, this agreement is favourable to commerce, and it is not apparent how it is contrary to free trade principles. If the Legislature is restricted from imposing prohibitions or differential duties, this restriction is not injurious; and when maximum rates of duty are settled, this restriction cannot do harm if its duration is for a limited period; security in business transactions is provided by such tariff arrangements.

Our conclusions are—

(1) that under the varying jurisprudence of nations commercial treaties are adopted by common consent;

(2) that their provisions depend upon the general and fiscal policy of each State;

(3) that tariff arrangements, if judiciously settled, benefit trade;

(4) that prohibitions, and discriminating or differential duties, are injurious to trade; and to international relations;

(5) that the most favoured nation clause leads to equality of

treatment and simplification of tariffs, and has become a most valuable provision alike for persons, trade, and navigation;

(6) that commercial treaties are now entered into by all States; and that they are necessary under modern conditions of commercial intercourse between nations. (C. M. K.*)

**Commons.**—*Early History.*—Commons are a relic of the system on which the lands of England were for the most part cultivated during the Middle Ages. The country was divided into vills, or townships—often, though not necessarily, or always, coterminous with the parish. In each stood a cluster of houses, a village, in which dwelt the men of the township, and around the village lay the arable fields and other lands, which they worked as one common farm. Save for a few small inclosures near the village—for gardens, orchards, or paddocks for young stock—the whole township was free from permanent fencing. The arable lands lay in large tracts, divided into compartments or fields, usually three in number, to receive in constant rotation the triennial succession of wheat (or rye), spring crops (such as barley, oats, beans, or peas), and fallow. Low-lying lands were used as meadows, and there were sometimes pastures fed according to fixed rules. The poorest land of the township was left waste—to supply feed for the cattle of the community, fuel, wood for repairs, and any other commodity of a renewable or practically inexhaustible character.[1] This waste land is the common of our own days.

It would seem likely that at one time there was no division, as between individual inhabitants or householders, of any of the lands of the township, but only of the products. But so far back as accurate information extends the arable land is found to be parcelled out, each householder owning strips in each field. These strips are always long and narrow, and lie in sets parallel with one another. The plough for cultivating the fields was maintained at the common expense of the village, and the draught oxen were furnished by the householders. From the time when the crop was carried till the next sowing, the field lay open to the cattle of the whole vill, which also had the free run of the fallow field throughout the year. But when two of the three fields were under crops, and the meadows laid up for hay, it is obvious that the cattle of the township required some other resort for pasturage. This was supplied by the waste or common. Upon it the householder turned out the oxen and horses which he contributed to the plough, and the cows and sheep, which were useful in manuring the common fields,—in the words of an old law case: "horses and oxen to plough the land, and cows and sheep to compester it." Thus the use of the common by each householder was naturally measured by the stock which he kept for the service of the common fields; and when, at a later period, questions arose as to the extent of the rights on the common, the necessary practice furnished the rule, that the commoner could turn out as many head of cattle as he could keep by means of the lands which were parcelled out to him,—the rule of levancy and couchancy, which has come down to the present day.

*Status of township.*

In the earliest post-Conquest times the vill or township is found to be associated with an over-lord. There has been much controversy on the question, whether the vill originally owned its lands free from any control, and was subsequently reduced to a state of subjection and to a large extent deprived of its ownership, or whether its whole history has been one of gradual emancipation, the ownership of the waste, or common, now ascribed by the law to the lord being a remnant of his ownership of all the lands of the vill. (See MANOR.)

At whatever date the over-lord first appeared, and whatever may have been the personal relations of the villagers to him from time to time after his appearance, there can be hardly any doubt that the village lands, whether arable, meadow, or waste, were substantially the property of the villagers for the purposes of use and enjoyment. They resorted freely to the common for such purposes as were incident to their system of agriculture, and regulated its use amongst themselves. The idea that the common was the "lord's waste," and that he had the power to do what he liked with it, subject to specific and limited qualifying rights in others, was, there is little doubt, the creation of the Norman lawyers.

*Statutes of Merton and Westminster the Second.*

One of the earliest assertions of the lord's proprietary interest in waste lands is contained in the Statute of Merton, a statute which, it is well to notice, was passed in one of the first assemblies of the Barons of England, before the Commons of the Realm were summoned to Parliament. This statute, which became law in the year 1235, provided "that the great men of England (which had enfeoffed knights and their freeholders of small tenements in their great manors)" might "make their profit of their lands, wastes, woods, and pastures," if they left sufficient pasture for the service of the tenements they had granted. Some fifty years later, another statute, that of Westminster the Second, supplemented the Statute of Merton by enabling the lord of the soil to inclose common lands, not only against his own tenants, but against "neighbours" claiming pasture there. These two pieces of legislation undoubtedly mark the growth of the doctrine which converted the over-lord's territorial sway into property of the modern kind, and a corresponding loosening of the hold of the rural townships on the wastes of their neighbourhood. To what extent the two Acts were used, it is very difficult to say. We know, from later controversies, that they made no very great change in the system on which the country was cultivated, a system to which, as we have seen, commons were essential. In some counties, indeed, inclosures had, by the Tudor period, made greater progress than in others. Tusser, in his eulogium on inclosed farming, cites Suffolk and Essex as inclosed counties by way of contrast to Norfolk, Cambridgeshire, and Leicestershire, where the open or "champion" (champain) system prevailed. The Statutes of Merton and Westminster may have had something to do with the progress of inclosed farming; but it is probable that their chief operation lay in furnishing the lord of the manor with a farm on the new system, side by side with the common fields, or with a deer park.

*The Black Death.*

The first event which really endangered the village system was the coming of the Black Death. This scourge is said to have swept away half the population of the country. The disappearance, by no means uncommon, of a whole family gave the over-lord of the vill the opportunity of appropriating, by way of escheat, the holding of the household in the common fields. The land-holding population of the townships and the persons interested in the commons were thus sensibly diminished.

During the Wars of the Roses the small cultivator is thought to have again made headway. But his diminished numbers, and the larger interest which the lords had acquired in the lands of each vill, no doubt facilitated the determined attack on the common-field system which marked the reigns of Henry VIII. and Edward VI.

[1] There is an entry on the Court Rolls of the Manor of Wimbledon of the division amongst the inhabitants of the vill of the crab-apples growing on the common.

This attack, which had for its chief object the conversion of arable land into pasture for the sake of sheep-breeding, was the outcome of many causes. It was no longer of importance to a territorial magnate to possess a large body of followers pledged to his interests by their connexion with the land. On the other hand, wool commanded a high price, and the growth of towns and of foreign commerce supplied abundant markets. At the same time the confiscation of the monastic possessions introduced a race of new over-lords—not bound to their territories by any family traditions, and also tended to spread the view that the strong hand was its own justification. In order to keep large flocks and send many bales of wool to market, each landowner strove to increase his range of pasture, and with this view to convert the arable fields of his vill into grass land. There is abundant evidence both from the complaints of writers such as Latimer and Sir Thomas More, and from the Statutes and Royal Commissions of the day, that large inclosures were made at this time, and that the process was effected with much injustice and accompanied by great hardship. "Where," says Bishop Latimer in one of his courageous and vigorous denunciations of "inclosers and rent-raisers," "there have been many householders and inhabitants, there is now but a shepherd and his dog." In the full tide of this movement, and despite Latimer's appeals, the Statutes of Merton and Westminster the Second were confirmed and re-enacted. Both common fields and commons no doubt disappeared in many places; and the country saw the first notable instalment of inclosure. But from the evidence of later years it is clear that a very large area of the country was still cultivated on the common-field system for another couple of centuries. When inclosure on any considerable scale again came into favour, it was effected on quite different principles; and before describing what was essentially a modern movement, it will be convenient to give a brief outline of the principles of law applicable to commons at the present day.

***The Tudor agrarian revolution.***

*Law.*—The distinguishing feature in law of common land is, that it is land the soil of which belongs to one person, and from which certain other persons take certain profits—for example, the bite of the grass by the mouth of cattle, or gorse, bushes, or heather for fuel or litter. The right to take such a profit is a right of common; the right to feed cattle on common land is a right of common of pasture; while the right of cutting bushes, gorse, or heather (more rarely of lopping trees) is known as a right of common of estovers or botes (from the Norman-French *estouffer*, and the Saxon *botan*, to furnish). Another right of common is that of turbary, or the right to cut turf or peat for fuel. There are also rights of taking sand, gravel, or loam for the repair and maintenance of land. The persons who enjoy any of these rights are called commoners.

***Rights of Common.***

From the sketch of the common-field system of agriculture which has been given, we shall readily infer that a large proportion of the commons of the country, and of the peculiarities of the law relating to commons, are traceable to that system. Thus, common rights are mostly attached to, or enjoyed with, certain lands or houses. A right of common of pasture usually consists of the right to turn out as many cattle as the farm or other private land of the commoner can support in winter; for, as we have seen, the enjoyment of the common, in the village system, belonged to the householders of the village, and was necessarily measured by their holdings in the common fields. The cattle thus commonable are said to be levant and couchant, *i.e.*, uprising and down-lying on the land. But it has now been decided that they need not in fact be so kept. At the present day a commoner may turn out any cattle belonging to him, wherever they are kept, provided they do not exceed in number the head of cattle which can be supported by the stored summer produce of the land in respect of which the right is claimed, together with any winter herbage it produces. The animals which a commoner may usually turn out are those which were employed in the village system—horses, oxen, cows, and sheep. These animals are termed commonable animals. A right may be claimed for other animals, such as donkeys, pigs, and geese; but they are termed non-commonable, and the right can only be established on proof of special usage. A right of pasture attached to land in the way we have described is said to be "appendant" or "appurtenant" to such land. Common of pasture appendant to land can only be claimed for commonable cattle; and it is held to have been originally attached only to arable land, though in claiming the right no proof that the land was originally arable is necessary. This species of common right is, in fact, the direct survival of the use by the village householder of the common of the township; while common of pasture appurtenant represents rights which grew up between neighbouring townships, or, in later times, by direct grant from the owner of the soil of the common to some other landowner, or (in the case of copyholders) by local custom.

The characteristic of connexion with house or land also marks other rights of common. Thus a right of taking gorse or bushes, or of lopping wood for fuel, called fire-bote, is limited to the taking of such fuel as may be necessary for the hearths of a particular house, and no more may be taken than is thus required. The same condition applies to common of turbary, which in its more usual form authorizes the commoner to cut the heather, which grows thickly upon poor soils, with the roots and adhering earth, to a depth of about 9 inches. Similarly, wood taken for the repairs of buildings (house-bote), or of hedges (hedge-bote or hey-bote), must be limited in quantity to the requirements of the house, farm buildings, and hedges of the particular property to which the right is attached. And heather taken for litter cannot be taken in larger quantities than is necessary for manuring the lands in respect of which the right is enjoyed. It is illegal to take the wood or heather from the common, and to sell it to any one who has not himself a right to take it. So, also, a right of digging sand, gravel, clay, or loam is usually appurtenant to land, and must be exercised with reference to the repair of the roads, or the improvement of the soil, of the particular property to which the right is attached.

We have already alluded to the fact that, in Norman and later days, every vill or township was associated with some over-lord,—some one responsible to the crown, either directly or through other superior lords, for the holding of the land and the performance of certain duties of defence and military support. To this lord the law has assigned the ownership of the soil of the common of the vill; and the common has for many centuries been styled the waste of the manor. The trees and bushes on the common belong to the lord, subject to any rights of lopping or cutting which the commoners may possess. The ground, sand, and subsoil are his, and even the grass, though the commoners have the right to take it by the mouths of their cattle. To the over-lord, also, was assigned a seignory over all the other lands of the vill; and the vill came to be termed his manor. At the present day it is the manorial system which must be invoked in most cases as the foundation of the curiously conflicting rights which co-exist on a common. (See MANOR.)

**Manorial Commons.**

Within the bounds of a manor, speaking generally, there are three classes of persons possessing an interest in the land, viz.:—

(*a*) Persons holding land freely of the manor, or freehold tenants.

(*b*) Persons holding land of the manor by copy of Court Roll, or copyhold tenants.

(*c*) Persons holding from the lord of the manor, by lease or agreement, or from year to year, land which was originally demesne, or which was once freehold or copyhold and has come into the lord's hands by escheat or forfeiture.

Amongst the first two classes we usually find the majority of the commoners on the wastes or commons of the manor. To every freehold tenant belongs a right of common of pasture on the commons, such right being "appendant" to the land which he holds freely of the manor. This right differs from most other rights of common in the characteristic that actual exercise of the right need not be proved. When once it is shown that certain land is held freely of the manor, it follows of necessity that a right of common of pasture for commonable cattle attaches to the land, and therefore belongs to its owner, and may be exercised by its occupant. "Common appendant," said the Elizabethan judges, "is of common right, and commences by operation of law and in favour of tillage."

Now this is exactly what we saw to be the case with reference to the use of the common of the vill by the householder cultivating the arable fields. The use was a necessity, not depending upon the habits of this or that householder; it was a use for commonable cattle only, and was connected with the tillage of the arable lands. It seems almost necessarily to follow that the freehold tenants of the manor are the representatives of the householders of the vill. However this may be, it is amongst the freehold tenants of the manor that we must first look for commoners on the waste of the manor.

Owing, however, to the light character of the services rendered by the freeholders, the connexion of their lands with the manor is often difficult to prove. Copyhold tenure, on the other hand, cannot be lost sight of; and in many manors copyholders are numerous, or were, till quite recently. Copyholders almost invariably possess a right of common on the waste of the manor; and when (as is usual) they exist side by side with freeholders, their rights are generally of the same character. They do not, however, exist as of common right, without proof of usage, but by the custom of the manor. Custom has been defined by a great judge (the late Sir George Jessel, M.R.) as local law. Thus, while the freehold tenants enjoy their rights by the general law of the land, the copyholders have a similar enjoyment by the local law of the manor. This, again, is what one might expect from the ancient constitution of a village community. The copyholders, being originally serfs, had no rights at law; but as they had a share in the tillage of the land, and gradually became possessed of strips in the common fields, or of other plots on which they were settled by the lord, they were admitted by way of indulgence to the use of the common; and the practice hardened into a custom. As might be expected, there is more variety in the details of the rights they exercise. They may claim common for cattle which are not commonable, if the custom extends to such cattle; and their claim is not necessarily connected with arable land.

In the present day large numbers of copyhold tenements have been enfranchised, *i.e.*, converted into freehold. The effect of this step is to sever all connexion between the land enfranchised and the manor of which it was previously held. Technically, therefore, the common rights previously enjoyed in respect of the land would be gone. When, however, there is no indication of any intention to extinguish such rights, the courts protect the copyholders in their continued enjoyment; and when an enfranchisement is effected under the statutes passed in modern years, the rights are expressly preserved. The commoners on a manorial common then will be, *primâ facie*, the freeholders and copyholders of the manor, and the persons who own lands which were copyhold of the manor but have been enfranchised.

The occupants of lands belonging to the lord of the manor, though they usually turn out their cattle on the common, do so by virtue of the lord's ownership of the soil of the common, and can, as a rule, make no claim to any right of common as against the lord, even though the practice of turning out may have obtained in respect of particular lands for a long series of years. When, however, lands have been sold by the lord of the manor, although no right of common attached by law to such lands in the lord's hands, their owners may subsequently enjoy such a right, if it appears from the language of the deeds of conveyance, and all the surrounding circumstances, that there was an intention that the use of the common should be enjoyed by the purchaser. The rules on this point are very technical; it is sufficient here to indicate that lands bought from a lord of a manor are not necessarily destitute of common rights.

**Rights of common not connected with manorial system.**

So far we have considered common rights as they have arisen out of the manorial system, and out of the still older system of village communities. There may, however, be rights of common quite unconnected with the manorial system. Such rights may be proved either by producing a specific grant from the owner of the manor or by long usage. It is seldom that an actual grant is produced, although it would seem likely that such grants were not uncommon at one time. But a claim founded on actual user is by no means unusual. Such a claim may be based (*a*) on immemorial usage, *i.e.*, usage for which no commencement later than the coronation of Richard I. can be shown, (*b*) on a presumed modern grant which has been lost, or (*c*) (in some cases) on the Prescription Act. There are special rules applicable to each kind of claim.

A right of common not connected with the manorial system may be, and usually is, attached to land; it may be measured, like a manorial right, by levancy and couchancy, or it may be limited to a fixed number of animals. Rights of the latter character seem to have been not uncommon in the Middle Ages. In one of his sermons against inclosure, Bishop Latimer tells us his father "had walk (*i.e.*, right of common) for 100 sheep." This may have been a right in gross, but was more probably attached to the "farm of £3 or £4 by year at the uttermost" which his father held. In a recent case a right of common for 200 sheep over the waste of the manor of Banstead was established in respect of the manor of South Tadworth. Such a right may be sold separately, and enjoyed by a purchaser independently of the tenement to which it was originally appurtenant. It then becomes a right of common in gross.

A right of common in gross is a right enjoyed irrespective of the ownership or occupancy of any lands. It may exist by express grant, or by user implying a modern lost grant, or by immemorial usage. It must be limited to a certain number of cattle, unless the right is claimed by actual grant. Such rights seldom arise in connexion with commons in the ordinary sense, but are a frequent incident of regulated or stinted pastures; the right is then generally known as a cattle-gate or beast-gate.

There may be rights over a common which exclude the owner of the soil from all enjoyment of some particular product of the common. Thus a person, or a class of persons, may be entitled to the whole of the corn, grass, underwood, or sweepage (*i.e.*, everything which falls to the

sweep of the scythe) of a tract of land, without possessing any ownership in the land itself, or in the trees or mines. Such a right is known as a right of sole vesture.

A more limited right of the same character is a right of sole pasturage—the exclusive right to take everything growing on the land in question by the mouths of cattle, but not in any other way. Either of these rights may exist throughout the whole year, or during part only. A right of sole common pasturage and herbage was given to a certain class of commoners in Ashdown Forest on the partition of the forest at the end of the 18th century.

***Rights in common fields.***

We have seen that the common arable fields and common meadows of a vill were thrown open to the stock of the community between harvest and seed-time. There is still to be found, here and there, a group of arable common fields, and occasionally a piece of grass land with many of the characteristics of a common, which turns out to be a common field or meadow. The Hackney Marshes and the other so-called commons of Hackney are really common fields or common meadows, and along the valley of the Lea a constant succession of such meadows is met with. They are still owned in parcels marked by metes; the owners have the right to grow a crop of hay between Lady Day and Lammas Day; and from Lammas to March the lands are subject to the depasturage of stock. In the case of some common fields and meadows the right of feed during the open time belongs exclusively to the owners; in others to a larger class, such as the owners and occupiers of all lands within the bounds of the parish. Anciently, as we have seen, the two classes would be identical. In some places new-comers not owning strips in the fields were admitted to the right of turn out; in others, not. Hence the distinction. Similar divergences of practice will be found to exist in Switzerland at the present day; *nieder-gelassene*, or new-comers, are in some communes admitted to all rights, while, in others, privileges are reserved to the *bürger*, or old inhabitant householders.

***Rights in Royal Forests.***

Some of the largest tracts of waste land to be found in England are the waste or commonable lands of Royal Forests or Chases. The thickets and pastures of Epping Forest, now happily preserved for London under the guardianship of the City Corporation, and the noble woods and far-stretching heaths of the New Forest, will be called to mind. Cannock Chase, unhappily inclosed according to law, though for the most part still lying waste, Dartmoor, and Ashdown Forest in Sussex, are other instances; and the list might be greatly lengthened. Space will not permit of any description of the forest system; it is enough, in this connexion, to say that the common rights in a forest were usually enjoyed by the owners and occupiers of land within its bounds (the class may differ in exact definition, but is substantially equivalent to this) without reference to manorial considerations. Epping Forest was saved by the proof of this right. It is often said that the right was given, or confirmed, to the inhabitants in consideration of the burden of supporting the deer for the pleasure of the king or of the owner of the chase. It seems more probable that the forest law prevented the growth of the manorial system, and with it those rules which have tended to restrict the class of persons entitled to enjoy the waste lands of the district.

***Prevention of inclosure.***

We have seen that in the case of each kind of common there is a division of interest. The soil belongs to one person; other persons are entitled to take certain products of the soil. This division of interest preserves the common as an open space. The commoners cannot inclose, because the land does not belong to them. The owner of the soil cannot inclose, because inclosure is inconsistent with the enjoyment of the commoners' rights. At a very early date it was held that the right of a commoner proceeded out of every part of the common, so that the owner of the soil could not set aside part for the commoner and inclose the rest. The Statutes of Merton and Westminster the Second were passed to get over this difficulty. But under these statutes the burden of proving that sufficient pasture was left was thrown upon the owner of the soil; such proof can very seldom be given. Moreover, the statutes have never enabled an inclosure to be made against commoners entitled to estovers or turbary. It seems clear that the statutes had become obsolete in the time of Edward VI., or they would not have been re-enacted. And we know that the zealous advocates of inclosure in the 18th century considered them worthless for their purposes. Practically it may be taken that, save where the owner of the soil of a common acquires all the lands in the township (generally coterminous with the parish) with which the common is connected, an inclosure cannot legally be effected by him. And even in the latter case it may be that rights of common are enjoyed in respect of lands outside the parish, and that such rights prevent an inclosure.

***The modern Inclosure Act.***

*Modern Inclosure.*—When, therefore, the common-field system began to fall out of gear, and the increase of population brought about a demand for an increased production of corn, it was felt to be necessary to resort to Parliament for power to effect inclosure. The legislation which ensued was based on two principles. One was, that all persons interested in the open land to be dealt with should receive a proportionate equivalent in inclosed land; the other, that inclosure should not be prevented by the opposition, or the inability to act, of a small minority. Assuming that inclosure was desirable, no more equitable course could have been adopted, though in details particular Acts may have been objectionable. The first Act was passed in 1709; but the precedent was followed but slowly, and not till the middle of the 18th century did the annual number of Acts attain double figures. The high-water mark was reached in the period from 1765 to 1785, when on an average forty-seven Acts were passed every year. From some cause, possibly the very considerable expense attending upon the obtaining of an Act, the numbers then began slightly to fall off. In the year 1793 a Board of Agriculture, apparently similar in character to the Chambers of Commerce of our own day, was established. Sir John Sinclair was its president, and Arthur Young, the well-known agricultural reformer, was its secretary. Owing to the efforts of this body, and of a Select Committee appointed by the House of Commons on Sinclair's motion, the first General Inclosure Act was passed in 1801. This Act would at the present day be called an Inclosure Clauses Act. It contained a number of provisions applicable to inclosures, which could be incorporated, by reference, in a private Bill. By this means, it was hoped, the length and complexity, and consequently the expense, of inclosure Bills would be greatly diminished. Under the stimulus thus applied inclosure proceeded apace. In the year 1801 no less than 119 Acts were passed, and the total area inclosed probably exceeded 300,000 acres. Three inclosures in the Lincolnshire Fens account for over 53,000 acres. As before, the movement after a time spent its force, the annual average of Acts falling to about twelve in the decade 1830–40. Another Parliamentary committee then sat to consider how inclosure might be promoted; and the result was the Inclosure Act, 1845, which, though much amended by subsequent legislation, still stands on the statute-book. The chief feature of that

Act was the appointment of a permanent Commission to make in each case all the inquiries previously made (no doubt capriciously and imperfectly) by Committees of the two Houses. The Commission, on being satisfied of the propriety of an inclosure, was to draw up a provisional order prescribing the general conditions on which it was to be carried out, and this order was to be submitted to Parliament by the Government of the day for confirmation. It is believed that these inclosure orders afford the first example of the provisional order system of legislation, which has recently attained such large proportions.

Again inclosure moved forward, and between 1845 and 1869 (when it received a sudden check) 600,000 acres passed through the hands of the Inclosure Commission. Taking the whole period of about a century and a half, when Parliamentary inclosure was in favour, and making an estimate of acreage where the Acts do not give it, the result may be thus summarized:—

| | Acres. |
|---|---|
| From 1709 to 1797 . . . . | 2,744,926 |
| ,, 1801 to 1842 . . . . | 1,307,964 |
| ,, 1845 to 1869 . . . . | 618,000 |
| Add for Forests inclosed under Special Acts . . . . . | 100,000 |
| | 4,770,890 |

The total area of England being 37,000,000 acres, we shall probably not be far wrong in concluding that about one acre in every seven was inclosed during the period in question. During the first period, the lands inclosed consisted mainly of common arable fields; during the second, many great tracts of moor and fen were reduced to severalty ownership. In the third period, inclosure probably related chiefly to the ordinary manorial common; and it seems likely that, on the whole, England would have gained, had inclosure stopped in 1845.

***Open space movement.***

As a fact it stopped in 1869. Before the Inclosure Commission had been in existence twenty years the feeling of the nation towards commons began to change. The rapid growth of towns, and especially of London, and the awakening sense of the importance of protecting the public health, brought about an appreciation of the value of commons as open spaces. Naturally, the metropolis saw the birth of this sentiment. An attempted inclosure in 1864 of the commons at Epsom and Wimbledon aroused strong opposition; and a Select Committee of the House of Commons was appointed to consider how the London commons could best be preserved. The Metropolitan Board of Works, then in the vigour of youth, though eager to become the open-space authority for London, could make no better suggestion than that all persons interested in the commons should be bought out, that the board should defray the expense by selling parts for building, and should make parks of what was left. Had this advice been followed, London would probably have lost two-thirds of the open space which she now enjoys. Fortunately a small knot of men, who afterwards formed the Commons Preservation Society, took a broader and wiser view. Chief amongst them were the late Mr Philip Lawrence, who acted as solicitor to the Wimbledon opposition, and subsequently organized the Commons Preservation Society, Mr George Shaw-Lefevre, chairman of that Society since its foundation, the late Mr John Locke, and the late Lord Mount Temple (then Mr W. F. Cowper). They urged that the conflict of legal interests, which is the special characteristic of a common, might be trusted to preserve it as an open space, and that all that Parliament could usefully do, was to restrict Parliamentary inclosure, and to pass a measure of police for the protection of commons as open spaces. The Select Committee adopted this view. On their report, was passed the Metropolitan Commons Act, 1866, which prohibited any further Parliamentary inclosures within the Metropolitan police area, and provided means by which a common could be put under local management. The lords of the manors in which the London commons lay felt that their opportunity of making a rich harvest out of land, valuable for building, though otherwise worthless, was slipping away; and a battle royal ensued. Inclosures were commenced, and the Statute of Merton prayed in aid. The public retorted by legal proceedings taken in the names of commoners. These proceedings—which culminated in the mammoth suit as to Epping Forest, with the Corporation of London as plaintiffs and fourteen lords of manors as defendants—were uniformly successful; and London commons were saved. By degrees the manorial lords, seeing that they could not hope to do better, parted with their interest for a small sum to some local authority; and a large area of the common land, not only in the county of London but in the suburbs, is now in the hands of the representatives of the ratepayers, and is definitely appropriated to the recreation of the public.

***Amendment of Statute of Merton.***

Moreover, the Commons Preservation Society was able to base, upon the uniform success of the commoners in the law courts, a plea for the amendment of the law. The Statute of Merton, we have seen, purports to enable the lord of the soil to inclose a common, if he leaves sufficient pasture for the commoners. This statute was constantly vouched in the litigation about London commons; but in no single instance was an inclosure justified by virtue of its provisions. It thus remained a trap to lords of manors, and a source of controversy and expense. In the year 1893 Lord Thring, at the instance of the Commons Preservation Society, carried through Parliament the Commons Law Amendment Act, which provided that in future no inclosure under the Statute of Merton should be valid, unless made with the consent of the Board of Agriculture, which was to consider the expediency of the inclosure from a public point of view.

***Rural commons.***

The movement to preserve commons as open spaces soon spread to the rural districts. Under the Inclosure Act of 1845 provision was made for the allotment of a part of the land to be inclosed for field gardens for the labouring poor, and for recreation. But those who were interested in effecting an inclosure often convinced the Inclosure Commissioners, that for some reason such allotments would be useless. To such an extent did the reservation of such allotments become discredited that, in 1869, the Commission proposed to Parliament the inclosure of 13,000 acres, with the reservation of only one acre for recreation, and none at all for field gardens. This proposal attracted the attention of the late Mr Fawcett, who, after much inquiry and consideration, came to the conclusion that inclosures were, speaking generally, doing more harm than good to the agricultural labourer, and that, under such conditions as the Commissioners were prescribing, they constituted a serious evil. With characteristic intrepidity he opposed the annual Inclosure Bill (which had come to be considered a mere form) and moved for a Committee on the whole subject. The ultimate result was the passing, seven years later, of the Commons Act, 1876. This measure, introduced by a Conservative Government, laid down the principle that an inclosure should not be allowed unless distinctly shown to be for the benefit, not merely of private persons, but of the neighbourhood generally and the public. It imposed many checks upon

the process, and, following the course already adopted in the case of Metropolitan commons, offered an alternative method of making commons more useful to the nation, viz., their management and regulation as open spaces. The effect of this legislation and of the changed attitude of the House of Commons towards inclosure has been almost to stop that process, except in the case of common fields or extensive mountain wastes. Only some twenty-four commons, comprising about 26,000 acres, have been inclosed by Act of Parliament since 1876.

*Regulation.*

We have alluded to the regulation of commons as open spaces. The primary object of this process is to bring a common under the jurisdiction of some constituted authority, which may make bye-laws, enforceable in a summary way before the magistrates of the district, for its protection, and may appoint watchers or keepers to preserve order and prevent wanton mischief. There are several means of attaining this object. Commons within the Metropolitan police district—the Greater London of the Registrar-General—are in this respect in a position by themselves. Under the Metropolitan Commons Acts, schemes for their local management may be made by the Board of Agriculture (in which the Inclosure Commission is now merged) without the consent either of the owner of the soil or the commoners—who, however, are entitled to compensation if they can show that they are injuriously affected. Outside the Metropolitan police district a provisional order for regulation may be made under the Commons Act, 1876, with the consent of the owner of the soil and of persons representing two-thirds in value of all the interests in the common. And under an Act passed in 1899 the council of any urban or rural district may, with the approval of the Board of Agriculture and without recourse to Parliament, make a scheme for the management of any common within its district, provided no notice of dissent is served on the Board by the lord of the manor or by persons representing one-third in value of such interests in the common as are affected by the scheme. There is yet another way of protecting a common. A parish council may, by agreement, acquire an interest in it, and may make bye-laws for its regulation under the Local Government Act, 1894. It is probable that in future commons outside the Metropolitan police area will be managed chiefly under the Acts of 1894 and 1899. They undoubtedly proceed on right lines. For, with the growth of efficient local government, commons naturally fall to be protected and improved by the authority of the district.

*Statistics.*

It remains to say a word as to the extent of common land still remaining open in England and Wales. In 1843 it was estimated that there were still 10,000,000 acres of common land and common-field land. In 1874 another return made by the Inclosure Commission made a guess of 2,632,772. These two returns were made from the same materials, viz., the Tithe Commutation Awards. As less than 700,000 acres had been inclosed in the intervening period, it is obvious that the two estimates are mutually destructive. In July 1875 another version was given in the Return of Landowners (generally known as the Modern Domesday Book), compiled from the valuation lists made for the purposes of rating. This return put the commons of the country (not including common fields) at 1,524,648 acres. It is impossible to view any of these returns as accurate. Those compiled from the Tithe Commutation Awards are based largely on estimates, since there are many parishes where the tithes had not been commuted. On the other hand, the valuation lists do not show waste and unoccupied land (which is not rated), and consequently the information as to such lands in the Return of Landowners was based on any materials which might happen to be at the disposal of the Clerk of the Guardians. All we can say, therefore, is that the acreage of the remaining common land of the country is probably somewhere between 1,500,000 and 2,000,000 acres. It is most capriciously distributed. In the Midlands there is very little to be found, while in a county of poor soil, like Surrey, nearly every parish has its common, and there are large tracts of heath and moor. In 1866, returns were made to Parliament by the Overseers of the Poor of the commons within 15 and within 25 miles of Charing Cross. The acreage within the larger area was put at 38,450 acres, and within the smaller at 13,301; but owing to the difference of opinion which sometimes prevails upon the question, whether land is common or not, and the carelessness of some parish authorities as to the accuracy of their returns, even these figures cannot be taken as more than approximately correct. The Metropolitan police district, within which the Metropolitan Commons Acts are in force, approaches in extent to a circle of 15 miles' radius. Within this district nearly 12,000 acres of common land have been put under local management, either by means of the Commons Acts or under special legislation. London is to be congratulated on having secured so much recreation ground on its borders. But when the enormous population of the capital and its rapid growth and expansion are considered, the conclusion is inevitable, that not one acre of common land within an easy railway journey of the metropolis can be spared.

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**Como,** chief town of the Italian province of Como, and situated at the south-western extremity of the lake of the same name. Next to Milan, Como has made more rapid progress than any Lombard city since 1875. Its population, which numbered 25,560 in 1881, was 38,902 in 1901, while the population of the province was 576,276 in 1901, having increased by 61,226 since 1881. The density of the population is 2·16 per square kilometre. In Como and its immediate neighbourhood many large silk-weaving establishments have been founded. In consequence of the construction of a funicular railway from Como to Brunate Hill, 716 metres above the city, a new quarter and climatic station have grown up at Brunate. Between 1881 and 1900, 179 kilometres of new railways were built in the province of Como, besides two funicular railways and an electric tramway. A further electric line is in course of construction. The making of provincial and State roads has kept pace with the growth of railway communication. At the same time, the navigation of the three lakes of Como, Maggiore, and Lugano, both by steam and sailing vessels, has notably increased. A telephone system, 310 miles in length, connects Como with the chief communes of the province. In 1900 the industrial establishments of the province of Como numbered 870, of which nearly one-half are devoted to various branches of the silk industry. There are, besides, cotton industries, paper-making, iron-working, telegraph cables, lime-kilns, and cement factories. The number of workmen and workwomen employed in the silk industry is

55,000. In 1860 Como possessed 3000 hand looms; in 1899, 11,000, while 3500 machine looms had been introduced. Since one machine loom is equal to three hand looms, the weaving potentiality of Como has been multiplied sevenfold in thirty years. The importance of this development is the more noteworthy in view of the fact that, while Como possesses 3500 steam looms, only 2000 exist in the rest of Italy. The Como factories yield products of an estimated annual value of 60,000,000 lire. Most of the Como silk is exported, especially to London and to the Levant.

The mountainous character of the province of Como and the excessive subdivision of landed property retard the introduction of improved methods of agriculture. The Agricultural Unions, however, have succeeded in promoting the use of artificial manure and in increasing the productivity of the soil. The most important improvements have taken place in regard to the raising of silk-worms by the introduction of a system of selecting the eggs, and by modifications of the peasants' houses. Industrial progress and agricultural improvements have combined in producing in the province an unusual degree of prosperity. The spirit of initiative and the activity of the inhabitants found expression in 1899 in the Silk and Electrical Exhibition, organized to celebrate the first centenary of the invention of the electric pile by Alessandro Volta, a native of Como. The Exhibition, opened in May 1899, was destroyed by fire in the following July, but was rebuilt and reopened within a few weeks by its original organizers. An International Electrical Congress took place in connexion with the Exhibition. The distinction gained as early as the ninth century in building and architecture by the *Magistri Comacini* still excites the emulation of the inhabitants of the region, who, as specialists in the art of building, emigrate to all parts of Europe. The spirit of reverence for historical buildings and local artistic memories has led to the restoration during the last few years of Como Cathedral, and of the churches of Sant' Abbondio, San Fedele, San Carpoforo, and other minor monuments of the province. (L. Bi.)

**Como,** a lake of North Italy, lying at the foot of the Rhætic Alps, directly north from Milan. Area, according to Marinelli, $56\frac{1}{4}$ square miles; maximum depth, 1358 ft.; altitude above sea-level, 653 ft.; temperature at the bottom, 42°·8 Fahr. During the day a southerly wind, the Breva, blows pretty constantly, and during the night a northerly wind, the Tivano. The difference between "high" water and "low" water levels amounts to as much as 16 ft. Its shores are thickly studded with silk factories.

**Comoro Islands,** a group of islands belonging to France, situated half-way between Madagascar and the African continent, to the north of the Mozambique Channel. The following table of the area and population of the only four of any size gives one of the sets of figures offered by various authorities:—

| Island. | Area (square miles). | Population. |
|---|---|---|
| Mayotte | 140 | 9,000 |
| Great Comoro | 385 | 50,000 |
| Moheli | 90 | 9,000 |
| Anjouan | 145 | 12,000 |
| Total | 760 | 80,000 |

The islands are of volcanic formation and bristle with mountains, the highest of which is Coratola (8500 feet). The soil is very fertile, and covered with forests of cocoanut and fig trees. The climate is in general warm, but not torrid nor unsuitable for Europeans. The dry season lasts from May to October, the rest of the year being rainy. The natives, who form practically the whole of the population, are of Malagasy, Negro, and Arab blood. The more important localities are Dzaudai, a small island off Mayotte, where are the government headquarters; M'sapéré, on the opposite mainland, which is the chief centre of trade in the island; Bambao, in Anjouan; Fomboni, in Moheli; and Movoni, in Great Comoro.

Mayotte was occupied as a colony in 1843, and has long been completely subject to the French, who, however, have experienced some trouble in the other islands, over which they extended a protectorate in 1886. The administration, as regulated by the decree of September 1899, is under a governor of the whole group, who himself administers Mayotte, but governs the other three islands through administrators. At Mayotte there are a tribunal of first instance and a paymaster. Each island has its own local budget. That of Mayotte, which alone receives a subvention from France, shares more than half the totals, which in 1901 were estimated to balance at about £20,000. Mayotte also appropriated £1055 in the 1901 colonial budget of France, and in consequence of a destructive cyclone in 1898 borrowed £20,000, to be paid in 20 years, without interest. Great Comoro has a debt of £38,000. Mayotte produces sugar, vanilla, rice, coffee, cacao. For the rest, Anjouan is the most favourable to cultivation, especially of vanilla, but the cocoanut is gathered. In Great Comoro copra is prepared and zebras are reared. The only industrial establishments in the group are sugar-works and saw-mills. Trade statistics are only issued for Mayotte, but this term may include the whole group. In 1898 imports totalled £28,300 (France £21,200). In 1898 exports totalled £49,320 (France £47,890). The movement of the vessels of the Messageries Maritimes at Mayotte reaches 5000 tons for vessels with cargoes. At present it is rather because of their strategic than their commercial value that the Comoros are of importance. A coaling station has been established among them.

See Henrique. *Les Colonies Françaises.* Paris, 1889.—Lee. *French Colonies.* Foreign Office Report, 1900. *L'Année Coloniale*, Paris, 1900. (P. L.)

**Company.**—Joint stock enterprise derives its vitality from the co-operative principle, by which a multitude of small investors create a fund to be used in furtherance of some commercial undertaking for the common benefit of all. The natural growth and expansion of this fruitful principle was checked until the middle of the nineteenth century by the notorious risks attaching to unlimited liability. In the case of an ordinary partnership, though their liability is unlimited, the partners can generally tell what risks they are incurring. Not so the shareholders of a company. They delegate the management of their business to a board of directors, and they may easily find themselves committed by the fraud or folly of its members to engagements which in the days of unlimited liability meant ruin. Failures like those of Overend and Gurney, and of the Glasgow Bank, caused widespread misery and alarm. It was not until limited liability had been grafted on the stock of the co-operative system that the real potency of the principle of industrial co-operation became apparent. We owe the adoption of the limited liability principle to the clear-sightedness of Lord Sherbrooke—then Mr Robert Lowe—and to the vigorous advocacy of Lord Bramwell. We owe it to Lord Bramwell also that the principle was made a feasible one. The practical difficulty was how to bring home to persons dealing with the company notice that the liability of the share-

holders was limited. Lord Bramwell solved the problem by a happy suggestion—"write it on my tombstone," he said humorously to a friend. This was that the company should add to its name the word "Limited"—paint it up on its premises, and use it on all its invoices, bills, promissory notes, and other documents. The proposal was adopted by the Legislature and has worked successfully. The best evidence of the influence which the introduction of limited liability has exercised is to be found in the returns of companies registered under the Act of 1862. That Act contemplates three classes of companies—(1) companies limited by shares, (2) companies limited by guarantee, (3) unlimited companies. The number of companies limited by shares which were registered from the commencement of the Act to the year 1901 is 60,000; of companies limited by guarantee, 1300; of unlimited companies, 140. The companies limited by shares show a progressive increase from 689 in 1863 to 4675 in 1897; the unlimited companies registered in 1863 were 8 in number, in 1897 they were nil. The unlimited company is practically an extinct species. The company limited by shares has become the normal type: it is incomparably the most important, and as such it is chiefly dealt with in this article.

*Companies Limited by Shares.*—The Companies Act, 1862, was intended to constitute a comprehensive code of law applicable to joint stock trading companies for the whole of the United Kingdom. Recognizing the mischief of large trading concerns being carried on by fluctuating bodies, the Act begins by declaring that no company, association, or partnership, consisting of more than twenty persons, or ten in the case of banking, shall be formed after the commencement of the Act for the purpose of carrying on any business which has for its object the acquisition of gain by the company, association, or partnership, or by the individual members thereof, unless it is registered as a company under the Act, or is formed in pursuance of some other Act of Parliament or of letters patent, or is a company engaged in working mines within and subject to the jurisdiction of the Stannaries. Broadly speaking, the meaning of the Act is that all commercial undertakings, as distinguished from literary or charitable associations, shall be registered. "Business" has a more extensive signification than "trade." Having thus cleared the ground the Act goes on to provide in what manner a company may be formed under the Act. The machinery is simple, and is described as follows:—

"Any seven or more persons associated for any lawful purpose may, by subscribing their names to a memorandum of association and otherwise complying with the requisitions of this Act in respect of registration, form an incorporated company with or without limited liability" (§ 6). The fact that six of the subscribers are mere dummies, clerks, or nominees of the seventh, will not affect the validity of the company; so the House of Lords decided in *Salomon* v. *Salomon and Co.* (1897, A. C. 22). The document to be subscribed—the Memorandum of Association—corresponds, in the case of companies formed under the Companies Act, 1862, to the charter or deed of settlement in the case of other companies. The form of it is given in the schedule to the Act, and varies slightly according as the company is limited by shares or guarantee, or is unlimited. (See the 2nd schedule to the Act, forms A, B, C, D.) It is required to state, in the case of a company limited by shares, the five following matters:—

***Memorandum of Association.***

1. The name of the proposed company, with the addition of the word "limited" as the last word in such name.
2. The part of the United Kingdom, whether England, Scotland, or Ireland, in which the registered office of the company is proposed to be situate.
3. The objects for which the proposed company is to be established.
4. A declaration that the liability of the members is limited.
5. The amount of capital with which the company proposes to be registered, divided into shares of a certain fixed amount.

No subscriber of the memorandum is to take less than one share, and each subscriber is to write opposite his name the number of shares he takes.

These five matters the Legislature has deemed of such intrinsic importance that it has required them to be set out in the company's Memorandum of Association. They are the essential conditions of incorporation, and as such they must not only be stated, but the policy of the Legislature has made them unalterable, with certain exceptions.

The most important of these five conditions is the third, and its importance consists in this, that the objects defined in the memorandum circumscribe the sphere of the company's activities. This principle, which is one of public policy and convenience, and is known as the "*ultra vires* doctrine," carries with it important consequences, because every act done or contract made by a company *ultra vires*, *i.e.*, in excess of its powers, is absolutely null and void. The policy, too, is a sound one. Shareholders contribute their money on the faith that it is to be employed in prosecuting certain objects, and it would be a violation of good faith if the company, *i.e.*, the majority of shareholders, were to be allowed to divert it to something quite different. So strict is the rule that not even the consent of every individual shareholder can give validity to an *ultra vires* act. The consent of all the shareholders was, till quite recently, equally incompetent to alter the objects defined in the memorandum, as being part of the so-called charter. The inconveniences attending this unalterability of the objects were, however, so sensibly felt that in 1890 the Companies (Memorandum of Association) Alteration Act was passed, qualifying the prohibition against alteration, but only to a limited extent. This Act enables a company to obtain the sanction of the Court to an alteration of the objects in its memorandum when it appears that the alteration is required for certain specified purposes, such as the carrying on of the company's business more economically or more efficiently.

***Articles of Association.***

A company's Memorandum of Association was described by Lord Cairns as its charter. The Articles of Association are the regulations for its internal management—the terms of the partnership agreed upon by the shareholders among themselves. They regulate such matters as the transfer and forfeiture of shares, calls upon shares, the appointment and qualification of directors, their powers and proceedings, general meetings of the shareholders, votes, dividends, the keeping and audit of accounts, and other such matters. In regard to these internal regulations the Legislature has left the company free to adopt whatever terms of association it chooses. It has furnished in the schedule to the Companies Act, 1862 (Table A), a model or specimen set of regulations, but their adoption, wholly or in part, is optional; only if a company does not register articles of its own these statutory regulations are to apply. When, as is commonly the case, a company decides to have articles of its own framing, such articles must be expressed in separate paragraphs, numbered arithmetically, and signed by the subscribers of the memorandum. They must also be printed, stamped like a deed, and attested. When so perfected, they are to be delivered, with the Memorandum of Association, to the Registrar of Joint Stock Com-

panies, who is to retain and register them. The stamp duty charged on the company's capital must at the same time be paid. The Memorandum and Articles of Association thereupon become public documents, and any person may inspect them on payment of a fee of one shilling. This has important consequences, because every person dealing with the company is presumed to be acquainted with its constitution, and to have read its memorandum and articles. The articles also, upon registration, bind the company and its members to the same extent as if each member had subscribed his name and affixed his seal to them.

The capital which is required to be stated in the Memorandum of Association is what is known as the nominal capital. This nominal capital must be distinguished from the subscribed capital, which is the aggregate amount agreed to be paid by those who have taken shares in the company. Under the Companies Act, 1900, a "minimum subscription" may be fixed by the articles, and if it is, the directors cannot go to allotment on less: if it is not, then the whole of the capital offered for subscription must be subscribed. A company may increase its capital, consolidate it, subdivide it into shares of smaller amount, or convert paid-up shares into stock, and for this purpose modify its Memorandum of Association; but a limited company cannot reduce its capital either by direct or indirect means without the sanction of the Court. The inviolability of the capital is a condition of incorporation—the price of the privilege of trading with limited liability, and by no subterfuge will a company be allowed to evade this cardinal rule of policy, either by paying dividends out of capital, or buying its own shares, or returning money to shareholders. But the prohibition against reduction means that the capital must not be reduced by the voluntary act of the company, not that a company's capital must be kept intact. It is embarked in the company's business, and it must run the risks of such business. If part of it is lost there is no obligation on the company to replace it and to cease paying dividends until such lost capital is repaid. The company may in such a case—and no course can be more beneficial to it—write off the lost capital and go on trading with the reduced amount. But for this purpose the sanction of the Court must be obtained by petition.

*Capital.*

A company being a legal abstraction, invisible and intangible, can do nothing in its own person. It must act through agents. These agents are commonly called directors, though they are occasionally described by other names, such as committee men, council, or managers. The first directors of a company are generally appointed by the Articles of Association. Their consent to act must now, under the Companies Act, 1900, be filed with the Registrar of Joint Stock Companies. Directors other than the first are elected at the annual general meeting, a certain proportion of the acting directors—usually one-third—retiring under the articles by rotation each year, and their places being filled up by election. A share qualification is often required, on the well-recognized principle that a substantial stake in the undertaking is the best guarantee of fidelity to the company's interests. A director once appointed cannot be removed during his term of office by the shareholders, unless there is a special provision for that purpose in the Articles of Association; but a company may dismiss a director if the articles—as is usually the case—authorize dismissal. The authority and powers of directors are *primâ facie* those necessary for carrying on the ordinary business of the company, but as a rule they are more particularly defined by the Articles of Association. For instance, it is commonly prescribed how and when the directors may make calls, to what amount they may borrow, in what circumstances they may forfeit shares, or veto transfers, or invest funds, and what shall constitute a quorum of the board. Whenever, indeed, specific directions are desirable they may properly be given by the articles. But superadded to and supplementing these specific powers there is usually inserted in the articles a general power of management in terms similar to those of Clause 58 of the statutory regulations known as Table A. The powers, whether general or specific, thus confided to directors are in the nature of a trust, and the directors must exercise them with a single eye to the benefit of the company. It would, however, give a very erroneous idea of their positions and functions to speak of them as trustees. They have to carry on the company's business, to extend and consolidate it, and to do this they must have a free hand and a large discretion to deal with the exigencies of the commercial situation. This large discretion the law allows them, so long as they keep within the limits set by the company's Memorandum and Articles. They are not to be held liable for mere errors of judgment, still less for being defrauded. That would make their position intolerable. All that the law requires of them is that they should be faithful to their duties as agents—"honest and diligent." They must not, for instance, delegate their duties, or accept a bribe, or make a secret profit, or pay dividends out of capital, or misapply the company's funds.

*Directors.*

Where in these or in any other ways directors are guilty of misfeasance or breach of trust in regard to the company or its property, the remedy of the company, if it is a going concern, is by action against the delinquent; but where a company is being wound up, the Legislature has provided a summary mode of proceeding under the Winding-up Act, 1890, by which the official receiver or liquidator, or any creditor or contributory of the company may take out what is known as a misfeasance summons, to compel the delinquent director or officer to repay the misapplied moneys or make compensation. Directors who circulate a prospectus containing statements which they know to be false, with intent to induce any person to become a shareholder, may be prosecuted under § 84 of the Larceny Act, 1861. They are also liable criminally for falsification of the company's books, and for this or any other criminal offence the Court in winding-up may, on the application of the liquidator, direct a prosecution.

*Misfeasance.*

A share is an aliquot part of a company's nominal capital. The amount may be anything from 1s. to £1000. The tendency of late years has been to keep the denomination low, and so to appeal to a wider public. Shares of £100, or even £10, are now the exception. The most common amount is either £1 or £5. Shares are of various kinds,—ordinary, preference, deferred, founders', and management. Into what classes of shares the original capital of the company shall be divided, what shall be the amount of each class, and their respective rights, privileges, and priorities, are matters for the consideration of the promoters of the company, and must depend on its special circumstances and requirements.

*Shares.*

A company may issue preference shares even if there is no mention of them in the Memorandum of Association, but it is, as a rule, desirable that the Memorandum define the rights of preference shareholders, as their rights cannot then be altered or infringed. The preference given may be as to dividends only, or as to dividends and capital. The dividend, again, may be payable out of the year's profits only, or cumulative. The question for the company is, what must be offered to attract investors. Founders'

shares — which originated with private companies — are shares which usually take the whole or half the profits after payment of a dividend of 7 or 10 per cent to the ordinary shareholders. They are much less in favour than they used to be.

An agreement to take shares is like any other agreement. It is constituted by offer, acceptance, and communication of the acceptance to the offerer. The offer in the case of shares is usually in the form of an application in writing to the company, made in response to a prospectus, requesting the company to allot the applicant a certain number of shares in the undertaking on the terms of the prospectus, and agreeing to accept the shares, or any smaller number, which may be allotted to the applicant. Under the Companies Act, 1900, an allottee is entitled to rescind his contract unless the minimum subscription has been obtained. When an application is accepted the shares are allotted, and a letter of allotment is posted to the applicant. Allotment is the usual, but not the only, evidence of acceptance. As soon as the letter of allotment is posted the contract is complete, even though the letter never reaches the applicant. An application for shares can be withdrawn at any time before acceptance. As soon as the contract is complete, it is the duty of the company to enter the shareholder's name in the register of members, and to issue to him a certificate under the seal of the company, evidencing his title to the shares.

***Register of members.***

The register of members plays an important part in the scheme of the company system, under the Companies Act, 1862. The principle of limited liability having been once adopted by the Legislature, justice required not only that such limitation of liability should be brought home by every possible means to persons dealing with the company, but also that such persons should know as far as possible what was the limited capital—the sole fund available to satisfy their claims, what amount had been called up, what remained uncalled, who were the persons to pay, and in what amounts. These data might materially assist a person dealing with the company in determining whether he would give it credit or not; in any case they are matters which the public had a right to know. The Legislature, recognizing this, has exacted as a condition of the privilege of trading with limited liability that the company shall keep a register with those particulars in it, which shall be accessible to the public at all reasonable times. In order that this register may be accurate, and correspond with the true liability of membership for the time being, the Court is empowered under the Companies Act, 1862, to rectify it in a summary way, on application by motion, by ordering the name of a person to be entered or removed. This power can be exercised by the Court, whether the dispute as to membership is one between the company and an alleged member, or between one alleged member and another, but the machinery of the section is not meant to be used to try claims to rescind agreements to take shares. The proper proceeding in such cases is by action.

***Payment for shares.***

The same policy of guarding against an abuse of limited liability is evinced in the provision of the Act that shares in the case of a limited company shall be paid for in full. The Legislature has allowed such companies to trade with limited liability, but the price of the privilege is that the limited capital to which alone the creditors can look shall at least be a reality. It is therefore *ultra vires* for a limited company to issue its shares at a discount; but there was nothing in the Companies Act, 1862, which required that the shares of a limited company, though they must be paid up in full, must be paid up in cash. They might be paid "in meal or in malt," and it accordingly became common for shares to be allotted in payment for furniture, plate, advertisements, or services. The result was that the consideration was often illusory, shares being issued to be paid for in some commodity which had no certain criterion of value. To remedy this evil the Legislature enacted in the Companies Act, 1867 (§ 25), that every share in any company should be held subject to the payment of the whole amount thereof in cash, unless otherwise determined by a contract in writing filed with the Registrar of Joint Stock Companies at or before the issue of the shares. This section not infrequently caused hardship where shares had been honestly paid for in the equivalent of cash, but owing to inadvertence no contract had been filed; and it has now been repealed by the Companies Act, 1900, and the old law restored. In reverting to the earlier law, and allowing shares to be paid for in any adequate consideration, the Legislature has, however, exacted a safeguard. It has required the company to file with the Registrar of Joint Stock Companies a return stating, in the case of shares allotted in whole or in part for a consideration other than cash, the number of the shares so allotted, and the nature of the consideration—property, services, &c.—for which they have been allotted.

Though every share carries with it the liability to pay up the full amount in cash, the liability is only to pay when and if the directors call for it to be paid up. A call must fix the time and place for payment, otherwise it is bad.

***Rescission of agreement.***

When a person takes shares from a company on the faith of a prospectus containing any false or fraudulent representations of fact material to the contract, he is entitled to rescind the contract. The company cannot keep a contract obtained by the misrepresentation or fraud of its agents. This is an elementary principle of law. The misrepresentation, for purposes of rescission, need not be fraudulent; it is sufficient that it is false in fact: fraud or recklessness of assertion will give the shareholder a further remedy by action of deceit, or under the Directors' Liability Act, 1890; but, to entitle him to rescind, the shareholder must show that he took the shares on the faith or partly on the faith of the false representation: if not, it was innocuous. A shareholder claiming to rescind must do so promptly. It is too late to commence proceedings after a winding-up has begun.

***Transfer of shares.***

The shares or other interest of any member in a company are personal estate and may be transferred in the manner provided by the regulations of the company. As Lord Blackburn said, it was one of the chief objects with which joint stock companies were established, that the shares should be capable of being easily transferred; but though every shareholder has a *primâ facie* right to transfer his shares, this right is subject to the regulations of the company, and the company may and often does by its regulations require that a transfer shall receive the approval of the board of directors before being registered, — the object being to secure the company against having an insolvent or undesirable shareholder (the nominee perhaps of a rival company) substituted for a solvent and acceptable one. This power of the directors to refuse a transfer must not be exercised arbitrarily or capriciously. If it were, it would amount to a confiscation of the shares. Directors, for instance, cannot veto a transfer because they disapprove of the purpose for which it is being made (*e.g.*, to multiply votes), if there is no objection to the transferee.

A company can only pay dividends out of profits—defined as the "earnings of a concern after deducting

the expenses of earning them." To pay dividends out of capital is not only *ultra vires* but illegal, as constituting a return of capital to shareholders. Before paying dividends, directors must take reasonable care to secure the preparation of proper balance-sheets and estimates, and must exercise their judgment as business men on the balance-sheets and estimates submitted to them. If they fail to do this, and pay dividends out of capital, they will not be held excused. The onus is on them to show that the dividends have been paid out of profits. The Court as a rule does not interfere with the discretion of directors in the matter of paying dividends, unless they are doing something *ultra vires*.

***Dividends.***

The Companies Acts, and the regulations under them, regard the directors of a company as the persons in whom the management of the company's affairs is vested. But they also contemplate the ultimate controlling power as residing in the shareholders. A controlling power of this kind can only assert itself through general meetings; and that it may have proper opportunities of doing so, every company is required to hold a general meeting, commonly called the statutory meeting, within—as now fixed by the Companies Act, 1900—three months from the date at which it is entitled to commence business, and thenceforward one general meeting at least every year. This annual general meeting is usually called the ordinary general meeting. Other meetings are extraordinary general meetings. Notices convening a general meeting must inform the shareholders of the particular business to be transacted; otherwise any resolutions passed at the meeting will be invalidated. Voting is generally regulated by the articles. Sometimes a vote is given to a shareholder for every share held by him, but more often a scale is adopted; for instance, one vote is given for every share up to ten, with an additional vote for every five shares beyond the first ten shares up to one hundred, and an additional vote for every ten shares beyond the first hundred. In default of any regulations, every member has one vote only. Sometimes preference shareholders are given no vote at all.

***Meetings.***

The machinery of company formation is generally set in motion by a person known as a promoter. This is a term of business, not law. It means, to use Chief-Justice Cockburn's words, a person "who undertakes to form a company with reference to a given project and to set it going, and who takes the necessary steps to accomplish that purpose." Whether what a person has done towards this end constitutes him a promoter or not, is a question of fact; but once an affirmative conclusion is reached, equity clothes such promoter with a fiduciary relation towards the company which he has been instrumental in creating. This doctrine is now well established, and its good sense is apparent when once the position of the promoter towards the company is understood. Promoters—to use Lord Cairns's language in *Erlanger* v. *New Sombrero Phosphate Co.* (3 App. Cas. 1236)—"have in their hands the creation and moulding of the company. They have the power of defining how and when and in what shape and under what supervision it shall start into existence and begin to act as a trading corporation." Such a control over the destinies of the company involves correlative obligations towards it, and one of these obligations is that the promoter must not take advantage of the company's helplessness. A promoter may sell his property to the company, but he must make full and fair disclosure of his interest in order that the company may determine whether it will or will not authorize its trustee or agent to make a profit out of the sale. It is not a sufficient disclosure in such a case for the promoter merely to refer in the prospectus to a contract which, if read by the shareholders, would inform them of his interest. They are under no obligation to inquire. It is for the promoter to bring home notice, not constructive but actual, to the shareholders. When a company is promoted for acquiring property—to work a mine, for instance, or carry on a going business—the usual course is for the promoter to frame a draft agreement for the sale of the property to the company or to a trustee on its behalf. The memorandum and articles of the intended company are then prepared, and an article is included authorizing or requiring the directors to adopt the draft agreement for sale. In pursuance of this authority the directors at the first meeting after incorporation take the draft agreement into consideration; and if they approve, adopt it—provisionally, that is—for under the Companies Act, 1900, no contract is to bind a company unless it has obtained a certificate from the Registrar of Joint Stock Companies that it has complied with certain formalities entitling it to commence business. Where they do so in the exercise of an honest and independent judgment, no exception can be taken to the transaction; but where the directors happen to be nominees of the promoter, perhaps qualified by him and acting in his interest, the plan is obviously open to grave abuse.

***Promoter.***

When a company intends to appeal to the public to subscribe its capital, the usual way of doing so is by issuing a prospectus. A prospectus is an invitation to the public to take shares on the faith of the statements therein contained, and is thus the basis of the agreement to take the shares; there therefore rests on those who are responsible for its issue an obligation to act with the most perfect good faith—*uberrima fides*—and this obligation has been repeatedly emphasized by judges of the highest eminence. (See the observations of Lord Herschell in *Derry* v. *Peek*, 14 App. Cas. 376.) Directors must be perfectly candid with the public; they must not only state what they do state with strict and scrupulous accuracy, but they must not omit any fact which, if disclosed, would falsify the statements made. This is the general obligation of directors when issuing a prospectus; but on this general obligation the Legislature has engrafted special requirements. By the Companies Act, 1867, it required the dates and names of the parties to any contract entered into by the company or its promoters or directors before the issue of the prospectus, to be disclosed in the prospectus; otherwise the prospectus was to be deemed fraudulent. This enactment has now been repealed by the Companies Act, 1900, but only in favour of more stringent provisions. Under the new Act not only is every prospectus to be signed and filed with the Registrar of Joint Stock Companies before it can be issued, but the prospectus must set forth a series of specified particulars about the company—the contents of the Memorandum of Association, with the names of the signatories, the share qualification (if any) of the directors, the minimum subscription on which the directors may proceed to allotment, the shares and debentures issued otherwise than for cash, the names and addresses of the vendors, the amount paid for underwriting the company, the amount of preliminary expenses, of promotion money (if any), and the interest (if any) of every director in the promotion or in property to be acquired by th company. Neglect of this statutory duty of disclosure will expose directors to personal liability. For false or fraudulent statements—as distinguished from non-disclosure—in a prospectus directors are liable in an action of deceit or under the Directors' Liability Act, 1900. This Act was passed to meet the decision of the House of Lords in *Peek* v. *Derry* (12 App. Cas. 33), that a director could not

***Prospectus.***

be made liable in an action of deceit for an untrue statement in a prospectus, unless the plaintiff could prove that the director had made the untrue statement fraudulently. The Directors' Liability Act enacts in substance that when once a prospectus is proved to contain a material statement or fact which is untrue, the persons responsible for the prospectus are to be liable to pay compensation to any one who has subscribed on the faith of the prospectus, unless they can prove that they had reasonable ground to believe, and did in fact believe, the statement to be true. Actions under this Act have been extremely rare, but it may have had the effect of making directors more careful in their statements.

**Private companies.** It has become very common of late years for a private trader to convert his business into a limited company, with a view not to offering the shares to the public, but to securing the advantages incident to incorporation. Companies of this kind form one-third of the whole number of companies registered yearly, and are known as "Private Companies," to distinguish them from companies which appeal to the public to subscribe their capital. The special characteristic of the private company is not, however, the manner in which the capital is raised, but the fact that the shares are held in a few hands.

The so-called "one-man company" is a variety of the private company. The fact that a company is formed by one man, with the aid of six dummy subscribers, is not in itself (as was at one time supposed) a fraud on the policy of the Companies Acts, but it is occasionally used for the purpose of committing a fraud, as where an insolvent trader turns himself into a limited company in order to evade bankruptcy; and it is to an abuse of the Act of this kind that the term "one-man company" owes its opprobrious signification.

*Companies Limited by Guarantee.*—The second class of limited companies are those limited by guarantee, as distinguished from those limited by shares. In the company limited by guarantee each member agrees, in the event of a winding-up, to contribute a certain amount to the assets. The interests of the members of a guarantee company have no nominal value in money like the shares of other companies, a form of constitution which was designed, as has been stated by Lord Thring, who drafted the Companies Act, 1862, to give a superior elasticity to the company. The property of the company simply belongs to the company in certain fractional amounts. This makes it convenient for clubs, syndicates, and other associations which do not require the interest of members to be expressed in terms of cash.

*Companies not for Gain.*—Associations formed to promote commerce, art, science, religion, charity, or any other useful object may, with the sanction of the Board of Trade, register under the Companies Act, 1862, with limited liability, but without the addition of the word "Limited," upon proving to the Board that it is the intention of the association to apply the profits or income of the association in promoting its objects, and not in payment of dividends to members (C. A., 1867, § 23). In lieu of the word "Company," the association may adopt as part of its name some such title as chamber, club, college, guild, institute, or society. The power given by this section has proved very useful, and many kinds of associations have availed themselves of it, *e.g.*, medical institutes, law societies, nursing homes, and chambers of commerce. No such association can hold more than two acres of land without the license of the Board of Trade.

*Cost-Book Mining Companies.*—These are in substance mining partnerships. They derive their name from the partnership agreement, the expenses and receipts of the mine, the names of the shareholders, and any transfers of shares being entered in a "cost-book." The affairs of the company are managed by an agent known as a "purser," who from time to time makes calls on the members for the expenses of working. A cost-book company is not bound to register under the Companies Act, 1862, but it may do so.

*British Companies Abroad.*—The status of British companies trading abroad, so far as Germany, France, Belgium, Greece, Italy, and Spain are concerned, is expressly recognized in a series of conventions entered into between those countries and Great Britain. Where no such convention exists the status of an immigrant corporation depends upon international comity, which allows foreign corporations, as it does foreign persons, to sue, to make contracts, and hold real estate, in the same way as domestic corporations or citizens; provided the stranger corporation does not offend against the policy of the State in which it seeks to trade.

**Winding up.** A company once incorporated under the Companies Act, 1862, cannot be put an end to except through the machinery of a winding-up, though the name of a company which is commercially defunct may be struck off the register of Joint Stock Companies by the registrar under § 7 of the Companies Act, 1880. Winding-up is of two kinds: (1) voluntary winding-up, either purely voluntary or carried on under the supervision of the Court; and (2) winding-up by the Court. Of these by far the more common is a voluntary winding-up. Ninety per cent of the companies that come to an end are so wound up; and this is in accordance with the policy of the Legislature, evinced throughout the Companies Acts, that shareholders should manage their own affairs—winding-up being one of such affairs. **Voluntary.** A voluntary winding-up is carried out by the shareholders passing a special resolution requiring the company to be wound up voluntarily, or an extraordinary resolution to the effect that it has been proved to the shareholders' satisfaction that the company cannot, by reason of its liabilities, continue its business, and that it is advisable to wind it up (C. A., 1862, § 129). The resolution is generally accompanied by the appointment of a liquidator. In a purely voluntary winding-up there is a power given by § 138 for the company or any contributory to apply to the Court in any matter arising in the winding-up, but seemingly by an oversight of the Legislature the same right was not given to creditors. This has now been rectified by the Companies Act, 1900, § 25. A creditor may also in a proper case obtain an order for continuing the voluntary winding-up under the supervision of the Court. Such an order has also the advantage of operating as a stay of any actions or executions pending against the company. Except in these respects, the winding-up remains a voluntary one. The Court does not actively intervene unless set in motion; but it requires the liquidator to bring his accounts into chambers every quarter, so that it may be informed how the liquidation is proceeding. When the affairs of the company are fully wound up, the liquidator calls a meeting, lays his accounts before the shareholders, and the company is dissolved by operation of law three months after the date of the meeting (C. A., 1862, §§ 142, 143).

**By the Court.** Irrespective of voluntary winding-up, the Legislature has defined certain events in which a company formed under the Companies Act, 1862, may be wound up by the Court. These events are: (1) when the company has passed a resolution requiring the company to be wound up by the Court; (2) when the company does not commence its business

within a year or suspends it for a year; (3) when the members are reduced to less than seven; (4) when the company is unable to pay its debts, and (5) whenever the Court is of opinion that it is just and equitable that the company should be wound up (C. A., 1862, § 79). A petition for the purpose may be presented either by a creditor, a contributory, or the company itself. Where the petition is presented by a creditor who cannot obtain payment of his debt, a winding-up order is *ex debito justitiæ* as against the company or shareholders, but not as against the wishes of a majority of creditors.

The procedure on the making of a winding-up order is now governed by §§ 7, 8, 9 of the Winding-up Act, 1890. The official receiver, as liquidator *pro tem.*, requires a statement of the affairs of the company verified by the directors, and on it reports to the Court as to the causes of the company's failure, and whether further inquiry is desirable. If he further reports that in his opinion fraud has been committed in the promotion or formation of the company by a particular person, the Court may order such person to be publicly examined.

A liquidator's duty is to protect, collect, realize, and distribute the company's assets; and for this purpose he advertises for creditors, makes calls on contributories, sues debtors, takes misfeasance proceedings, if necessary, against directors or promoters, and carries on the company's business, supposing the goodwill to be an asset of value—with a view to selling it as a going concern. He is assisted, like a trustee in bankruptcy, by a committee of inspection, composed of creditors and contributories.

**Reconstruction.** A large number of companies now wind-up only to reconstruct. The reasons for a reconstruction are generally either to raise fresh capital, or to get rid of onerous preference shares, or to enlarge the scope of the company's objects, which is otherwise impracticable owing to the unalterability of the Memorandum of Association. Reconstructions are carried out in one of two ways: (1) by sale and transfer of the company's undertaking and assets to a new company, either under a power to sell contained in the Company's Memorandum of Association or under § 161 of the Companies Act, 1862; or (2) by a scheme of arrangement, sanctioned by the Court, under the Joint Stock Companies Arrangements Act, 1870.

*Public Companies.*—Besides trading companies there is another large class, which for shortness may be called public companies, *i.e.*, companies constituted by special Act of Parliament for the purpose of constructing and carrying on some undertaking of public utility, such as railways, canals, docks, waterworks, gasworks. The rights of members of these companies, the duties and liabilities of the undertakers and directors, depend on the conjoint operation of the Companies Special Act and of the Companies Clauses Acts, 1845, 1863, 1869. The special Act supplies the peculiar powers and provisions which the particular company requires, and the Companies Clauses Acts those general powers and provisions which are necessarily or usually inserted in the constitution of such public company,—regulating the distribution of capital, the transfer of shares, payment of calls, borrowing, and general meetings. A distinguishing feature of these companies is that, being sanctioned by the Legislature for undertakings of public utility, the policy of the law will not allow them to be broken up or destroyed by creditors. It gives creditors only a charge on the receipts—"the fruit of the tree."

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**Comparetti, Domenico** (1835——), Italian scholar, was born at Rome, 27th June 1835. His father, a native of Liguria, who had fought under Napoleon, had destined his son for a military career, but the boy had such a marked distaste for physical exertion that this idea had to be abandoned. Instead, he began to study at the University of Rome, and took his degree in 1855 in natural science and mathematics. Directly afterwards he entered his uncle's pharmacy as assistant. Here he diligently pursued his profession, though he was gradually learning that his real bent was for literature, not science. His scanty leisure was now given to study, and every coin he could spare was spent on books. He learned Greek by himself, and gained facility in the modern language by conversing with the Greek students at the university. In spite of all disadvantages, he not only mastered the difficulties of the language, but became before long one of the chief classical scholars of Italy. In 1857 he made a translation of some recently discovered fragments of Hyperides, and added to it a dissertation on that orator. This was published in the *Rheinisches Museum*, and was followed by a notice of the annalist Granius Licinianus, and one on the oration of Hyperides on the Lamian War. He also wrote some articles for the *Spettatore Fiorentino* and the *Archivio Storico Italiano*. In 1859 he was appointed professor of Greek at Pisa on the recommendation of the Duke of Sermoneta. A few years later he was called to a similar post at Florence, remaining emeritus professor at Pisa also. At this time he made the acquaintance of a Jewish lady from Odessa, who became his wife. Residing in Rome, and lecturing on Greek antiquities, he has taken an active interest in the Forum excavations. He is a member of the governing bodies of the academies of Milan, Venice, Naples, and Turin. The list of his writings is long and varied. Of his works in classical literature, the best known are an edition of the *Euxenippus* of Hyperides, and monographs on Pindar and Sappho. In the *Kalewala and the Traditional Poetry of the Finns*, he discusses the national epic of Finland and its heroic songs, with a view to solving the problem whether an epic could be composed by the interweaving of such national songs. He comes to a negative conclusion, and applies this reasoning to the Homeric problem. He treats this question again in a treatise on the so-called Peisistratean edition of Homer. His *Vergil in the Middle Ages*, which has been translated into English, traces the strange vicissitudes by which the great Augustan poet became successively grammatical fetich, Christian prophet, and wizard. Together with Professor Alessandro of Ancona, Comparetti edited a collection of Italian national songs and stories, many of which had been collected and written down by himself for the first time.

**Compass.**—The Mariner's compass is an instrument by means of which the directive force of that great magnet, the Earth, upon a freely-suspended needle, is utilized for a purpose essential to navigation. The needle is so mounted that it only moves freely in the horizontal plane, and therefore the horizontal component of the earth's force alone directs it. The direction assumed by the needle is not generally towards the geographical north, but diverges towards the east or west of it, making a horizontal angle with the true meridian, called the Magnetic Variation or Declination; amongst mariners this angle is known as the Variation of the compass. In the usual navigable waters of the world the variation alters from 30° to the east to 45° to the west of the geographical meridian, being

westerly in the Atlantic and Indian oceans, easterly in the Pacific. The vertical plane passing through the longitudinal axis of such a needle is known as the Magnetic Meridian. Following the first chart of lines of equal variation compiled by Halley in 1700, charts of similar type have been published from time to time embodying recent observations and corrected for the secular change, thus providing seamen with values of the variation accurate to about 30′ of arc. Possessing these data it is easy to ascertain by observation the effects of the iron in a ship in disturbing the compass, and it will be found for the most part in every vessel that the needle is deflected from the magnetic meridian by a horizontal angle called the Deviation of the compass; in some directions of the ship's head adding to the known variation of the place, in other directions subtracting from it. Local magnetic disturbance of the needle due to magnetic rocks is observed on land in all parts of the world, and in certain places extends to the land under the sea, affecting the compasses on board the ships passing over it. The general direction of these disturbances in the northern hemisphere is an attraction of the north-seeking end of the needle; in the southern hemisphere, its repulsion. The approaches to Cossack, North Australia; Cape St Francis, Labrador; the coasts of Madagascar and Iceland, are remarkable for such disturbance of the compass. The compass as we know it is the result of the necessities of navigation, which have increased from century to century. It consists of five principal parts—the card, the needles, the bowl, a jewelled cap, and the pivot. The card or "fly," formerly made of cardboard, now consists of a disc either of mica covered with paper, or of paper alone, but in all cases the card is divided into points and degrees as shown in Fig. 1.

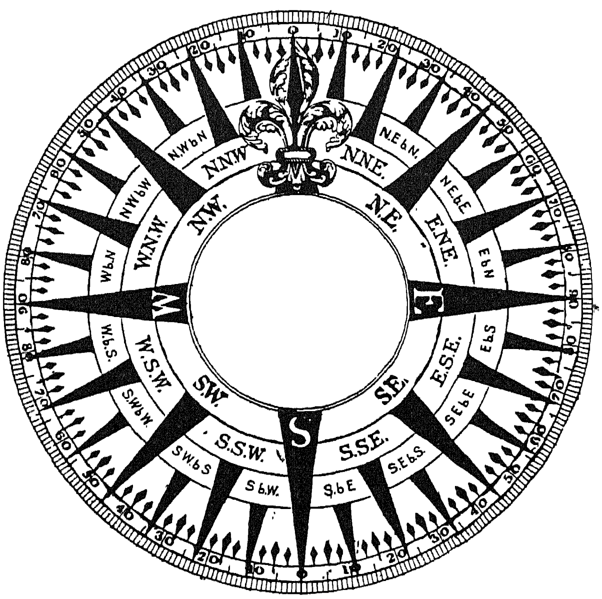


Fig. 1.—Compass Card.

The outer margin is divided into degrees with 0° at north and south, and 90° at east and west; the 32 points with half and quarter points are seen immediately within the degrees. The north point is marked with a *fleur-de-lis*, and the principal points, N.E., E., S.E., &c., with their respective names, whilst the intermediate points in the figure have also their names engraved for present information. The arc contained between any two points is 11° 15′. The mica card is generally mounted on a brass framework, F F, with a brass cap, C, fitted with a sapphire centre and carrying four magnetized needles, N, N, N, N, as in Fig. 2. The more modern form of card consists of a broad ring of paper marked with degrees and points, as in Fig. 1, attached to a frame like that in Fig. 3, where an outer

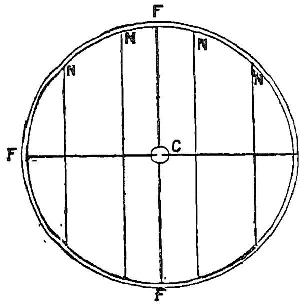


Fig. 2.—Admiralty Compass (Frame and Needles).

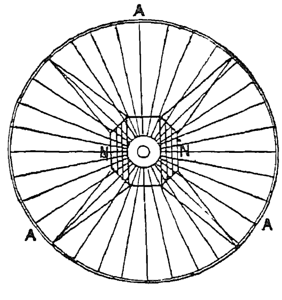


Fig. 3.—Thomson's (Lord Kelvin's) Compass (Frame and Needles).

aluminium ring, A A, is connected by 32 radial silk threads to a central disc of aluminium, in the centre of which is a round hole designed to receive an aluminium cap with a highly-polished sapphire centre worked to the form of an open cone. To direct the card eight short light needles, N N, are suspended by silk threads from the outer ring. The magnetic axis of any system of needles must exactly coincide with the axis passing through the north and south points of the card. Single needles are never used, two being the least number, and these so arranged that the moment of inertia about every diameter of the card shall be the same. The combination of card, needles, and cap is generally termed "the card"; on the continent of Europe it is called the "rose." The section of a compass bowl in Fig. 4 shows the mounting of a Thomson card on its pivot, which in common with the pivots of most other compasses is made of brass, tipped with osmium-iridium, which although very hard can be

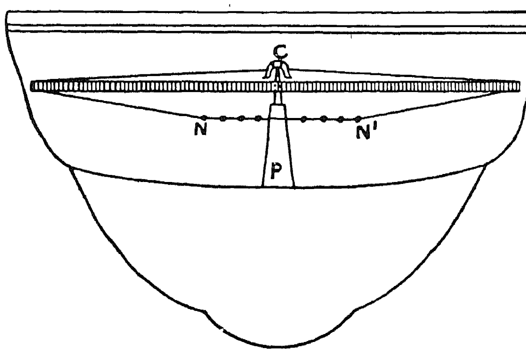


Fig. 4.—Section of Thomson's Compass Bowl. C, aluminium cap with sapphire centre; N, N′, needles; P, pivot stem with pivot.

sharply pointed and does not corrode. Fig. 4 shows the general arrangement of mounting all compass cards in the bowl. In Fig. 5 another form of compass called a liquid or spirit compass is shown partly in section. The card nearly floats in a bowl filled with distilled water, to which 35 per cent. of alcohol is added to prevent freezing; the bowl is hermetically sealed with pure india-rubber, and a corrugated expansion chamber is attached to the bottom to allow for the expansion and contraction of the liquid. The card is a mica disc, either painted as in Fig. 1, or covered with linen upon which the degrees and points are printed, the needles being enclosed in brass.

Great steadiness of card under severe shocks and vibrations, combined with a minimum of friction in the cap and pivot, is obtained with this compass. All compasses are fitted with a gimbal ring to keep the bowl and card level under every circumstance of a ship's motion in a seaway, the ring being connected with the binnacle or pedestal by means of journals or knife edges. On the inside of every

compass bowl a vertical black line is drawn, called the "lubber's point," and it is imperative that when the compass is placed in the binnacle the line joining the

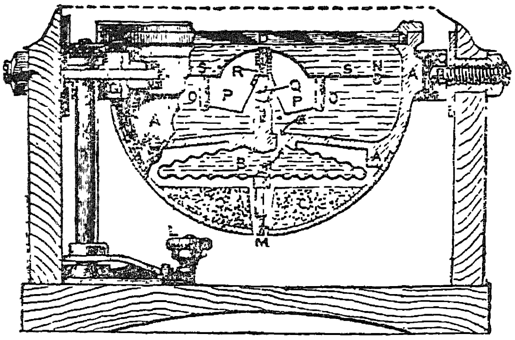


FIG. 5.—Liquid Compass. A, bowl, partly in section; B, expansion chamber; D, the gla [illegible] out to expand chamber when filling bowl; M, screw [illegible] filling, with screw plug; O, O, magnetic needles; [illegible]; Q, iridium pivot; R, sapphire cap; S, mica card.

pivot and the lubber's point be parallel to the keel of the vessel. Thus, when a degree on the card is observed opposite the lubber's point, the angle between the direction in which the ship is steering and the north point of the compass or course is at once seen; and if the magnetic variation and the disturbing effects of the ship's iron are known, the desired angle between the ship's course and the geographical meridian can be computed. In every ship a position is selected for the navigating or standard compass as free from neighbouring iron as possible, and by this compass all courses are shaped and bearings taken. It is also provided with an azimuth circle or mirror and a shadow pin or style placed in the centre of the glass cover, by either of which the variable angle between the compass north and true north, called the "total error," or variation and deviation combined, can be observed. The binnacles or pedestals for compasses are generally constructed of wood about 45 inches high, and fitted to receive and alter at pleasure the several magnet and soft iron correctors. They are also fitted with different forms of suspension in which the compass is mounted to obviate the mechanical disturbance of the card caused by the vibration of the hull in ships driven by powerful engines.

The effects of the iron and steel used in the construction of ships upon the compass have occupied the attention of the ablest physicists of the 19th century, with results which enable navigators to conduct their ships with perfect safety. The hull of an iron or steel ship is a magnet, and the distribution of its magnetism depends upon the direction of the ship's head when building, this result being produced by induction from the earth's magnetism, developed and impressed by the hammering of the plates and frames during the process of building. The disturbance of the compass by the magnetism of the hull is generally modified, sometimes favourably, more often unfavourably, by the magnetized fittings of the ship, such as masts, conning towers, deck houses, engines, and boilers. Thus in every ship the compass needle is more or less subject to deviation differing in amount and direction for every azimuth of the ship's head. This was first demonstrated by Commander Matthew Flinders by experiments made in H.M.S. *Investigator* in 1800–3, and in 1810 led that officer to introduce the practice of placing the ship's head on each point of the compass, and noting the amount of deviation whether to the east or west of the magnetic north, a process which is in full exercise at the present day, and is called "swinging ship." When speaking of the magnetic properties of iron it is usual to adopt the terms "soft" and "hard." Soft iron is iron which becomes instantly magnetized by induction when exposed to any magnetic force, but has no power of retaining its magnetism. Hard iron is less susceptible of being magnetized, but when once magnetized it retains its magnetism permanently. The term "iron" used in these pages includes the "steel" now commonly employed in shipbuilding. If an iron ship be swung when upright for deviation, and the mean horizontal and vertical magnetic forces at the compass positions be also observed in different parts of the world, mathematical analysis shows that the deviations are caused partly by the permanent magnetism of hard iron, partly by the transient-induced magnetism of soft iron both horizontal and vertical, and in a lesser degree by iron which is neither magnetically hard nor soft, but which becomes magnetized in the same manner as hard iron, though it gradually loses its magnetism on change of conditions, as, for example, in the case of a ship, repaired and hammered in dock, steaming in an opposite direction at sea. This latter cause of deviation is called sub-permanent magnetism. The horizontal directive force on the needle on board is nearly always less than on land, sometimes much less, whilst in armour-plated ships it ranges from ·8 to ·2 when the directive force on land = 1·0. If the ship be inclined to starboard or to port additional deviation will be observed, reaching a maximum on north and south points, decreasing to zero on the east and west points. Each ship has its own magnetic character, but there are certain conditions which are common to vessels of the same type.

Instead of observing the deviation solely for the purposes of correcting the indications of the compass when disturbed by the iron of the ship, the practice is to subject all deviations to mathematical analysis with a view to their mechanical correction. The whole of the deviations when the ship is upright may be expressed nearly by five co-efficients, A, B, C, D, E. Of these A is a deviation constant in amount for every direction of the ship's head. B has reference to horizontal forces acting in a longitudinal direction in the ship, and caused partly by the permanent magnetism of hard iron, partly by vertical induction in vertical soft iron either before or abaft the compass. C has reference to forces acting in a transverse direction, and caused by hard iron. D is due to transient induction in horizontal soft iron, the direction of which passes continuously under or over the compass. E is due to transient induction in horizontal soft iron unsymmetrically placed with regard to the compass. When data of this character have been obtained the compass deviations may be mechanically corrected to within 1°—always adhering to the principle that "like cures like." Thus the part of B caused by the permanent magnetism of hard iron must be corrected by permanent magnets horizontally placed in a fore and aft direction; the other part caused by vertical soft iron by means of bars of vertical soft iron, called Flinders bars, before or abaft the compass. C is compensated by permanent magnets athwartships and horizontal; D by masses of soft iron on both sides of the compass, and generally in the form of cast-iron spheres, with their centres in the same horizontal plane as the needles; E is usually too small to require correction; A is fortunately rarely of any value, as it cannot be corrected. The deviation observed when the ship inclines to either side is due—(1) to hard iron acting vertically upwards or downwards; (2) to vertical soft iron immediately below the compass; (3) to vertical induction in horizontal soft iron when inclined. To compensate (1) vertical magnets are used; (3) is partly corrected by the soft iron correctors of D; (2) and the remaining part of (3) cannot be conveniently corrected for more than one geographical position at a time. Although a compass may thus be made practically correct for a given time and place, the

magnetism of the ship is liable to changes on changing her geographical position, and especially so when steaming at right angles or nearly so to the magnetic meridian, for then sub-permanent magnetism is developed in the hull. Some vessels are more liable to become sub-permanently magnetized than others, and as no corrector has been found for this source of deviation the navigator must determine its amount by observation. Hence, however carefully a compass may be placed and subsequently compensated, the mariner has no safety without constantly observing the bearings of the sun, stars, or distant terrestrial objects, to ascertain its deviation. The results of these observations are entered in a compass journal for future reference when fog or darkness prevails.

Every compass and corrector supplied to the ships of the Royal Navy is previously examined in detail at the Compass Observatory established by the Admiralty at Deptford. A trained observer acting under the superintendent of compasses is charged with this important work. The superintendent, who is a naval officer, is also charged with the investigation of the magnetic character of all H.M. ships, to point out the most suitable positions for the compasses when a ship is designed, and subsequently to keep himself informed of their behaviour from the time of the ship's first trial. A museum containing compasses of various types invented during the 19th century is attached to the Compass Observatory at Deptford.

The mariner's compass during the early part of the 19th century was still a very imperfect instrument, although numerous inventors had tried to improve it. In 1837 the Admiralty Compass Committee was appointed to make a scientific investigation of the subject, and propose a form of compass suitable alike for azimuth and steering purposes. The committee reported in July 1840, and after minor improvements by the makers the Admiralty compass, the card of which is shown in Figs. 1 and 2, was adopted by the Government. Until 1876, when Sir William Thomson introduced his patent compass, this compass was not only the regulation compass of the Royal Navy, but was largely used in foreign countries in the same or a modified form. The introduction of powerful engines causing serious vibration to compass cards of the Admiralty type, coupled with the prevailing desire for larger cards, the deviation of which could also be more conveniently compensated, led to the gradual introduction of the Thomson compass. Several important points were gained in the latter: the quadrantal deviation could be finally corrected for all latitudes; frictional error at the cap and pivot was reduced to a minimum, the average weight of the card being 200 grains; the long free vibrational period of the card was found to be favourable to its steadiness when the vessel was rolling. The first liquid compass used in England was invented by Francis Crow, of Faversham, in 1813. It is said that the idea of a liquid compass was suggested to Crow by the experience of the captain of a coasting vessel whose compass card was oscillating wildly until a sea broke on board filling the compass bowl, when the card became steady. Subsequent improvements were made by Dant, and especially by Ritchie, of Boston, U.S.A. In 1888 the form of liquid compass (Fig. 5) now solely used in torpedo boats and torpedo boat destroyers was introduced. It has also proved to be the most trustworthy compass under the shock of heavy gun fire at present available. The deflector is an instrument designed to enable an observer to reduce the deviations of the compass to an amount not exceeding 2° during fogs, or at any time when bearings of distant objects are not available. It is certain that if the directive forces on the north, east, south, and west points of a compass are equal, there can be no deviation. With the deflector any inequality in the directive force can be detected, and hence the power of equalizing the forces by the usual soft iron and magnet correctors. Several kinds of deflector have been invented, that of Lord Kelvin (Sir William Thomson) being the simplest, but Dr Waghorn's is also very effective. The use of the deflector is generally confined to experts.

*The Magnetism of Ships.*—In 1814 Flinders first showed (see Flinders's *Voyage*, vol. ii. appx. ii.) that the abnormal values of the variation observed in the wood-built ships of his day was due to deviation of the compass caused by the iron in the ship; that the deviation was zero when the ship's head was near the north and south points; that it attained its maximum on the east and west points, and varied as the sine of the azimuth of the ship's head reckoned from the zero points. He also described a method of correcting deviation by means of a bar of vertical iron so placed as to correct the deviation nearly in all latitudes. This bar, now known as a "Flinders bar," is still in general use. In 1820 Dr Young (see Brande's *Quarterly Journal*, 1820) investigated mathematically the magnetism of ships. In 1824 Professor Barlow introduced his correcting plate of *soft* iron. Trials in certain ships showed that their magnetism consisted partly of hard iron, and the use of the plate was abandoned. In 1835 Captain Johnson, R.N., showed from experiments in the iron steamship *Garry Owen* that the vessel acted on an external compass as a magnet. In 1838 Airy (Astronomer-Royal) magnetically examined the iron steamship *Rainbow* at Deptford, and from his mathematical investigations (see *Phil. Trans. R. S.*, 1839) deduced his method of correcting the compass by permanent magnets and soft iron, giving practical rules for the same in 1840. Airy's and Flinders's correctors form the basis of all compass correctors to this day. In 1838 Poisson published his *Memoir on the Deviation of the Compass caused by the Iron in a Vessel*. In this he gave equations resulting from the hypothesis that the magnetism of a ship is partly due to the permanent magnetism of hard iron and partly to the transient-induced magnetism of soft iron; that the latter is proportional to the intensity of the inducing force, and that the length of the needle is infinitesimally small compared to the distance of the surrounding iron. From Poisson's equations Archibald Smith deduced the formulæ given in the *Admiralty Manual for Deviations of the Compass* (1st ed., 1862), a work which has formed the basis of numerous other manuals since published in Great Britain and other countries. In view of the serious difficulties connected with the inclining of every ship, Smith's formulæ for ascertaining and providing for the correction of the heeling error with the ship upright continue to be of great value to safe navigation. In 1855 the Liverpool Compass Committee commenced its work of investigating the magnetism of ships of the mercantile marine, resulting in three reports to the Board of Trade, all of great value, the last being presented in 1861.

See articles on Magnetism of Ships and Deviations of the Compass, *Phil. Trans.* 1839–83, *Journal United Service Inst.* 1859–1889, *Trans. Nav. Archit.* 1860–61–62, *Report of Brit. Assoc.* 1862, *London Quarterly Rev.* 1865; also *Admiralty Manual*, edit. 1862–63–69–93–1900; and TOWSON'S *Practical Information on Deviations of the Compass*, 1886. (E. W. C.)

**Compensation.**—The term "Compensation" is applied in English law to a number of different forms of legal reparation, *e.g.*, to persons injured by felony, or—under the Riot (Damages) Act, 1886—to persons whose property has been stolen, destroyed, or injured by rioters. It is due, under the Agricultural Holdings Act, 1883, for agricultural improvements; and, under the Workmen's Compensation Act, 1897, to workmen, in respect of accidents in certain forms of employment. The word is, however, in its strict and most familiar sense, a *nomen juris* for the reparation or satisfaction made to the owners of property which is taken by the executive government or by local bodies or corporations, under statutory authority, for public purposes. There are two main legal theories on which such appropriation of private property is justified. The American may be taken as a representative illustration of the one, and the English of the other. Though not included in the definition of "eminent domain," the necessity for compensation is recognized as incidental to that power. The normal procedure is admirably described in Bouvier's *Law Dict.*, ed. Rawle, 1897, *s.v.* "Eminent Domain." According to the law of the United States, there resides in every sovereign State, either as a residuum of the proprietary rights which it creates or protects, or (which is the better opinion) as an incident of its sovereignty, power to take, without reference to the question of compensation, the property of its subjects for purposes of a public character. This power is called "Eminent Domain." In English law the only exact analogue to this doctrine is to be found in the prerogative right (which now exists chiefly in theory) of the Crown to expropriate the lands of subjects for the purposes of the defence of the realm (see *Attorney-General* v. *Tomline*, 1879, 12 Ch. D. 214). With that exception, the rule of English constitutional law is that the property of the citizen cannot be seized for purposes which are really "public" without a fair pecuniary

**Eminent domain.**

equivalent being given to him; and, as the money for such compensation must come from Parliament, the practical result is that the seizure can only be effected under legislative authority. An action for illegal interference with the property of the subject is not maintainable against officials of the Crown or Government sued in their official capacity or as an official body. But Crown or Government officials may be sued in their individual capacity for such interference, even if they acted with the authority of the Government (cp. *Raleigh* v. *Goschen*, 1898, 1 Ch. 73; 67 L. J. Ch. 59).

*Lands Clauses Acts.*—Down to 1845 every Act authorizing the purchase of lands had, in addition to a number of common form clauses, a variety of special clauses framed with a view to meeting the particular circumstances with which it dealt. In 1845, however, a statute based on the recommendations of a select committee, appointed in the preceding year, was passed; the object being to diminish the bulk of the special Acts, and to introduce uniformity into Private Bill legislation by classifying the common form clauses, embodying them in general statutes, and enabling them to be incorporated into the special statutes by reference. The statute by which this change was initiated was the Lands Clauses Consolidation Act, 1845; and the policy has been continued by a series of later statutes which, together with the Act of 1845, are now grouped under the generic title of "The Lands Clauses Acts."

The public purposes for which lands are taken are threefold. Certain public departments, such as the War Office and the Admiralty, may acquire lands for national purposes. Local authorities are enabled to exercise similar powers for an enormous variety of municipal purposes, *e.g.*, the housing of the working classes, the improvement of towns, elementary and technical education. Lastly, the promoters of public undertakings of a commercial character, such as railways and harbours, carry on their operations under statutes in which the provisions of the Lands Clauses Acts are incorporated.

Lands may be taken under the Lands Clauses Acts either by agreement or compulsorily. The first step in the proceedings is a "notice to treat," or intimation by the promoters of their readiness to purchase the land, coupled with a demand for particulars as to the estate and the interests in it. The landowner on whom the notice is served may meet it by agreeing to sell, and the terms may then be settled by consent of the parties themselves, or by arbitration, if they decide to have recourse to that mode of adjusting the difficulty. If the property claimed is a house, or other building or manufactory, the owner has a statutory right to require the promoters by a counter-notice to take the whole, even although a part would serve their purpose. This rule, however, is, in modern Acts, often modified by special clauses. On receipt of the counter-notice the promoters must either assent to the requirement contained in it, or abandon their notice to treat. On the other hand, if the landowner fails within twenty-one days after receipt of the notice to treat to give the particulars which it requires, the promoters may proceed to exercise their compulsory powers and obtain assessment of the compensation to be paid. As a general rule, it is a condition precedent to the exercise of these powers by a company that the capital of the undertaking should be fully subscribed. Compensation, under the Lands Clauses Acts, is assessed in four different modes:—(1) by justices, where the claim does not exceed £50, or a claimant who has no greater interest than that of a tenant for a year, or from year to year, is required to give up possession before the expiration of his tenancy; (2) by arbitration (*a*) when the claim exceeds £50, and the claimant desires arbitration, and the interest is not a yearly tenancy, (*b*) when the amount has been ascertained by a surveyor, and the claimant is dissatisfied, (*c*) when superfluous lands are to be sold, and the parties and the promoters cannot agree as to the price; lands become "superfluous" if taken compulsorily on an erroneous estimate of the area needed, or if part only was needed and the owner compelled the promoters under the power above mentioned to take the whole, or in cases of abandonment; (3) by a jury, when the claim exceeds £50, and (*a*) the claimant does not signify his desire for arbitration, or no award has been made within the prescribed time, or (*b*) the claimant applies in writing for trial by jury; (4) by surveyors, nominated by justices, where the owner is under disability, or does not appear at the appointed time, or the claim is in respect of commonable rights, and a committee has not been appointed to treat with the promoters.

Promoters are not allowed without consent of the owner to enter upon lands which are the subject of proceedings under the Lands Clauses Acts, except for the purpose of making a survey, unless they have executed a statutory bond and made a deposit, at the Law Courts Branch of the Bank of England, as security for the performance of the conditions of the bond.

*Measure of Value.*—(1) Where land is taken, the basis on which compensation is assessed is the commercial value of the land to the owner at the date of the notice to treat. Potential value may be taken into account, and also goodwill of the property in a business. This rule, however, excludes any consideration of the principle of "betterment," according to which promoters would be allowed to set off against an owner's claim for compensation any enhancement of the value of his land by the use of the land taken by the promoters. Statutory recognition has been given to this principle in some of the American states and in some British colonies (*e.g.*, Victoria, &c.); and in England public bodies have been empowered in local Acts to recoup themselves for their outlay by receiving from the owners of premises and lands part of the enhanced value created by local improvements. [See Browne and Allan, *Compensation*, 1896, pp. 121, 683; and the report of a select committee of the House of Lords on the subject, *ib.* p. 684; and the London County Council (Tower Bridge, Southern Approach) Act, 1894.] (2) Where land, although not taken, is "injuriously affected" by the works of the promoters, compensation is payable for loss or damage resulting from any act, legalized by the promoters' statutory powers, which would otherwise have been actionable, or caused by the execution (not the use) of the works authorized by the undertaking.

***Betterment.***

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(A. W. R.)

**Compiègne,** chief town of arrondissement, department of Oise, France, 37 miles east of Beauvais, on railway from Paris. The famous castle of Compiègne now serves as a museum, and contains an important collection of Cambodian and Gallo-Roman antiquities. A monument to Joan of Arc was erected in 1880. In the vicinity are important sugar-mills. Population (1881), 11,116; (1891), 11,877; (1896), 12,380; (1901), 16,503.

**Compressed Air.** See POWER, TRANSMISSION OF (PNEUMATIC).

**Concarneau,** a seaport and railway station,

France, department of Finistère, arrondissement of Quimper, 14 miles south-east of that town. The town occupies a very picturesque situation. The old portion stands on an island, and is surrounded by ramparts, parts of which date from the 15th century. It is an important centre of the sardine and mackerel fisheries, in which in 1899, 555 boats with 2966 men were employed. Lobsters are also largely reared. Population (1881), 5006; (1896), 6343.

**Concepción,** a city in Chile, capital of a province and department of the same name, near the mouth of the Bio-Bio, in 36° 49′ 37″ S. lat. and 73° 06′ W. long., 355 miles south of Santiago. Its altitude above the sea is 40 feet. Its population in 1895 was 39,837, and in 1898 it was 51,781. It is connected with the rest of the country by three lines of railway. It is an episcopal see, has a public school for boys, one for girls, an agricultural school, a seminary, and various other establishments. It publishes four newspapers. It is the principal commercial centre of Southern Chile, large quantities of wheat, flour, and wool being exported from it, through Talcahuano.

**Concepción,** or **Villa Concepción,** the principal city in the northern part of Paraguay, with a population, including its suburbs, of 15,000, 125 miles north-north-east of Asunción, and about 345 feet above sea-level. It has a national college, two public schools, a custom-house, a good harbour, a large market, two banks, a sub-department of the Agricultural Bank, a post office, street railway, and telephone company. It is the point whence most of the yerba maté is exported, and to which importation is made direct from all countries. Across the river is the English missionary station, the territory of which extends many miles into the interior, among the Indians.

**Concord,** a town and village of Middlesex county, Massachusetts, U.S.A., in the north-eastern part of the state, on the Boston and Maine and the Fitchburg (now a part of the Boston and Maine) Railways. Besides its distinction in revolutionary history, the town is known as the home of Emerson, Hawthorne, Thoreau, and other literary men. Population (1880), 3922; 1890, 4427; (1900), 5652.

**Concord,** capital of Merrimac county, New Hampshire, U.S.A., and of the state. It is situated in the southern part of the state, in 43° 12′ N. lat. and 71° 30′ W. long., at an altitude of 252 feet, on Merrimac river, which here is not navigable, but furnishes excellent water-power. The city has an area of 64 square miles, and is on the Boston and Maine Railway. Population (1880), 13,843; (1890), 17,004; (1900), 19,632.

**Concord,** capital of Cabarrus county, North Carolina, U.S.A., in the Piedmont region, on the Rocky river, and on the Southern Railway. Population (1890), 4339; (1900), 7910, including 1789 negroes.

**Condensation of Gases.**—If the volume of a gas continually decreases at a constant temperature, for which an increasing pressure is required, two cases may occur:—(1) The volume may continue to be homogeneously filled. (2) If the substance is contained in a certain volume, and if the pressure has a certain value, the substance may divide into two different phases, each of which is again homogeneous. The value of the temperature T decides which case will occur. The temperature which is the limit above which the space will always be homogeneously filled, and below which the substance divides into two phases, is called the *critical temperature* of the substance. It differs greatly for different substances, and if we represent it by $T_c$, the condition for the condensation of a gas is that T must be below $T_c$. If the substance is divided into two phases two different cases may occur. The denser phase may be either a liquid or a solid. The limiting temperature for these two cases, at which the division into three phases may occur, is called the *triple point*. Let us represent it by $T_3$; if the term "condensation of gases" is taken in the sense of "liquefaction of gases"—which is usually done—the condition for condensation is $T_c > T > T_3$. The opinion sometimes held that for all substances $T_3$ is the same fraction of T (the value being about $\frac{1}{2}$), has decidedly not been rigorously confirmed. Nor is this to be expected on account of the very different form of crystallization which the solid state presents. Thus for $CO_2$, for which $T_c = 304°$ on the absolute scale, and for which we may put $T_3 = 216°$, this fraction is about 0·7; for water it descends down to 0·42, and for other substances it may be still lower.

**Critical temperature.**

If we confine ourselves to temperatures between $T_c$ and $T_3$ the gas will pass into a liquid if the pressure is sufficiently increased. When the formation of liquid sets in we call the gas a *saturated vapour*. If the decrease of volume is continued the gas pressure remains constant till all the vapour has passed into liquid. The invariability of the properties of the phases is in close connexion with the invariability of the pressure (called *maximum tension*). Throughout the course of the process of condensation these properties remain unchanged, provided the temperature remain constant; only the relative quantity of the two phases changes. Until all the gas has passed into liquid a further decrease of volume will not require increase of pressure. But as soon as the liquefaction is complete a slight decrease of volume will require a great increase of pressure, liquids being but slightly compressible.

The pressure required to condense a gas varies with the temperature, becoming higher as the temperature rises. The highest pressure will therefore be found at $T_c$ and the lowest at $T_3$. We shall represent the pressure at $T_c$ by $p_c$. It is called the *critical pressure*. The pressure at $T_3$ we shall represent by $p_3$. It is called the *pressure of the triple point*. The values of $T_c$ and $p_c$ for different substances will be found at the end of this article. The values of $T_3$ and $p_3$ are accurately known only for a few substances. As a rule $p_3$ is small, though occasionally it is greater than 1 atmosphere. This is the case with $CO_2$, and we may in general expect it if the value of $T_3/T_c$ is large. In this case there can only be a question of a real boiling-point (under the normal pressure) if the liquid can be supercooled.

**Critical pressure.**

We may find the value of the pressure of the saturated vapour for each T in a geometrical way by drawing in the theoretical isothermal a straight line parallel to the $v$ axis in such a way, that $\int_{v_1}^{v_2} p dv$ will have the same value whether the straight line or the theoretical isothermal is followed. This construction, given by Maxwell, may be considered as a result of the application of the general rules for co-existing equilibrium, which we owe to Willard Gibbs. The construction derived from the rules of Gibbs is as follows:—Construe the free energy at a constant temperature, *i.e.*, the quantity $-\int p dv$ as ordinate, if the abscissa represents $v$, and determine the inclination of the double tangent. Another construction derived from the rules of Gibbs might be expressed as follows:—Construe the value of $pv - \int p dv$ as ordinate, the abscissa representing $p$, and determine the point of intersection of two of the three branches of this curve.

As an approximate, half-empirical formula for the calculation of the pressure, $-\log \frac{p}{p_c} = f\left(\frac{T_c - T}{T}\right)$ may be used.

It would follow from the law of corresponding states that in this formula the value of $f$ is the same for all substances, the molecules of which do not associate to form larger molecule-complexes. In fact, for a great many substances, we find a value for $f$, which differs but little from 3, *e.g.*, ether, $CO_2$, benzene, benzene derivatives, chloric ethyl, ethane, &c. As the chemical structure of these substances differs greatly, and association, if it takes place, must largely depend upon the structure of the molecule, we conclude from this approximate equality that the fact of this value of $f$ being equal to about 3 is characteristic for normal substances in which, consequently, association is excluded. Substances known to associate, such as organic acids and alcohols, have a sensibly higher value of $f$. Thus M. Estreicher (Cracow, 1896) calculates that for fluor-benzene $f$ varies between 3·07 and 2·94; for ether between 3·0 and 3·1; but for water between 3·2 and 3·33, and for methyl alcohol between 3·65 and 3·84, &c. For isobutyl alcohol $f$ even rises above 4. It is, however, remarkable that for oxygen $f$ has been found almost invariably equal to 2·47 from Olszewski's observations, a value which is appreciably smaller than 3. This fact makes us again seriously doubt the correctness of the supposition that $f=3$ is a characteristic for non-association.

It is a general rule that the volume of saturated vapour decreases when the temperature is raised, while that of the co-existing liquid increases. We know only one exception to this rule, and that is the volume of water below 4° C. If we call the liquid volume $v_l$, and the vapour $v_v$, $v_v - v_l$ decreases if the temperature rises, and becomes zero at $T_c$. The limiting value, to which $v_l$ and $v_v$ converge at $T_c$, is called the *critical volume*, and we shall represent it by $v_c$.

***Critical volume.***

According to the law of corresponding states the values both of $v_l/v_c$ and $v_v/v_c$ must be the same for all substances, if $T/T_c$ has been taken equal for them all. According to the investigations of Sydney Young, this holds good with a high degree of approximation for a long series of substances. Important deviations from this rule for the values of $v_v/v_l$ are only found for those substances in which the existence of association has already been discovered by other methods. Since the lowest value of T, for which investigations on $v_l$ and $v_v$ may be made, is the value of $T_3$; and since $T_3/T_c$, as has been observed above, is not the same for all substances, we cannot expect the smallest value of $v_l/v_c$ to be the same for all substances. But for low values of T, viz., such as are near $T_3$, the influence of the temperature on the volume is but slight, and therefore we are not far from the truth, if for normal substances we take the minimum value of $v/v_c$ as being equal for all normal substances, and put it at about $\frac{1}{3}$. Moreover, the influence of the polymerization (association) on the liquid volume appears to be small, so that we may even attribute the value $\frac{1}{3}$ to substances which are not normal. The value of $v_v/v_c$ at $T=T_3$ differs widely for different substances. If we take $p_3$ so low that the law of Boyle-Gay-Lussac may be applied, we can calculate $v_3/v_c$ by means of the formula $\frac{p_3 v_3}{T_3}=k\frac{p_c v_c}{T_c}$, provided $k$ be known. According to the observations of Sydney Young this factor has proved to be 3·77 for normal substances. In consequence $\frac{v_3}{v_c}=3{\cdot}77\,\frac{p_c}{p_3}\frac{T_3}{T_c}$. A similar formula, but with another value of $k$, may be given for associating substances, provided the saturated vapour does not contain any complex molecules. But if it does, as is the case with acetic acid, we must also know the degree of association. It can, however, only be found by measuring the volume itself.

Matthias has remarked that the following relation exists between the densities of the saturated vapour and of the co-existing liquid:—

***Rule of the rectilinear diameter.***

$$\rho_l + \rho_v = 2\rho_c\left\{1 + a\left(1 - \frac{T}{T_c}\right)\right\},$$

and that, accordingly, the curve which represents the densities at different temperatures possesses a rectilinear diameter. According to the law of corresponding states, $a$ would be the same for all substances. Many substances, indeed, actually appear to have a rectilinear diameter, and the value of $a$ appears approximatively to be the same. In a *Mémoire présenté à la société royale à Liège*, 15th June 1899, Matthias gives a list of some twenty substances for which $a$ has a value lying between 0·95 and 1·05. It had been already observed by Sydney Young that $a$ is not perfectly constant even for normal substances. For associating substances the diameter is not rectilinear. Whether the value of $a$, near 1, may serve as a characteristic for normal substances is rendered doubtful by the fact that for nitrogen $a$ is found equal to 0·6813, and for oxygen to 0·8. At $T=T_c/2$, the formula of Matthias, if $\rho_v$ be neglected with respect to $\rho_l$, gives the value $2+a$ for $\rho_l/\rho_c$.

The heat required to convert a molecular quantity of liquid coexisting with vapour into saturated vapour at the same temperature is called *molecular latent heat*. It decreases with the rise of the temperature, because at a higher temperature the liquid has already expanded, and because the vapour into which it has to be converted is denser.

***Latent heat.***

At the critical temperature it is equal to zero on account of the identity of the liquid and the gaseous states. If we call the molecular weight $m$ and the latent heat per unit of weight $r$, then, according to the law of corresponding states, $mr/T$ is the same for all normal substances, provided the temperatures are corresponding. According to Trouton the value of $mr/T$ is the same for all substances if we take for T the boiling-point. As the boiling-points under the pressure of one atmosphere are generally not equal fractions of $T_c$, the two theorems are not identical; but as the values of $p_c$ for many substances do not differ so much as to make the ratios of the boiling-points under the pressure of one atmosphere differ greatly from the ratios of $T_c$, an approximate confirmation of the law of Trouton may be compatible with an approximate confirmation of the consequence of the law of corresponding states. If we take the term boiling-point in a more general sense, and put T in the law of Trouton to represent the boiling-point under an arbitrary equal pressure, we may take the pressure equal to $p_c$ for a certain substance. For this substance $mr/T$ would be equal to zero, and the values of $mr/T$ would no longer show a trace of equality. At present direct trustworthy investigations about the value of $r$ for different substances are wanting; hence the question whether as to the quantity $mr/T$ the substances are to be divided into normal and associating ones cannot be answered. Let us divide the latent heat into heat necessary for internal work and heat necessary for external work. Let $r'$ represent the former of these two quantities, then:—

$$r = r' + p(v_v - v_l).$$

Then the same remark holds good for $mr'/T$ as has been made for $mr/T$. The ratio between $r$ and that part that is necessary for external work is given in the formula,

$$\frac{r}{p(v_v - v_l)} = \frac{T}{p}\frac{dp}{dT}.$$

By making use of the approximate formula for the vapour tension: $-$ Nap. log. $\frac{p}{p_c}=f'\left(\frac{T_c - T}{T}\right)$, we find

$$\frac{r}{p(v_v - v_l)} = f'\frac{T_c}{T}.$$

At $T = T_c$ we find for this ratio $f'$, a value which for normal substances is equal to $3/0{\cdot}4343 = 7$. At the critical temperature the quantities $r$ and $v_v - v_l$ are both equal to 0, but they have a finite ratio. As we may equate $p(v_v - v_l)$ with $pv_v = RT$ at very low temperatures, we get, if we take into consideration that R expressed in calories is equal to $2/m$, the value $2f'T_c = 14T_c$ as limiting value for $mr$ for normal substances. This value for $mr$ has, however, merely the character of a rough approximation — especially since the factor $f'$ is not perfectly constant.

All the phenomena which accompany the condensation of gases into liquids may be explained by the supposition, that the condition of aggregation which we call liquid differs only in quantity, and not in quality, from that which we call gas. We imagine a gas to consist of separate molecules of a certain mass $\mu$, having a certain velocity depending on the temperature. This velocity is distributed according to the law of probabilities, and furnishes a quantity of *vis viva* proportional to the temperature. We must attribute extension to the molecules, and they will attract one another with a force which quickly decreases with the distance. Even those suppositions which reduce molecules to centra of forces, like that of Maxwell, lead us to the result that the molecules behave in mutual collisions as if they had extension—an extension which in this case is not constant, but determined by the law of repulsion in the collision, the law of the distribution, and the value of the velocities. In order to explain capillary phenomena it was assumed so early as Laplace, that between the molecules of the same substance an attraction exists which quickly decreases with the distance. That this attraction is found in gases too is proved by the fall which occurs in the temperature of a gas that is expanded without performing external work. We are still perfectly in the dark as to the cause of this attraction, and opinion differs greatly as to its dependence on the distance. Nor is this knowledge necessary in order to find the influence of the attraction, for a homogeneous state, on the value of the external pressure which is required to keep the moving molecules at a certain volume (T being given). We may, viz., assume either in the strict sense, or as a first approximation, that the influence of the attraction is quite equal to a pressure which is proportional to the square of the density. Though this molecular pressure is small for gases, yet it will be considerable for the great densities of liquids, and calculation shows that we may estimate it at more than 1000 atmos., possibly increasing up to 10,000. We may now make the same supposition for a liquid as for a gas, and imagine it to consist of molecules, which for non-associating substances are the same as those of the rarefied vapour; these, if T is the same, have the same mean *vis viva* as the vapour molecules, but are more closely massed together. Starting from this supposition and all its consequences, the author of this article has derived the following formula, which would hold both for the liquid state and for the gaseous state :—

***Nature of a liquid.***

$$\left(p + \frac{a}{v^2}\right)(v - b) = RT.$$

It follows from this deduction that for the rarefied gaseous state $b$ would be four times the volume of the molecules, but that for greater densities the factor 4 would decrease. If we represent the volume of the molecules by $\beta$, the quantity $b$ will be found to have the following form :—

$$b = 4\beta\left\{1 - \gamma_1\left(\frac{4\beta}{v}\right) + \gamma_2\left(\frac{4\beta}{v}\right)^2 \text{ \&c.}\right\}$$

Only two of the successive coefficients $\gamma_1$, $\gamma_2$, &c., have been worked out, for the determination requires very lengthy calculations, and has not even led to definitive results (Boltzmann, *Proc. Royal Acad. Amsterdam*, March 1899). The latter formula supposes the molecules to be rigid spheres of invariable size. If the molecules are things which are compressible, another formula for $b$ is found, which is different according to the number of atoms in the molecule (*Proc. Royal Acad. Amsterdam*, 1900–1). If we keep the value of $a$ and $b$ constant, the given equation will not completely represent the net of isothermals of a substance. Yet even in this form it is sufficient as to the principal features. From it we may argue to the existence of a critical temperature, to a minimum value of the product $pv$, to the law of corresponding states, &c. Some of the numerical results to which it leads, however, have not been confirmed by experience. Thus it would follow from the given equation that $\frac{p_c v_c}{T_c} = \frac{3}{8}\frac{pv}{T}$, if the value of $v$ is taken so great that the gaseous laws may be applied, whereas Sydney Young has found $1/3{\cdot}77$ for a number of substances instead of the factor $3/8$. Again it follows from the given equation, that if $a$ is thought to be independent of the temperature, $\frac{T_c}{p_c}\left(\frac{dp}{dT}\right)_c = 4$, whereas for a number of substances a value is found for it which is near 7. If we assume with Clausius that $a$ depends on the temperature, and has a value $a'\frac{273}{T}$, we find $\frac{T_c}{p_c}\left(\frac{dp}{dT}\right)_c = 7$.

That the accurate knowledge of the equation of state is of the highest importance is universally acknowledged, because in connexion with the results of thermodynamics it will enable us to explain all phenomena relating to ponderable matter. This general conviction is shown by the numerous efforts made to complete or modify the given equation, or to replace it by another, for instance, by Clausius, Tait, Amagat, Boltzmann, Jäger, Dieterici, Galitzine, Rose Innes, and Reinganum.

If we hold to the supposition that the molecules in the gaseous and the liquid state are the same—which we may call the supposition of the identity of the two conditions of aggregation—then the heat which is given out by the condensation at constant T is due to the potential energy lost in consequence of the coming closer of the molecules which attract each other, and then it is equal to $a\left(\frac{1}{v_l} - \frac{1}{v_v}\right)$. If $a$ should be a function of the temperature, it follows from thermodynamics that it would be equal to $\left(a - T\frac{da}{dT}\right)\left(\frac{1}{v_l} - \frac{1}{v_v}\right)$. Not only in the case of liquid and gas, but always when the volume is diminished, a quantity of heat is given out equal to $a\left(\frac{1}{v_1} - \frac{1}{v_2}\right)$ or $\left(a - T\frac{da}{dT}\right)\left(\frac{1}{v_1} - \frac{1}{v_2}\right)$.

If, however, when the volume is diminished at a given temperature, and also during the transition from the gaseous to the liquid state, combination into larger molecule-complexes takes place, the total internal heat may be considered as the sum of that which is caused by the combination of the molecules into greater molecule-complexes and by their approach towards each other. We have the simplest case of possible greater complexity when two molecules combine to one. From the course of the changes in the density of the vapour we assume that this occurs, *e.g.*, with $NO_2$ and acetic acid, and the somewhat close agreement of the observed density of the vapour with that which is calculated from the hypothesis of such an association to double-molecules, makes this supposition almost a certainty. In

***Associating substances.***

such cases the molecules in the much denser liquid state must therefore be considered as double-molecules, either completely so or in a variable degree depending on the temperature. The given equation of state cannot hold for such substances. Even though we assume that $a$ and $b$ are not modified by the formation of double-molecules, yet RT is modified, and since it is proportional to the number of the molecules, it is diminished by the combination. The laws found for normal substances will, therefore, not hold for such associating substances. Accordingly for substances for which we have already found an anormal density of the vapour, we cannot expect the general laws for the liquid state, which have been treated above, to hold good without modification, and in many respects such substances will therefore not follow the law of corresponding states. There are, however, also substances of which the anormal density of vapour has not been stated, and which yet cannot be ranged under this law, *e.g.*, water and alcohols. The most natural thing, of course, is to ascribe the deviation of these substances, as of the others, to the fact that the molecules of the liquid are polymerized. In this case we have to account for the following circumstance, that whereas for $NO_2$ and acetic acid in the state of saturated vapour the degree of association increases if the temperature falls, the reverse must take place for water and alcohols. Such a difference may be accounted for by the difference in the quantity of heat released by the polymerization to double-molecules or larger molecule-complexes. The quantity of heat given out when two molecules fall together may be calculated for $NO_2$, and acetic acid from the formula of Gibbs for the density of vapour, and it proves to be very considerable. With this the following fact is closely connected. If in the $pv$ diagram, starting from a point indicating the state of saturated vapour, a geometrical locus is drawn of the points which have the same degree of association, this curve, which passes towards isothermals of higher T if the volume diminishes, requires for the same change in T a greater diminution of volume than is indicated by the border-curve. For water and alcohols this geometrical locus will be found on the other side of the border-curve, and the polymerization heat will be small, *i.e.*, smaller than the latent heat. For substances with a small polymerization heat the degree of association will continually decrease if we move along the border-curve on the side of the saturated vapour in the direction towards lower T. With this, it is perfectly compatible that for such substances the saturated vapour, *e.g.*, under the pressure of one atmosphere, should show an almost normal density. Saturated vapour of water at 100° has a density which seems nearly 4 per cent. greater than the theoretical one, an amount which is greater than can be ascribed to the deviation from the gas-laws. For the relation between $v$, T, and $x$, if $x$ represents the fraction of the number of double-molecules, the following formula has been found (*Moleculartheorie Zeitschrift Ph. Ch.*, 1890, Leipzig):

$$\log \frac{x(v-b)}{(1-x)^2} = 2\frac{E_1 - E_2}{R_1 T} + C,$$

from which

$$\frac{T}{v-b}\left(\frac{dv}{dT}\right)_x = -2\frac{E_1 - E_2}{R_1 T}$$

which may elucidate what precedes.

**Condensation of substances with low $T_c$.** By far the majority of substances have a value of $T_c$ above the ordinary temperature, and diminution of volume (increase of pressure) is sufficient to condense such gaseous substances into liquids. If $T_c$ is but little above the ordinary temperature, a great increase of pressure is in general required to effect condensation. Substances for which $T_c$ is much higher than the ordinary temperature $T_0$, *e.g.*, $T_c > {}^5/_3 T_0$, occur as liquids, even without increase of pressure; that is, at the pressure of one atmosphere. The value ${}^5/_3$ is to be considered as only a mean value, because of the inequality of $p_c$. The substances for which $T_c$ is smaller than the ordinary temperature are but few in number. Taking the temperature of melting ice as a limit, these gases are in successive order: $CH_4$, NO, $O_2$, CO, $N_2$, and $H_2$ (the recently-discovered gases are left out of account). If these gases are compressed at 0° centigrade they do not show a trace of liquefaction, and therefore they were long known under the name of "permanent gases." The discovery, however, of the critical temperature carried the conviction that these substances would not be "permanent gases" if they were compressed at much lower T. Hence the problem arose how "low temperatures" were to be brought about. Considered from a general point of view the means to attain this end may be described as follows: we must make use of the above-mentioned circumstance that heat disappears when a substance expands, either with or without performing external work. According as this heat is derived from the substance itself which is to be condensed, or from the substance which is used as a means of cooling, we may divide the methods for condensing the so-called permanent gases into two principal groups.

**Liquids as means of cooling.** In order to use a liquid as a cooling bath it must be placed in a vacuum, and it must be possible to keep the pressure of the vapour in that space at a small value. According to the boiling-law, the temperature of the liquid must descend to that at which the maximum tension of the vapour is equal to the pressure which reigns on the surface of the liquid. If the vapour, either by means of absorption or by an air-pump, is exhausted from the space, the temperature of the liquid and that of the space itself depend upon the value of the pressure which finally prevails in the space. From a practical point of view the value of $T_3$ may be regarded as the limit to which the temperature falls. It is true that if the air is exhausted to the utmost possible extent, the temperature may fall still lower, but when the substance has become solid, a further diminution of the pressure in the space is of little advantage. At any rate, as a solid body evaporates only on the surface, and solid gases are bad conductors of heat, further cooling will only take place very slowly, and will scarcely neutralize the influx of heat. If the pressure $p_3$ is very small, it is perhaps practically impossible to reach $T_3$; if so, $T_3$ in the following lines will represent the temperature practically attainable. There is thus for every gas a limit below which it is not to be cooled further, at least not in this way. If, however, we can find another gas for which the critical temperature is sufficiently above $T_3$ of the first chosen gas, and if it is converted into a liquid by cooling with the first gas, and then treated in the same way as the first gas, it may in its turn be cooled down to $(T_3)_2$. Going on in this way, continually lower temperatures may be attained, and it would be possible to condense all gases, provided the difference of the successive critical temperatures of two gases fulfils certain conditions. If the ratio of the absolute critical temperatures for two gases, which succeed one another in the series, should be sensibly greater than 2, the value of $T_3$ for the first gas is not, or not sufficiently, below the $T_c$ of the second gas. This is the case when one of the gases is nitrogen, on which hydrogen would follow as second gas. Generally, however, we shall take atmospheric air instead of nitrogen. Though this mixture of $N_2$ and $O_2$ will show other critical phenomena than a simple substance, yet we shall continue to speak of a $T_c$ for air, which is given at −140° C., and for which, there-

fore, $T_c$ amounts to 133° absolute. The lowest T which may be expected for air in a highly rarefied space may be evaluated at 60° absolute—a value which is higher than the $T_c$ for hydrogen. Without new contrivances it would, accordingly, not be possible to reach the critical temperature of $H_2$. The method by which we try to obtain successively lower temperatures by making use of successive gases is called the "cascade method." It is not self-evident that by sufficiently diminishing the pressure on a liquid, it may be cooled to such a degree that the temperature will be lowered to $T_3$, if the initial temperature was equal to $T_c$, or but little below it, and we can even predict with certainty that this will not be the case for all substances. It is possible, too, that long before the triple point is reached the whole liquid will have evaporated. The most favourable conditions will, of course, be attained when the influx of heat is reduced to a minimum. As a limiting case we imagine the process to be adiabatic. Now the question has become, Will an isentropic line, which starts from a point of the border-curve on the side of the liquid not far from the critical point, remain throughout its descending course in the heterogeneous region, or will it leave the region on the side of the vapour? As early as 1878 the author of this article (*Verslagen Kon. Akad. Amsterdam*) pointed out that the former may be expected to be the case only for substances for which $c_p/c_v$ is large, and the latter for those for which it is small; in other words, the former will take place for substances the molecules of which contain few atoms, and the latter for substances the molecules of which contain many atoms. Ether is an example of the latter class, and if we say that the quantity $h$ (specific heat of the saturated vapour) for ether is found to be positive, we state the same thing in other words. It is not necessary to prove this theorem further here, as the molecules of the gases under consideration contain only two atoms and the total evaporation of the liquid is not to be feared.

In the practical application of this cascade-method some variation is found in the gases chosen for the successive stages. Thus chloric methyl, ethylene, and oxygen are used in the cryogenic laboratory of Leyden, while Professor Dewar has used air as the last term. Carbonic acid is not to be recommended on account of the comparatively high value of $T_3$. In order to prevent loss of gas a system of "circulation" is employed. This method of obtaining low temperatures is decidedly laborious, and requires very intricate apparatus, but it has the great advantage that very *constant* low temperatures may be obtained, and can be regulated arbitrarily within pretty wide limits.

***Cooling by expansion.***

In order to lower the temperature of a substance down to $T_3$, it is not always necessary to convert it first into the liquid state by means of another substance, as was assumed in the last method for obtaining low temperatures. Its own expansion is sufficient, provided the initial condition be properly chosen, and provided we take care, even more than in the former method, that there is no influx of heat. Those conditions being fulfilled, we may, simply by adiabatic expansion, not only lower the temperature of some substances down to $T_3$, but also convert them into the liquid state. This is especially the case with substances the molecules of which contain few atoms.

Let us imagine the whole net of isothermals for homogeneous phases drawn in a *pv* diagram, and in it the border-curve. Within this border-curve, as in the heterogeneous region, the theoretical part of every isothermal must be replaced by a straight line. The isothermals may therefore be divided into two groups, viz., those which keep outside the heterogeneous region, and those which cross this region. Hence an isothermal, belonging to the latter group, enters the heterogeneous region on the liquid side, and leaves it at the same level on the vapour side. Let us imagine in the same way all the isentropic curves drawn for homogeneous states. Their form resembles that of isothermals in so far as they show a maximum and a minimum, if the entropy-constant is below a certain value, while if it is above this value, both the maximum and the minimum disappear, the isentropic line in a certain point having at the same time $\frac{dp}{dv}$ and $\frac{d^2p}{dv^2}=0$ for this particular value of the constant. This point, which we might call the critical point of the isentropic lines, lies in the heterogeneous region, and therefore cannot be realized, since as soon as an isentropic curve enters this region its theoretical part will be replaced by an empiric part. If an isentropic curve crosses the heterogeneous region, the point where it enters this region must, just as for the isothermals, be connected with the point where it leaves the region by another curve. When $c_p/c_v=k$ (the limiting value of $c_p/c_v$ for infinite rarefaction is meant) approaches unity, the isentropic curves approach the isothermals and *vice versâ*. In the same way the critical point of the isentropic curves comes nearer to that of the isothermals. And if $k$ is not much greater than 1, *e.g.*, $k<1{\cdot}08$, the following property of the isothermals is also preserved, viz., that an isentropic curve, which enters the heterogeneous region on the side of the liquid, leaves it again on the side of the vapour, not of course at the same level, but at a lower point. If, however, $k$ is greater, and particularly if it is so great as it is with molecules of one or two atoms, an isentropic curve, which enters on the side of the liquid, however far prolonged, always remains within the heterogeneous region. But in this case all isentropic curves, if sufficiently prolonged, will enter the heterogeneous region. Every isentropic curve has one point of intersection with the border-curve, but only a small group intersect the border-curve in three points, two of which are to be found not far from the top of the border-curve and on the side of the vapour. Whether the sign of $h$ (specific heat of the saturated vapour) is negative or positive, is closely connected with the preceding facts. For substances having $k$ great, $h$ will be negative if T is low, positive if T rises, while it will change its sign again before $T_c$ is reached. The values of T, at which change of sign takes place, depend on $k$. The law of corresponding states holds good for this value of T for all substances which have the same value of $k$.

Now the gases which were considered as permanent are exactly those for which $k$ has a high value. From this it would follow that every adiabatic expansion, provided it be sufficiently continued, will bring such substances into the heterogeneous region, *i.e.*, they can be condensed by adiabatic expansion. But since the final pressure must not fall below a certain limit, determined by experimental convenience, and since the quantity which passes into the liquid state must remain a fraction as large as possible, and since the expansion never can take place in such a manner that no heat is given out by the walls or the surroundings, it is best to choose the initial condition in such a way that the isentropic curve of this point cuts the border-curve in a point on the side of the liquid, lying as low as possible. The border-curve being rather broad at the top, there are many isentropic curves which penetrate the heterogeneous region under a pressure which differs but little from $p_c$. Availing himself of this property, Olszewski has determined $p_c$ for hydrogen at 20 atmospheres. Isentropic curves, which lie on the right and on the left of this group, will show a point of condensation at a lower pressure. Olszewski has investigated this for those lying on the right, but not for those on the left.

From the equation of state $\left(p+\frac{a}{v^2}\right)(v-b)=\mathrm{RT}$, the equation of the isentropic curve follows as $\left(p+\frac{a}{v^2}\right)(v-b)^k=\mathrm{C}$, and from this we may deduce $\mathrm{T}(v-b)^{k-1}=\mathrm{C}'$. This latter relation shows in how high a degree the cooling depends on the amount by which $k$ surpasses unity, the change in $v-b$ being the same.

What has been said concerning the relative position of the border-curve and the isentropic curve may be easily tested for points of the border-curve which represent rarefied gaseous states, in the following way. Following the border-curve we found before $f\frac{\mathrm{T}_c}{\mathrm{T}}$ for the value of $\frac{\mathrm{T}}{p}\frac{dp}{d\mathrm{T}}$. Following the isentropic curve the value of $\frac{\mathrm{T}}{p}\frac{dp}{d\mathrm{T}}$ is equal to $\frac{k}{k-1}$. If $\frac{k}{k-1}<f\frac{\mathrm{T}_c}{\mathrm{T}}$, the isentropic curve rises more steeply than the border-curve. If we take $f=7$ and choose the value of $\mathrm{T}_c/2$ for T—a temperature at which the saturated vapour may be considered to follow the gas-laws—then $k/k-1=14$, or $k=1\cdot07$ would be the limiting value for the two cases. At any rate $k=1\cdot41$ is great enough to fulfil the condition, even for other values of T. Pictet has availed himself of this adiabatic expansion for condensing many permanent gases, and it must also be used when, in the cascade method, $\mathrm{T}_3$ of one of the gases lies above $\mathrm{T}_c$ of the next.

A third method of condensing the permanent gases is applied in Linde's apparatus for liquefying air. Under a high pressure $p_1$ a current of gas is conducted through a narrow spiral, returning through another spiral which surrounds the first. Between the end of the first spiral and the beginning of the second the current of gas is reduced to a much lower pressure $p_2$ by passing through a tap with a fine orifice. On account of the expansion resulting from this sudden decrease of pressure, the temperature of the gas, and consequently of the two spirals, falls sensibly. If this process is repeated with another current of gas, this current, having been cooled in the inner spiral, will be cooled still further, and the temperature of the two spirals will become still lower. If the pressures $p_1$ and $p_2$ remain constant the cooling will increase with the lowering of the temperature. In Linde's apparatus this cycle is repeated over and over again, and after some time (about two or three hours) it becomes possible to draw off liquid air.

***Linde's apparatus.***

The cooling which is the consequence of such a decrease of pressure was experimentally determined in 1854 by Lord Kelvin (then Professor W. Thomson) and Joule, who represent the result of their experiments in the formula

$$\mathrm{T}_1-\mathrm{T}_2=\gamma\frac{p_1-p_2}{\mathrm{T}^2}.$$

In their experiments $p_2$ was always 1 atmosphere, and the amount of $p_1$ was not large. It would, therefore, be certainly wrong, even though for a small difference in pressure the empiric formula might be approximately correct, without closer investigation to make use of it for the differences of pressure used in Linde's apparatus, where $p_1=200$ and $p_2=18$ atmospheres. For the existence of a most favourable value of $p_1$ is in contradiction with the formula, since it would follow from it that $\mathrm{T}_1-\mathrm{T}_2$ would always increase with the increase of $p_1$. Nor would it be right to regard as the cause for the existence of this most favourable value of $p_1$ the fact that the heat produced in the compression of the expanded gas, and therefore $p_1/p_2$, must be kept as small as possible, for the simple reason that the heat is produced in quite another part of the apparatus, and might be neutralized in different ways.

Closer examination of the process shows that if $p_2$ is given, a most favourable value of $p_1$ must exist for the cooling itself. If $p_1$ is taken still higher, the cooling decreases again, and we might take a value for $p_1$ for which the cooling would be zero, or even negative.

If we call the energy per unit of weight $\epsilon$ and the specific volume $v$, the following equation holds :—

$$\epsilon_1+p_1v_1-p_2v_2=\epsilon_2,$$

or

$$\epsilon_1+p_1v_1=\epsilon_2+p_2v_2.$$

According to the symbols chosen by Gibbs, $\chi_1=\chi_2$.

As $\chi$ is determined by $\mathrm{T}_1$ and $p_1$, and $\chi_2$ by $\mathrm{T}_2$ and $p_2$, we obtain, if we take $\mathrm{T}_1$ and $p_2$ as being constant,

$$\left(\frac{\delta\chi_1}{\delta p_1}\right)_{\mathrm{T}_1}dp_1=\left(\frac{\delta\chi_2}{\delta\mathrm{T}_2}\right)_{p_2}d\mathrm{T}_2.$$

If $\mathrm{T}_2$ is to have a minimum value, we have

$$\left(\frac{\delta\chi_1}{\delta p_1}\right)_{\mathrm{T}_1}=0,\ \text{or}\ \left(\frac{\delta\chi_1}{\delta v_1}\right)_{\mathrm{T}_1}=0.$$

From this follows

$$\left(\frac{\delta\epsilon_1}{\delta v_1}\right)_{\mathrm{T}_1}+\left[\frac{\delta(p_1v_1)}{\delta v_1}\right]_{\mathrm{T}_1}=0.$$

As $\left(\frac{\delta\epsilon_1}{\delta v_1}\right)_{\mathrm{T}}$ is positive, we shall have to take for the maximum cooling such a pressure that the product $pv$ decreases with $v$, viz., a pressure larger than that at which $pv$ has the minimum value. By means of the equation of state mentioned already, we find for the value of the specific volume that gives the greatest cooling, the formula

$$\frac{\mathrm{RT}_1b}{(v_1-b)^2}=\frac{2a}{v_1^2},$$

and for the value of the pressure

$$p_1=27p_c\left[1-\sqrt{\frac{4}{27}\frac{\mathrm{T}_1}{\mathrm{T}_c}}\right]\left[3\sqrt{\frac{4}{27}\frac{\mathrm{T}_1}{\mathrm{T}_c}}-1\right].$$

If we take the value $2\mathrm{T}_c$ for $\mathrm{T}_1$, as we may approximately for air when we begin to work with the apparatus, we find for $p_1$ about $8p_c$, or more than 300 atmospheres. If we take $\mathrm{T}_1=\mathrm{T}_c$, as we may at the end of the process, we find $p_1=2.5p_c$, or 100 atmospheres. The constant pressure which has been found the most favourable in Linde's apparatus is a mean of the two calculated pressures. In a theoretically perfect apparatus we ought, therefore, to be able to regulate $p_1$ according to the temperature in the inner spiral.

The critical temperatures and pressures of the permanent gases are given in the following table, the former being expressed on the absolute scale and the latter in atmospheres :—

| | $\mathrm{T}_c$ | $p_c$ | | $\mathrm{T}_c$ | $p_c$ |
|---|---|---|---|---|---|
| $CH_4$ | 191·2° | 55 | CO | 133·5° | 35·5 |
| NO | 179·5° | 71·2 | $N_2$ | 127° | 35 |
| $O_2$ | 155° | 50 | Air | 133° | 39 |
| Argon | 152° | 50·6 | $H_2$ | 40° | 20 |

According to Professor Dewar the critical temperature of $H_2$ is about 32° absolute, and the critical pressure about 15 atmospheres (*Proc. Roy. Inst. Great Britain*, 7th June 1899). (See also LIQUID GASES.)

(J. D. V. D. W.)

**Conduction of Heat.**—The mathematical theory of conduction of heat was developed early in the 19th century by Fourier and other workers, and was brought to so high a pitch of excellence that little has remained for later writers to add to this department of the subject. In fact, for a considerable period, the term "theory of heat" was practically synonymous with the mathematical treatment of conduction. A summary of Fourier's analysis will be found in HEAT (*Ency. Brit.* vol. xi.), and the theory need not be considered in detail here, except in so far as it is required for the definition and explanation of fundamental terms. The main object of the present article is to describe more recent work, and to discuss experimental difficulties and methods of measurement.

1. *Mechanism of Conduction.*—Conduction of heat implies transmission by contact from one body to another or between contiguous particles of the same body, but does not include transference of heat by the motion of masses or streams of matter from one place to another. This is termed *Convection* (see RADIATION), and is most im-

portant in the case of liquids and gases owing to their mobility. Conduction, however, is generally understood to include diffusion of heat in fluids due to the agitation of the ultimate molecules, which is really molecular convection. It also includes diffusion of heat by internal radiation, which must occur in transparent substances. In measuring conduction of heat in fluids, it is possible to some extent to eliminate the effects of molar convection or mixing, but it would not be possible to distinguish between diffusion, or internal radiation, and conduction. Some writers have supposed that the ultimate atoms are conductors, and that heat is transferred through them when they are in contact. This, however, is merely transferring the properties of matter in bulk to its molecules. It is much more probable that heat is really the kinetic energy of motion of the molecules, and is passed on from one to another by collisions. Further, if we adopt Weber's hypothesis of electric atoms, capable of diffusing through metallic bodies and conductors of electricity, but capable of vibration only in non-conductors, it is possible that the ultimate mechanism of conduction may be reduced in all cases to that of diffusion in metallic bodies or internal radiation in dielectrics. The high conductivity of metals is then explained by the small mass and high velocity of diffusion of these electric atoms. Assuming the kinetic energy of an electric atom at any temperature to be equal to that of a gaseous molecule, its velocity, on Professor J. J. Thomson's estimate of the mass, must be upwards of forty times that of the hydrogen molecule.

2. *Law of Conduction.*—The experimental Law of Conduction, which forms the basis of the mathematical theory, was established in a qualitative manner by Fourier and the early experimentalists. Although it is seldom explicitly stated as an experimental law, it should really be regarded in this light, and may be briefly worded as follows:—"*The rate of transmission of heat by conduction is proportional to the temperature gradient.*"

The "rate of transmission of heat" is here understood to mean the quantity of heat transferred in unit time through unit area of cross-section of the substance, the unit area being taken perpendicular to the lines of flow. It is clear that the quantity transferred in any case must be jointly proportional to the area and the time. The "gradient of temperature" is the fall of temperature in degrees per unit length along the lines of flow. The *Thermal Conductivity* of the substance is the constant ratio of the rate of transmission to the temperature gradient. To take the simple case of the "wall" or flat plate considered by Fourier for the definition of Thermal Conductivity, suppose that a quantity of heat $Q$ passes in the time $T$ through an area $A$ of a plate of conductivity $k$ and thickness $x$, the sides of which are constantly maintained at temperatures $\theta'$ and $\theta''$. The rate of transmission of heat is $Q/AT$, and the temperature gradient, supposed uniform, is $(\theta' - \theta'')/x$, so that the law of conduction leads at once to the equation—

$$Q/AT = k(\theta' - \theta'')/x = kd\theta/dx. \qquad (1)$$

This relation applies accurately to the case of the steady flow of heat in parallel straight lines through a homogeneous and isotropic solid, the isothermal surfaces, or surfaces of equal temperature, being planes perpendicular to the lines of flow. If the flow is steady, and the temperature of each point of the body invariable, the rate of transmission must be everywhere the same. If the gradient is not uniform, its value may be denoted by $d\theta/dx$. In the steady state, the product $kd\theta/dx$ must be constant, or the gradient must vary inversely as the conductivity, if the latter is a function of $\theta$ or $x$. One of the simplest illustrations of the rectilinear flow of heat is the steady outflow through the upper strata of the earth's crust, which may be considered practically plane in this connexion. This outflow of heat necessitates a rise of temperature with increase of depth. The corresponding gradient is of the order of 1° C. in 100 feet, but varies inversely with the conductivity of the strata at different depths.

3. *Variable State.*—A different type of problem is presented in those cases in which the temperature at each point varies with the time, as is the case near the surface of the soil with variations in the external conditions between day and night or summer and winter. The flow of heat may still be linear if the horizontal layers of the soil are of uniform composition, but the quantity flowing through each layer is no longer the same. Part of the heat is used up in changing the temperature of the successive layers. In this case it is generally more convenient to consider as unit of heat the thermal capacity $c$ of unit volume, or that quantity which would produce a rise of one degree of temperature in unit volume of the soil or substance considered. If $Q$ is expressed in terms of this unit in equation, (1) it is necesssary to divide by $c$, or to replace $k$ on the right hand side by the ratio $k/c$. This ratio determines the rate of diffusion of temperature, and is called the *Thermometric Conductivity* or, more shortly, the *Diffusivity.* The velocity of propagation of temperature waves will be the same under similar conditions in two substances which possess the same diffusivity, although they may differ in conductivity.

4. *Emissivity.*—Fourier defined another constant expressing the rate of loss of heat at a bounding surface per degree of difference of temperature between the surface of the body and its surroundings. This he called the *External Conductivity*, but the term *Emissivity* is more convenient. Taking Newton's law of cooling, that the rate of loss of heat is simply proportional to the excess of temperature, the emissivity would be independent of the temperature. This is generally assumed to be the case in mathematical problems, but the assumption is admissible only in rough work, or if the temperature difference is small. The emissivity really depends on every variety of condition, such as the size, shape, and position of the surface, as well as on its nature; it varies with the rate of cooling, as well as with the temperature excess, and it is generally so difficult to calculate, or to treat in any simple manner, that it forms the greatest source of uncertainty in all experimental investigations in which it occurs.

5. *Experimental Methods.* — Measurements of conductivity present peculiar difficulties on account of the variety of quantities to be observed, the slowness of the process of conduction, the impossibility of isolating a quantity of heat, and the difficulty of exactly realizing the theoretical conditions of the problem. The most important methods may be classified roughly under three heads—(1) Steady Flow, (2) Variable Flow, (3) Electrical. The methods of the first class may be further subdivided according to the form of apparatus employed. The following are some of the special cases which have been utilized experimentally:—

6. *The "Wall" or Plate Method.*—This method endeavours to realize the conditions of equation, (1) namely, uniform rectilinear flow. Theoretically this requires an infinite plate, or a perfect heat insulator, so that the lateral flow can be prevented or rendered negligible. This condition can generally be satisfied with sufficient approximation with plates of reasonable dimensions. To find the conductivity, it is necessary to measure all the quantities which occur in equation (1) to a similar order of accuracy. The area $A$ from which the heat is collected need not be the whole surface of the plate, but a measured central area where the flow is most nearly uniform. This variety is known as

the "Guard-Ring" method, but it is generally rather difficult to determine the effective area of the ring. There is little difficulty in measuring the time of flow, provided that it is not too short. The measurement of the temperature gradient in the plate generally presents the greatest difficulties. If the plate is thin, it is necessary to measure the thickness with great care, and it is necessary to assume that the temperatures of the surfaces are the same as those of the media with which they are in contact, since there is no room to insert thermometers in the plate itself. This assumption does not present serious errors in the case of bad conductors, such as glass or wood, but has given rise to large mistakes in the case of metals. The conductivities of thin slices of crystals have been measured by Lees by pressing them between plane amalgamated surfaces of metal. This gives very good contact, and the conductivity of the metal being more than 100 times that of the crystal, the temperature of the surface is determinate.

In applying the plate method to the determination of the conductivity of iron, Hall has recently succeeded in overcoming this difficulty by coating the plate thickly with copper on both sides, and deducing the difference of temperature between the two surfaces of junction of the iron and the copper from the thermo-electric force observed by means of a number of fine copper wires attached to the copper coatings at different points of the disc. The advantage of the thermo-junction for this purpose is that the distance between the surfaces of which the temperature-difference is measured, is very exactly defined. The disadvantage is that the thermo-electric force is very small, about ten-millionths of a volt per degree, so that a small accidental disturbance may produce a serious error with a difference of temperature of only 1° between the junctions. The chief uncertainty in applying this method appears to have arisen from variations of temperature at different parts of the surface, due to inequalities in the heating or cooling effect of the stream of water flowing over the surfaces. Uniformity of temperature could only be secured by using a high velocity of flow, or violent stirring. Neither of these methods could be applied in this experiment. The temperatures indicated by the different pairs of wires differed by as much as 10 per cent., but the mean of the whole would probably give a fair average. The heat transmitted was measured by observing the flow of water (about 20 gm./sec.), and the rise of temperature (about 0·5° C.) in one of the streams. The results appear to be entitled to considerable weight on account of the directness of the method, and the full consideration of possible errors. They were as follows:—

Cast-iron, $k=0{\cdot}1490$ C.G.S. at 30° C., temp. coef. $-0{\cdot}00075$.
Pure iron, $k=0{\cdot}1530$ at 30° C., temp. coef. $-0{\cdot}0003$.

The discs were 10 cms. in diam., and nearly 2 cms. thick, plated with copper to a thickness of 2 mm. The cast-iron contained about 3·5 per cent. of carbon, 1·4 per cent. of silicon, and 0·5 per cent. of manganese.

7. *Tube Method.*—If the inside of a glass tube is exposed to steam, and the outside to a rapid current of water, or *vice versâ*, the temperatures of the surfaces of the glass may be taken to be very approximately equal to those of the water and steam, which may be easily observed. If the thickness of the glass is small compared with the diameter of the tube, say one-tenth, equation (1) may be applied with sufficient approximation, the area $A$ being taken as the mean between the internal and external surfaces. It is necessary that the thickness $x$ should be approximately uniform. Its mean value may be determined most satisfactorily from the weight and the density. The heat $Q$ transmitted in a given time $T$ may be deduced from an observation of the rise of temperature of the water, and the amount which passes in the interval. This is one of the simplest of all methods in practice, but it involves the measurement of several different quantities, some of which are difficult to observe accurately. The employment of the tube form evades one of the chief difficulties of the plate method, namely, the uncertainty of the flow at the boundary of the area considered. Unfortunately the method cannot be applied to good conductors, like the metals, because the difference of temperature between the surfaces may be five or ten times less than that between the water and steam in contact with them, even if the water is energetically stirred.

8. *Cylinder Method.*—A variation of the tube method, which can be applied to metals and good conductors, depends on the employment of a thick cylinder with a small axial hole in place of a thin tube. The actual temperature of the metal itself can then be observed by inserting thermometers or thermo-couples at measured distances from the centre. This method has been applied by Callendar and Nicolson (*Brit. Assoc. Report*, 1897), to cylinders of cast-iron and mild steel, 5 inches in diam. and 2 feet long, with one-inch axial holes. The surface of the central hole was heated by steam under pressure, and the total flow of heat was determined by observing the amount of steam condensed in a given time. The outside of the cylinder was cooled by water circulating in a spiral screw thread in a very narrow space with high velocity under a pressure of 120 ℔ per square inch. A very uniform surface temperature was thus obtained. The lines of flow in this method are radial. The isothermal surfaces are coaxial cylinders. The areas of successive surfaces vary as their radii, hence the rate of transmission $Q/AT$ varies inversely as the radius $r$, and is $Q/2\pi rlT$, if $l$ is the length of the cylinder, and $Q$ the total heat, calculated from the condensation of steam observed in a time $T$. The outward gradient is $d\theta/dr$, and is negative if the central hole is heated. We have therefore the equation—

$$-kd\theta/dr=Q/2\pi rlT. \tag{2}$$

If $k$ is constant the solution is evidently, $\theta=a\log r+b$, where $a=-Q/2\pi klT$, and $b$ and $k$ are determined from the known values of the temperatures observed at any two distances from the axis. This gives an average value of the conductivity over the range, but it is better to observe the temperatures at three distances, and to assume $k$ to be a linear function of the temperature, in which case the solution of the equation is still very simple, namely—

$$\theta+e\theta^2/2=a\log r+b, \tag{3}$$

where $e$ is the temperature-coefficient of the conductivity. The chief difficulty in this method lay in determining the effective distances of the bulbs of the thermometers from the axis of the cylinder, and in ensuring uniformity of flow of heat along different radii. For these reasons the temperature-coefficient of the conductivity could not be determined satisfactorily on this particular form of apparatus, but the mean results were probably trustworthy to 1 or 2 per cent. They refer to a temperature of about 60° C., and were—

Cast-iron, 0·109; mild steel, 0·119, C.G.S.

These are much smaller than Hall's results. The cast-iron contained nearly 3 per cent. each of silicon and graphite, and 1 per cent. each of phosphorus and manganese. The steel contained less than 1 per cent. of foreign materials. The low value for the cast-iron was confirmed by two entirely different methods given below.

9. *Forbes's Bar Method.*—Observation of the steady distribution of temperature along a bar heated at one end was very early employed by Fourier, Despretz, and others for the comparison of conductivities. It is the most convenient method in the case of good conductors on account of the great facilities which it permits for the measurement of the temperature gradient at different points, but it has the disadvantage that the results depend almost entirely on a knowledge of the external heat loss or emissivity, or, in comparative experiments, on the assumption that it is the same in different cases. The method of Forbes (in which the conductivity is deduced from the steady distribution of temperature on the assumption that the rate of loss of heat at each point of the bar is the same as that observed in an auxiliary experiment in which a short bar of the same kind is set to cool under conditions which are supposed to be identical), is too well known to require detailed description, but a consideration of its weak points is very instructive, and the results have been most remarkably misunderstood and misquoted. The method gives directly, not $k$, but $k/c$. Tait repeated Forbes's experiments, using one of the same iron bars, and endeavoured to correct his results for the variation of the specific heat $c$. Mitchell, under Tait's direction, repeated the experiments with the same bar nickel-plated, correcting the thermometers for stem-exposure, and also varying the conditions by cooling one end, so as to obtain a steeper gradient. The results of Forbes, Tait, and Mitchell, on the same bar, and Mitchell's two results by different methods, are quoted by Landoldt and Börnstein as if they referred to different metals. This is not very surprising, if the values in the following table are compared:—

TABLE I. *Thermal Conductivity of Forbes's Iron Bar D (1·25 Inches Square). C.G.S. Units.*

| Temp. Cent. | Uncorrected for Variation of c. | | | | Corrected for Variation of c. | | | |
|---|---|---|---|---|---|---|---|---|
| | Forbes. | Tait. | Mitchell: Cooled. | | Forbes. | Tait. | Mitchell: Cooled. | |
| 0° | ·207 | ·231 | ·197 | ·178 | ·213 | ·238 | ·203 | ·184 |
| 100° | ·157 | ·198 | ·178 | ·190 | ·168 | ·212 | ·190 | ·197 |
| 200° | ·136 | ·176 | ·160 | ·181 | ·152 | ·196 | ·178 | ·210 |

The variation of $c$ is uncertain. The values credited to Forbes are those given by Everett on Balfour Stewart's authority. Tait gives different figures. The values given in the column headed "cooled" are those found by Mitchell with one end of the bar cooled. The discrepancies are chiefly due to the error of the

fundamental assumption that the rate of cooling is the same at the same temperature under the very different conditions existing in the two parts of the experiment. They are also partly caused by the large uncertainties of the corrections, especially those of the mercury thermometers under the peculiar conditions of the experiment. The results of Forbes are interesting historically as having been the first approximately correct determinations of conductivity in absolute value. The same method was applied by R. W. Stewart (*Phil. Trans.*, 1892), with the substitution of thermo-couples (following Wiedemann) for mercury thermometers. This avoids the very uncertain correction for stem-exposure, but it is doubtful how far an insulated couple, inserted in a hole in the bar, may be trusted to attain the true temperature. The other uncertainties of the method remain. R. W. Stewart found for pure iron, $k = \cdot 175\ (1 - \cdot 0015\ t)$ C.G.S. Hall using a similar method found for cast-iron at 50° C. the value ·105, but considers the method very uncertain as ordinarily practised.

10. *Calorimetric Bar Method.*—To avoid the uncertainties of surface loss of heat, it is necessary to reduce it to the rank of a small correction by employing a large bar and protecting it from loss of heat. The heat transmitted should be measured calorimetrically, and not in terms of the uncertain emissivity. The apparatus shown in Fig. 1 was constructed by Callendar and

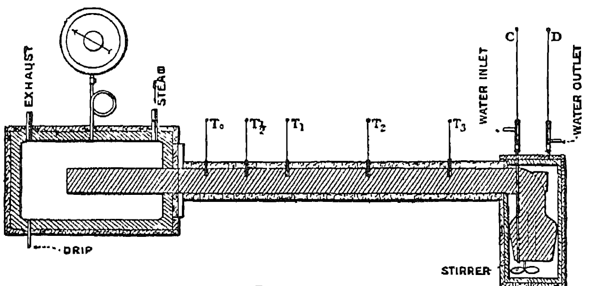



Fig. 1.

Nicolson with this object. The bar was a special sample of cast-iron, the conductivity of which was required for some experiments on the condensation of steam (*Proc. Inst. C.E.*, 1898). It had a diameter of 4 inches, and a length of 4 feet between the heater and the calorimeter. The emissivity was reduced to one quarter by lagging the bar like a steam-pipe to a thickness of 1 inch. The heating vessel could be maintained at a steady temperature by high-pressure steam. The other end was maintained at a temperature near that of the air by a steady stream of water flowing through a well-lagged vessel surrounding the bar. The heat transmitted was measured by observing the difference of temperature between the inflow and the outflow, and the weight of water which passed in a given time. The gradient near the entrance to the calorimeter was deduced from observations with five thermometers at suitable intervals along the bar. The results obtained by this method at a temperature of 40° C., varied from ·116 to ·118 C.G.S. from observations on different days, and were probably more accurate than those obtained by the cylinder method. The same apparatus was employed in another series of experiments by Ångström's method described below.

11. *Guard-Ring Method.*—This may be regarded as a variety of the plate method, but is more particularly applicable to good conductors, which require the use of a thick plate, so that the temperature of the metal may be observed at different points inside it. Berget (*Journ. Phys.* vii. p. 503, 1888) has applied this method directly to mercury, and has determined the conductivity of some other metals by comparison with mercury. In the case of mercury he employed a column in a glass tube 13 mm. in diam. surrounded by a guard cylinder of the same height, but 6 to 12 cm. in diam. The mean section of the inner column was carefully determined by weighing, and found to be 1·403 sq. cm. The top of the mercury was heated by steam, the lower end rested on an iron plate cooled by ice. The temperature at different heights was measured by iron wires forming thermo-junctions with the mercury in the inner tube. The heat-flow through the central column amounted to about 7·5 calories in 54 seconds, and was measured by continuing the tube through the iron plate into the bulb of a Bunsen ice calorimeter, and observing with a chronometer to a fifth of a second the time taken by the mercury to contract through a given number of divisions. The calorimeter tube was calibrated by a thread of mercury weighing 19 milligrams, which occupied eighty-five divisions. The contraction corresponding to the melting of 1 gramme of ice was assumed to be ·0906 c.c., and was taken as being equivalent to 79 calories (1 calorie = 15·59 mgrm. Hg.). The chief uncertainty of this method is the area from which the heat is collected, which probably exceeds that of the central column, owing to the disturbance of the linear flow by the projecting bulb of the calorimeter. This may partly account for the discrepancy in the following results:—

| | | | |
|---|---|---|---|
| Mercury, | $k = 0{\cdot}02015$ | C.G.S. | Berget. |
| ,, | $k = 0{\cdot}01479$ | ,, | Weber. |
| ,, | $k = 0{\cdot}0177$ | ,, | Ångstrom. |

12. *Variable-Flow Methods.*—In these methods the flow of heat is deduced from observations of the rate of change of temperature with time in a body exposed to known external or boundary conditions. No calorimetric observations are required, but the results are obtained in terms of the thermal capacity of unit volume $c$, and the measurements give the diffusivity $k/c$, instead of the calorimetric conductivity $k$. Since both $k$ and $c$ are generally variable with the temperature, and the mode of variation of either is often unknown, the results of these methods are generally less certain with regard to the actual flow of heat. As in the case of steady-flow methods, by far the simplest example to consider is that of the linear flow of heat in an infinite solid, which is most nearly realized in nature in the propagation of temperature waves in the surface of the soil. One of the best methods of studying the flow of heat in this case is to draw a series of curves showing the variations of temperature with depth in the soil for a series of consecutive days. The curves given in Fig. 2 were ob-

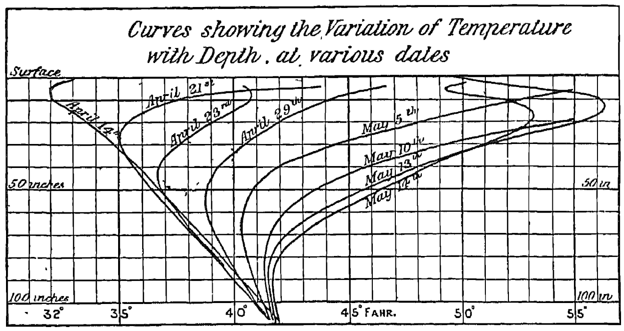



Fig. 2.

tained from the readings of a number of platinum thermometers buried in undisturbed soil in horizontal positions at M'Gill College, Montreal. The method of deducing the diffusivity from these curves is as follows:—

The total quantity of heat absorbed by the soil per unit area of surface between any two dates, and any two depths, $x'$ and $x''$, is equal to $c$ times the area included between the corresponding curves. This can be measured graphically without any knowledge of the law of variation of the surface temperature, or of the laws of propagation of heat waves. The quantity of heat absorbed by the stratum $(x'\ x'')$ in the interval considered can also be expressed in terms of the calorimetric conductivity $k$. The heat transmitted through the plane $x$ is equal per unit area of surface to the product of $k$ by the mean temperature gradient $(d\theta/dx)$ and the interval of time, $T - T'$. The mean temperature gradient is found by plotting the curves for each day from the daily observations. The heat absorbed is the difference of the quantities transmitted through the bounding planes of the stratum. We thus obtain the simple equation—

$$k'(d\theta'/dx') - k''(d\theta''/dx'') = c\ (\text{area between curves})/(T - T'), \quad (4)$$

by means of which the average value of the diffusivity $k/c$ can be found for any convenient interval of time, at different seasons of the year, in different states of the soil.

For the particular soil in question it was found that the diffusivity varied enormously with the degree of moisture, falling as low as ·0010 C.G.S. in the winter for the surface layers, which became extremely dry under the protection of the frozen ice and snow from December to March, but rising to an average of ·0060 to ·0070 in the spring and autumn. The greater part of the diffusion of heat was certainly due to the percolation of water. On some occasions, owing to the sudden melt-

ing of a surface layer of ice and snow, a large quantity of cold water, percolating rapidly, gave for a short time values of the diffusivity as high as ·0300. Excluding these exceptional cases, however, the variations of the diffusivity appeared to follow the variations of the seasons with considerable regularity in successive years. The presence of water in the soil always increased the value of $k/c$, and as it necessarily increased $c$, the increase of $k$ must have been greater than that of $k/c$.

13. *Periodic Flow of Heat.*—The above method is perfectly general, and can be applied in any case in which the requisite observations can be taken. A case of special interest and importance is that in which the flow is *periodic.* The general characteristics of such a flow are illustrated in Fig. 3, showing the propagation

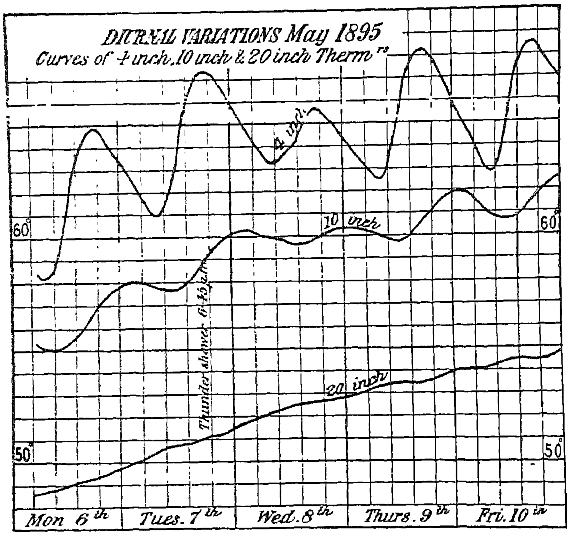



Fig. 3.

of temperature waves due to diurnal variations in the temperature of the surface. The daily range of temperature of the air and of the surface of the soil was about 20° F. On a sunny day, the temperature reached a maximum about 2 p.m., and a minimum about 5 a.m. As the waves were propagated downwards through the soil the amplitude rapidly diminished, so that at a depth of only 4 inches it was already reduced to about 6° F., and to less than 2° at 10 inches. At the same time, the epoch of maximum or minimum was retarded, about 4 hours at 4 inches, and nearly 12 hours at 10 inches, where the maximum temperature was reached between 1 and 2 a.m. The form of the wave was also changed. At 4 inches the rise was steeper than the fall, at 10 inches the reverse was the case. This is due to the fact that the components of shorter period are more rapidly propagated. For instance, the velocity of propagation of a wave having a period of a day is nearly twenty times as great as that of a wave with a period of one year, but on the other hand the penetration of the diurnal wave is nearly twenty times less, and the shorter waves die out more rapidly.

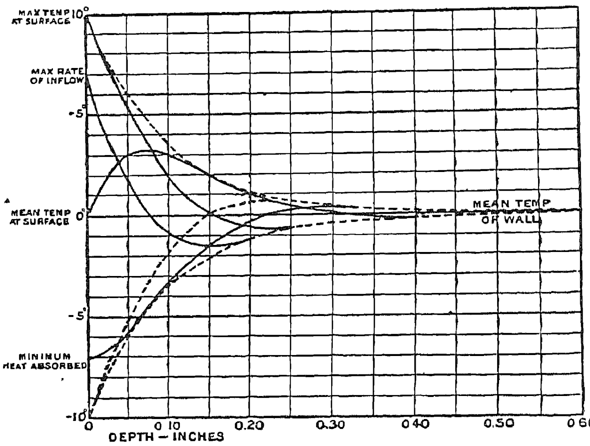
14. *A Simple-Harmonic or Sine Wave* is the only kind which is propagated without change of form. In treating mathematically the propagation of other kinds of waves, it is necessary to analyse them into their simple-harmonic components, which may be treated as being propagated independently. To illustrate the main features of the calculation, we may suppose that the surface is subject to a simple-harmonic cycle of temperature variation, so that the temperature at any time $t$ is given by an equation of the form—

$$\theta - \theta_0 = A \sin 2\pi nt = A \sin 2\pi t/T, \tag{5}$$

where $\theta_0$ is the mean temperature of the surface, $A$ the amplitude of the cycle, $n$ the frequency, and $T$ the period. In this simple case the temperature cycle at a depth $x$ is a precisely similar curve of the same period, but with the amplitude reduced in the proportion $e^{mx}$, and the phase retarded by the fraction $mx/2\pi$ of a cycle. The index-coefficient $m$ is $(\pi nc/k)^{\frac{1}{2}}$. The wave at a depth $x$ is represented analytically by the equation—

$$\theta - \theta_0 = Ae^{-mx} \sin (2\pi nt + mx). \tag{6}$$

A strictly periodic oscillation of this kind occurs in the working of a steam-engine, in which the walls of the cylinder are exposed to regular fluctuations of temperature with the admission and release of steam. The curves in Fig. 4 are drawn for a particular




Speed, 42 revolutions per minute; range, 20° at surface.

Fig. 4.

case, but they apply equally to the propagation of a simple-harmonic wave of any period in any substance changing only the scale on which they are drawn. The dotted boundary curves have the equation $\theta = \pm e^{-mx}$, and show the rate of diminution of the amplitude of the temperature oscillation with depth in the metal. The wave-length in Fig. 4 is 0·60 inch, at which depth the amplitude of the variation is reduced to less than one-five hundredth part ($e^{-2\pi}$) of that at the surface, so that for all practical purposes the oscillation may be neglected beyond one wave-length. At half a wave-length the amplitude is only 1/23rd of that at the surface. The wave-length in any case is $2\pi/m$.

The diffusivity can be deduced from observations at different depths $x'$ and $x''$, by observing the ratio of the amplitudes, which is $e^{m(x'-x'')}$ for a simple-harmonic wave. The values obtained in this way for waves having a period of one second and a wave-length of half an inch agreed very well with those obtained in the same cast-iron by Ångström's method (see below), with waves having a period of 1 hour and a length of 30 inches. This agreement was a very satisfactory test of the accuracy of the fundamental law of conduction, as the gradients and periods varied so widely in the two cases.

15. *Annual Variation.*—A similar method has frequently been applied to the study of variations of soil-temperatures by harmonic analysis of the annual waves. But the theory is not strictly applicable, as the phenomena are not accurately periodic, and the state of the soil is continually varying, and differs at different depths, particularly in regard to its degree of wetness. An additional difficulty arises in the case of observations made with long mercury thermometers buried in vertical holes, that the correction for the expansion of the liquid in the long stems is uncertain, and that the holes may serve as channels for percolation, and thus lead to exceptionally high values. The last error is best avoided by employing platinum thermometers buried horizontally. In any case results deduced from the annual wave must be expected to vary in different years according to the distribution of the rainfall, as the values represent averages depending chiefly on the diffusion of heat by percolating water. For this reason observations at different depths in the same locality often give very concordant results for the same period, as the total percolation and the average rate are necessarily nearly the same for the various strata, although

the actual degree of wetness of each may vary considerably. The following are a few typical values for sand or gravel deduced from the annual wave in different localities.—

TABLE II. *Diffusity of Sandy Soils. C.G.S. Units.*

| Observer. | Soil. | Locality. | Thermometer. | Diffusivity. |
|---|---|---|---|---|
| Kelvin, 1860 | Garden sand. | Edinburgh. | Mercury. | ·0087 |
| Neumann, 1863 | Sandy loam. | .. | ,, | ·0136 |
| Everett, 1860 | Gravel. | Greenwich. | ,, | ·0125 |
| Ångstrom, 1861 | Sandy clay. | Upsala. | ,, | ·0057 |
| ,, | ,, ,, | | ,, | ·0045 |
| Ångstrom | Coarse sand. | ,, | ,, | ·0094 |
| Rudberg | The same soil, place, and instruments reduced for different years. | | | ·0061 |
| Quetelet | | | | ·0074 |
| Callendar, 1895 | Garden sand. | Montreal. | Platinum. | ·0036 |
| Rambaut, 1900 | Gravel. | Oxford. | ,, | ·0074 |

The low value at Montreal is chiefly due to the absence of percolation during the winter. Rambaut's results were obtained with similar instruments similarly located, but he did not investigate the seasonal variations of diffusivity, or the effect of percolation. It is probable that the coarser soils, permitting more rapid percolation, would generally give higher results. In any case, it is evident that the transmission of heat by percolation would be much greater in porous soils and in the upper layers of the earth's crust than in the lower strata or in solid rocks. It is probable for this reason that the average conductivity of the earth's crust, as deduced from surface observations, is too large; and that estimates of the age of the earth based on such measurements are too low, and require to be raised; they would thereby be brought into better agreement with the conclusions of geologists derived from other lines of argument.

16. *Ångström's Method* consists in observing the propagation of heat waves in a bar, and is probably the most accurate method for measuring the diffusivity of a metal, since the conditions may be widely varied and the correction for external loss of heat can be made comparatively small. Owing, however, to the laborious nature of the observations and reductions, the method does not appear to have been seriously applied since its first invention, except in one solitary instance by the writer to the case of cast-iron (Fig. 1). The equation of the method is the same as that for the linear flow with the addition of a small term representing the radiation loss. The mathematical solution is given in the article HEAT (*Ency. Brit.* vol. xi.), assuming that $k$ and $c$ are both constants, and the coefficient of cooling also constant, over the range of the experiment. This is an admissible approximation if the range is small. The apparatus of Fig. 1 was designed for this method, and may serve to illustrate it. The steam pressure in the heater may be periodically varied by the gauge in such a manner as to produce an approximately simple harmonic oscillation of temperature at the hot end, while the cool end is kept at a steady temperature. The amplitudes and phases of the temperature waves at different points are observed by taking readings of the thermometers at regular intervals. In using mercury thermometers, it is best, as in the apparatus figured, to work on a large scale (4-inch bar) with waves of slow period, about 1 to 2 hours. Ångström endeavoured to find the variation of conductivity by this method, but he assumed $c$ to be the same for two different bars, and made no allowance for its variation with temperature. He thus found nearly the same rate of variation for the thermal as for the electric conductivity. His final results for copper and iron were as follows:—

$$\text{Copper, } k=0{\cdot}982\ (1-0{\cdot}00152\ \theta) \text{ assuming } c={\cdot}84476.$$
$$\text{Iron, } k=0{\cdot}1988\ (1-0{\cdot}00287\ \theta) \quad ,, \quad c={\cdot}88620.$$

Ångström's value for iron, when corrected for obvious numerical errors, and for the probable variation of $c$, becomes—

$$\text{Iron, } k=0{\cdot}164\ (1-0{\cdot}0013\ \theta),$$

but this is very doubtful as $c$ was not measured.

The experiments on cast-iron with the apparatus of Fig. 1 were varied by taking three different periods, 60, 90, and 120 minutes, and two distances, 6 inches and 12 inches, between the thermometers compared. In some experiments the bar was lagged with 1 inch of asbestos, but in others it was bare, the heat-loss being thus increased fourfold. In no case did this correction exceed 7 per cent. The extreme divergence of the resulting values of the diffusivity, including eight independent series of measurements on different days, was less than 1 per cent. Observations were taken at mean temperatures of 102° C. and 54° C., with the following results:—

$$\text{Cast-iron at } 102^\circ \text{ C., } k/c={\cdot}1296,\ c={\cdot}858,\ k={\cdot}1113$$
$$,, \quad ,, \quad 54^\circ \text{ C., } k/c={\cdot}1392,\ c={\cdot}823,\ k={\cdot}1144.$$

The variation of $c$ was determined by a special series of experiments. No allowance was made for the variation of density with temperature, or for the variation of the distance between the thermometers, owing to the expansion of the bar. Although this correction should be made if the definition were strictly followed, it is more convenient in practice to include the small effect of linear expansion in the temperature-coefficient in the case of solid bodies.

17. *Lorentz's Method.*—Neumann, Weber, Lorentz, and others have employed similar methods, depending on the observation of the rate of change of temperature at certain points of bars, rings, cylinders, cubes, or spheres. Some of these results have been widely quoted, but they are far from consistent, and it may be doubted whether the difficulties of observing rapidly varying temperatures have been duly appreciated in many cases. From an experimental point of view the most ingenious and complete method was that of Lorentz (*Wied. Ann.* xiii. p. 422, 1881). He deduced the variations of the mean temperature of a section of a bar from the sum $S$ of the E.M.F's. of a number of couples, inserted at suitable equal intervals $l$ and connected in series. The difference of the temperature gradients $D/l$ at the ends of the section was simultaneously obtained from the difference $D$ of the readings of a pair of couples at either end connected in opposition. The external heat-loss was eliminated by comparing observations taken at the same mean temperatures during heating and during cooling, assuming that the rate of loss of heat $f(S)$ would be the same in the two cases. Lorentz thus obtained the equations—

$$\text{Heating, } qk\ D/l=cql\ dS/dt+f(S).$$
$$\text{Cooling, } qk\ D'/l=cql\ dS'/dt'+f(S').$$
$$\text{Whence } k=cl^2(dS/dt-dS'/dt')/(D-D'). \qquad (7)$$

It may be questioned whether this assumption was justifiable, since the rate of change and the distribution of temperature were quite different in the two cases, in addition to the sign of the change itself. The chief difficulty, as usual, was the determination of the gradient, which depended on a difference of potential of the order of 20 microvolts between two junctions inserted in small holes 2 cms. apart in a bar 1·5 cms. in diameter. It was also tacitly assumed that the thermo-electric power of the couples for the gradient was the same as that of the couples for the mean temperature, although the temperatures were different. This might give rise to constant errors in the results. Owing to the difficulty of measuring the gradient, the order of divergence of individual observations averaged 2 or 3 per cent., but occasionally reached 5 or 10 per cent. The thermal conductivity was determined in the neighbourhood of 20° C. with a water jacket, and near 110° C. by the use of a steam jacket. The conductivity of the same bars was independently determined by the method of Forbes, employing an ingenious formula for the heat-loss in place of Newton's law. The results of this method differ 2 or 3 per cent. (in one case nearly 15 per cent.) from the preceding, but it is probably less accurate. The thermal capacity and electrical conductivity were measured at various temperatures on the same specimens of metal. Owing to the completeness of the recorded data, and the great experimental skill with which the research was conducted, the results are probably among the most valuable hitherto available. One important result, which might be regarded as established by this work, was that the ratio $k/k'$ of the thermal to the electrical conductivity, though nearly constant for the good conductors at any one temperature such as 0° C., increased with rise of temperature nearly in proportion to the absolute temperature. The value found for this ratio at 0° C. approximated to 1500 C.G.S. for the best conductors, but increased to 1800 or 2000 for bad conductors like German silver and antimony. It is clear, however, that this relation cannot be generally true, for the cast-iron mentioned in the last section had a specific resistance of 112,000 C.G.S. at 100° C., which would make the ratio $k/k'=12{,}500$. The increase of resistance with temperature was also very small, so that the ratio varied very little with temperature.

18. *Electrical Methods.*—There are two electrical methods which have been recently applied to the measurement of the conductivity of metals, (*a*) the resistance method, devised by the writer, and applied by him, and also by King and Duncan, (*b*) the thermo-electric method, devised by Kohlrausch, and applied by Jæger and Dieselhorst. Both methods depend on the observation of the steady

distribution of temperature in a bar or wire heated by an electric current. The advantage is that the quantities of heat are measured directly in absolute measure, in terms of the current, and that the results are independent of a knowledge of the specific heat. Incidentally it is possible to regulate the heat supply more perfectly than in other methods.

(a) In the practice of the resistance method, both ends of a short bar are kept at a steady temperature by means of solid copper blocks provided with a water circulation, and the whole is surrounded by a jacket at the same temperature, which is taken as the zero of reference. The bar is heated by a steady electric current, which may be adjusted so that the external loss of heat from the surface of the bar is compensated by the increase of resistance of the bar with rise of temperature. In this case the curve representing the distribution of temperature is a parabola, and the conductivity $k$ is deduced from the mean rise of temperature $(R-R^{\circ})/aR^{\circ}$ by observing the increase of resistance $R-R^{\circ}$ of the bar, and the current C. It is also necessary to measure the cross-section $q$, the length $l$, and the temperature-coefficient $a$ for the range of the experiment.

In the general case, the distribution of temperature is observed by means of a number of potential leads. The differential equation for the distribution of temperature in this case includes the majority of the methods already considered, and may be stated as follows. The heat generated by the current $C$ at a point $x$ where the temperature-excess is $\theta$ is equal per unit length and time ($t$) to that lost by conduction $-d(qkd\theta/dx)/dx$, and by radiation $hp\theta$ (emissivity $h$, perimeter $p$), together with that employed in raising the temperature $qcd\theta/dt$, and absorbed by the Thomson effect $sCd\theta/dx$. We thus obtain the equation—

$$C^2R_o(1+a\theta)/l = -d(qkd\theta/dx)/dx + hp\theta + qcd\theta/dt + sCd\theta/dx. \quad (8)$$

If $C=0$, this is the equation of Ångstrom's method. If $h$ also is zero, it becomes the equation of variable flow in the soil. If $d\theta/dt=0$, the equation represents the corresponding cases of steady flow. In the electrical method, observations of the variable flow are useful for finding the value of $c$ for the specimen, but are not otherwise required. The last term, representing the Thomson effect, is eliminated in the case of a bar cooled at *both* ends, since it is opposite in the two halves, but may be determined by observing the resistance of each half separately. If the current $C$ is chosen so that $C^2R_oa=hpl$, the external heat-loss is compensated by the variation of resistance with temperature. In this case the solution of the equation reduces to the form—

$$\theta = x(l-x)C^2R_o/2lqk. \quad (9)$$

By a property of the parabola, the mean temperature is 2/3rds of the maximum temperature, we have therefore—

$$(R-R_o)/aR_o = lC^2R_o/12qk; \quad (10)$$

which gives the conductivity directly in terms of the quantities actually observed. If the dimensions of the bar are suitably chosen, the distribution of temperature is always very nearly parabolic, so that it is not necessary to determine the value of the critical current $C^2=hpl/aR_o$ very accurately, as the correction for external loss is a small percentage in any case. The chief difficulty is that of measuring the small change of resistance accurately, and of avoiding errors from accidental thermo-electric effects. In addition to the simple measurements of the conductivity (M'Gill College, 1895–96), some very elaborate experiments were made by King (*Proc. Amer. Acad.*, June 1898) on the temperature distribution in the case of long bars with a view to measuring the Thomson effect. Duncan (*M'Gill College Reports*, 1899), using the simple method under King's supervision, found the conductivity of very pure copper to be 1·007 for a temperature of 33° C.

(b) The method of Kohlrausch, as carried out by Jæger and Diesselhorst (*Berlin Acad.*, July 1899), consists in observing the difference of temperature between the centre and the ends of the bar by means of insulated thermo-couples. Neglecting the external heat-loss, and the variation of the thermal and electric conductivities $k$ and $k'$, we obtain, as before, for the difference of temperature between the centre and ends, the equation—

$$\theta_{max} - \theta_o = C^2Rl/8qk = ECl/8q = E^2k'/8k, \quad (11)$$

where $E$ is the difference of electric potential between the ends. Lorentz, assuming that the ratio $k/k'=a\theta$, had previously given—

$$\theta^2_{max} - \theta_o^2 = E^2/4a, \quad (12)$$

which is practically identical with the preceding for small differences of temperature. The last expression in terms of $k/k'$ is very simple, but the first is more useful in practice, as the quantities actually measured are $E$, $C$, $l$, $q$, and the difference of temperature. The current $C$ was measured in the usual way by the difference of potential on a standard resistance. The external heat-loss was estimated by varying the temperature of the jacket surrounding the bar, and applying a suitable correction to the observed difference of temperature. But the method (a) previously described appears to be preferable in this respect, since it is better to keep the jacket at the same temperature as the end-blocks. Moreover, the variation of thermal conductivity with temperature is small and uncertain, whereas the variation of electrical conductivity is large and can be accurately determined, and may therefore be legitimately utilized for eliminating the external heat-loss.

From a comparison of this work with that of Lorentz, it is evident that the values of the conductivity vary widely with the purity of the material, and cannot be safely applied to other specimens than those for which they were found.

19. *Conduction in Gases and Liquids.*—The theory of conduction of heat by diffusion in gases has a particular interest, since it is possible to predict the value on certain assumptions, if the viscosity is known. Some account of this will be found in the article on DIFFUSION OF GASES, or in Meyer's *Theory of Gases.* The experimental investigation presents difficulties on account of the necessity of eliminating the effects of radiation and convection, and the results of different observers often differ considerably from theory and from each other. The values found for the conductivity of air at 0° C. range from ·000048 to ·000057, and the temperature-coefficient from ·0015 to ·0028. The result should be independent of the pressure within wide limits if molar convection is eliminated, and should be proportional to the product of the viscosity and the specific heat at constant volume; but the numerical factor is probably different for different gases according to the complexity of the molecule.

The conductivity of liquids has been investigated by similar methods, generally variations of the thin plate or Guard-Ring method. A critical account of the subject is contained in a paper by Chree (*Phil. Mag.*, July 1887). Many of the experiments were made by comparative methods, taking a standard liquid such as water for reference. A recent determination of the conductivity of water by Milner and Chattock, employing an electrical method, deserves mention on account of the careful elimination of various errors (*Phil. Mag.*, July 1899). Their final result was $k=$ ·001433 at 20° C., which may be compared with the results of other observers, Lundquist (1869), ·00155 at 40° C.; Winkelmann (1874), ·00104 at 15° C.; Weber (corrected by Lorberg), ·00138 at 4° C., and ·00152 at 23·6° C.; Lees (*Phil. Trans.*, 1898), ·00136 at 25° C., and ·00120 at 47° C.; Chree, ·00124 at 18° C., and ·00136 at 19·5° C. The variations of these results illustrate the experimental difficulties. It appears probable that the conductivity of a liquid increases considerably with rise of temperature, although the contrary would appear from the work of Lees. A large mass of material has been collected, but the relations are obscured by experimental errors. (H. L. C.)

**Coney Island,** a sand bar at the west end of the south shore of Long Island, New York, U.S.A., within the corporate limits of Greater New York City. It is five miles long east and west, and about a mile in average breadth, and is separated from the mainland by a narrow creek and a stretch of marsh. It is about ten miles distant from the centre of Brooklyn, with which it is connected by several lines of railway, while with New York in summer it is connected by several lines of steamboats. It is a popular resort for the metropolis. On a fine sandy beach five miles in length, which gently shelves to the Atlantic and has little undertow, several seaside places—Manhattan Beach, Brighton Beach, West Brighton, and West End—face the sea. The first two have immense hotels, with ample pleasure-grounds and bath-houses. West Brighton is, in the season, the most crowded and most popular. All the

fun of the fair is to be found there, and the scene on a fine Sunday in summer beggars description.

**Confession.**—The confession of sins is commanded in the New Testament (James v. 16; 1 John i. 9); and it has always formed part of Christian worship. But further questions arise. To whom is the confession to be made? To the Church, or to a priest, or to one's neighbour: or is it due to God alone? Must all sins be confessed, or only the most heinous? Must they be counted up, and specified in detail? Again, all Christians agree that God forgives the sins of the penitent, and baptism is generally regarded as the sacrament of forgiveness; but is there further provision for sins committed by baptized Christians, who (it is agreed) cannot be baptized again? Has any authority to convey and apply God's pardon been given to man beyond the command to baptize?

Once more, it is generally agreed that to the Church or her ministers belong the right and the duty of excommunicating notorious sinners; and therefore (as most have thought) of readmitting them to communion, when satisfied of the genuineness of their repentance. But disputes on this subject gave rise to bitter struggles in early days (see *Ency. Brit.*, 9th ed., arts. MONTANISM, NOVATIAN, DONATISTS), and the modes of exercising discipline and ascertaining penitence have varied widely in the Church. Moreover, the most deadly sins are by no means always notorious, and the publication of some offences would only produce further scandal and mischief; and so there grew up a sort of compromise between public discipline and private confession to God alone; and the existing penitential systems of the Roman and Greek Churches have their roots rather in Church discipline and questions of admission to, and refusal of, communion than in the need the pious sinner feels of being personally reconciled to God. In the Middle Ages a theory that each sin, even though the sinner be forgiven by God, entails a definite quantity of purgative punishment, and so constitutes a debt to be discharged either in this world or the next, caused the idea of the reconciliation of the penitent to be further obscured by that of assessing his penalty; and in consequence it was necessary that he should in his confession enumerate all his "mortal" sins, reckoning up as precisely as possible the exact number of times he had been guilty of each. And it was even held that provided the sinner thus submitted to the tribunal of penance, it did not matter whether he was really contrite or not. But the intricate subject of mediæval teaching on "satisfaction" and on the sacramental character of penance fall beyond the scope of this article.

*Teaching of the Book of Common Prayer.*—The Church of England holds since the Reformation a central position in this as in many other matters; and to draw out her teaching will sufficiently illustrate the different views that are held. The Prayer-Book does not appoint that any public confession of sins shall be made by the adult candidate for baptism, and all it says on the subject is concerned with post-baptismal sin, which (it is implied) can be forgiven, however heinous. Confession of some sort is clearly regarded as a necessary element in the life of every Christian, for (since 1552) it forms part of each of the regular public services of the Church, and this acknowledgment of sin is to be made not merely in private to God, but twice daily (at least by the clergy) in the presence of the congregation. Though these confessions are naturally expressed in general terms, the rubric in the Forms of Prayer to be used at Sea (a service added in 1661) indicates that each person is intended to apply the words to his own case—"in which (humble confession) everyone ought seriously to reflect upon those particular sins of which his conscience shall accuse him." Moreover, at the beginning of the Communion service the Ten Commandments are recited one by one, and each is followed by a petition for pardon, in such a way as plainly to imply that each person is secretly to remember and confess his own breaches of each Commandment in turn. Thus the method of confession adopted in the public services of the Church of England, with which the Book of Common Prayer is primarily concerned, may be described as one of general confession to God in the face of the Church, to be in secret used by each member of the congregation for the confession of his own particular sins, and to be followed by public absolution. But three other methods of confession for private use are mentioned in the exhortations in the Communion service, which constitute the principal directory for private devotions among the authoritative documents of the English Church. First, all men are urged to practise secret confession to God alone. Ye are "to examine your lives and conversations by the rule of God's commandments; and whereinsoever ye shall perceive yourselves to have offended, either by will, word, or deed, there to bewail your own sinfulness, and to confess yourselves to Almighty God, with full purpose of amendment of life." Here clearly the sins are to be acknowledged in detail. Secondly, where the nature of the offence admits of it, the sinner is to acknowledge his wrong-doing to the neighbour he has aggrieved, and so far as he can to make restitution. And thirdly, and here we reach the chief point of controversy, the sinner who cannot satisfy his conscience by these other methods, is invited to open his grief to a minister of God's Word. Similarly, the sick man is to be *moved* (this word was inserted in 1661) to make a special confession of his sins if he feel his conscience troubled with any weighty matter. The Prayer-Book does not absolutely require that in this case the penitent should enumerate every sin he has committed; but evidently he is to unfold the whole of that which burdens his conscience. The priest is bound under the most stringent penalties never to divulge what he has thus learnt. See the 113th Canon of 1604, which, however, excepts crimes "such as by the laws of this realm the priest's own life may be called into question for concealing the same."

The history of the passages in the Exhortations about private confession is interesting. The first Prayer-Book of Edward VI. (1549) gives direction as follows:—"And if there be any of you whose conscience is troubled and grieved in anything, lacking comfort or counsel, let him come to me, or to some other discreet and learned priest, taught in the law of God, and confess, and open his sin and grief secretly, that he may receive such ghostly counsel, advice, and comfort that his conscience may be relieved, and that of us (as of the ministers of God and of the Church) he may receive comfort and absolution, to the satisfaction of his mind, and avoiding of all scruple and doubtfulness; requiring such as shall be satisfied with a general confession not to be offended with them that do use, to their further satisfying, the auricular and secret confession to the priest; nor those also which think needful or convenient, for the quietness of their own consciences, particularly to open their sins to the priest, to be offended with them that are satisfied with their humble confession to God, and the general confession to the Church." This was considerably shortened in the second Prayer-Book (1552). The word minister was substituted for priest. The objects of the private ministration are thus described: "that he may receive such ghostly counsel, advice, and comfort as his conscience may be relieved; and that by the ministry of God's Word he may receive comfort and the benefit of absolution, to the quieting of his conscience and avoiding of all scruple and doubtfulness." And the words about mutual toleration were unfortunately cut out. Further changes were made in 1661, when the passage was brought into its present shape.

As regards discipline, the rubrics upon the Communion service provide for the exclusion of notorious sinners, and the Commination service regrets the disuse of the public

discipline by which such were punished. The 33rd of the 39 Articles and certain Canons assume the existence of ecclesiastical courts for the excommunication and restoration of such persons; but it is long since such courts were put in motion, and for the most part notorious sinners excommunicate themselves.

The Prayer-Book uses very strong language on ministerial absolution. Power and commandment have been given to ministers to declare and pronounce the remission of sins (Mattins), and Christ's authority, which was primarily left to the Church, has been committed to the priest for this purpose (Visitation of the Sick; see also Ordering of Priests). This absolving power is exercised both in the public services of the Church and in private ministrations.

Thus Bishop Latimer in his 6th Sermon on the Lord's Prayer (1552) wrote: "The priest or minister, call him what you will, he hath power given unto him from our Saviour to absolve in such wise as he is commanded by Him . . . I would have them that are grieved in conscience to go to some godly man, which is able to minister God's Word, and there to fetch his absolution, if he cannot be satisfied in the public sermon; it were truly a thing which would do him much good . . . I may absolve you, as an officer of Christ, in the open pulpit in this wise, 'As many as confess their sins unto God . . . and believe . . . *Ego absolvo vos*; I as an officer of Christ, as His treasurer, absolve you in His Name.' This is the absolution that I can make by God's Word."

The Prayer-Book of 1549 pointed out that the benefit is conditional on the sincerity of the repentance. "For neither the absolution of the priest can anything avail (the impenitent), nor the receiving of this Holy Sacrament doth anything but increase their damnation." These words referred primarily, but not exclusively, to the public absolution in the Communion service. It is maintained by some that, except in the case of the sick, the only legitimate method of receiving absolution in the Church of England is in the public services of the congregation; and the Church of Ireland has recently made important alterations even in the passages that concern the sick, while the Protestant Episcopal Church of the United States has omitted that part of the Visitation Service altogether.

The main point of recent controversy in the Church of England has been the question of auricular confession, *i.e.*, confession made into the ear of the priest. Its essential features are that a priest hears the penitent "open his grief" in secret, and if he is satisfied of the sincerity of the repentance, he pronounces a special authoritative absolution. It is common also for him to give "ghostly counsel and advice," technically called "direction." And he may further impose certain conditions, such as the restitution of stolen property, and defer the absolution until these have been fulfilled. The priest thus hears secrets, has to form a judgment on the penitent's sincerity, and may lay definite commands upon the man or woman who has come to consult him. The early history of this practice has been sketched in the article CONFESSION in the 9th edition of this Encyclopædia, and it is there stated that it was not the Reformers' intention to abolish it, but that it was still common even at the end of the 17th century for priests to hear confessions. It is probably not too much to say that auricular confession has never altogether died out in the Church of England, but it is obvious that evidence on the subject must always be hard to find. Recently there has been a great increase and development of the practice, dating from the Oxford Movement in the early part of the 19th century. Two chief difficulties have attended this revival. In the first place, owing to the general disuse of such ministrations, there were very few English clergy who had experience in delicate questions of conscience; and there had been no treatment of casuistry since Sanderson and Jeremy Taylor (see *Ency. Brit.*, 9th ed., CASUISTRY). Those, then, who had to hear penitents unburden their souls were driven to the use of Roman writers on the subject. A book called *The Priest in Absolution* was compiled, and at first privately circulated among the clergy; but in 1877 a copy was produced in Parliament, and gave rise to much scandal and heated debate, especially in the House of Lords and in the newspapers. In the following year Dr Pusey published a translation of the Abbé Gaume's *Manual for Confessors*, abridged and "adapted to the use of the English Church." The other chief difficulty arose from the absence of any authoritative restraint on the hearing of confessions by young and unqualified priests. With characteristic love of liberty, the Church of England allows the penitent who wishes for special help to resort to any "discreet and learned minister," instead of sending him to his parish priest, as is the Roman rule (though in practice there are large exceptions). In 1873 a petition signed by 483 clergy was presented to Convocation asking for the "education, selection, and licensing of duly qualified confessors." The bishops declined so to act, but drew up a report on the subject of confession. The question excites the keenest feeling, and extreme views are held on either side. On the one hand, it is suggested that indecent questions might be asked of the young and innocent; and that frequent secret interviews give rise to scandal if not to sin. None will deny the reality of this last risk, but it may be doubted whether any other method of individual dealing with souls does not lead to the same dangers; and the greater formality of confession, especially if it takes place in church, may even afford something of protection to both sides. In consequence of recent outcry, inquiry was made in 1900 by the bishops, at the request of the House of Lords, into the number of confessional-boxes erected in parish churches within their dioceses. On investigation, the number of alleged cases dwindled into a mere handful. In 1898 the Bishop of Salisbury advised "the minister to sit within the altar rails . . . and to let the penitent kneel outside it" (*Considerations on Public Worship and on the Ministry of Penitence*). On the other hand, there are those who speak as if auricular confession were a necessary element in every Christian life (it is obligatory in the Roman Church at least once a year), and hold that post-baptismal sin of a grave sort can receive forgiveness in no other way. Such a view cannot be found within the covers of the English Prayer-Book.

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(W. O. B.)

**Confirmation.**—Confirmation, in the religious sense, is the initiatory rite supplementary to and completing baptism, which is especially connected with the gift of the Holy Ghost to the candidate. The word "confirmation" has only been used in this technical sense since the 5th century, and only in the Western Churches of Christendom and in their offshoots; but the rite itself has been practised in the Church from the beginning. The history of confirmation has passed through three stages. In the first ages of the Church, when it was recruited chiefly by converts who were admitted in full age, con-

firmation, or the laying-on of hands (Heb. vi. 2), followed close upon baptism, and in the majority of cases the two were combined in a single service. But only the highest order of ministers could confirm (see Acts viii. 14–17); whereas priests and deacons, and in an emergency lay men and even women, could baptize. There was therefore no absolute certainty that a believer who had been baptized had also received confirmation (Acts xix. 2). But two circumstances tended to prevent the occurrence of such irregularities. In the first place, there were in early days far more bishops in proportion to the number of believers than is the custom now; and secondly, it was the rule (except in cases of emergency) to baptize only in the season from Easter to Pentecost, and the bishop was always present and laid his hands on the newly baptized. Moreover, in the third and fourth centuries the infants of Christian parents were frequently left unbaptized for years, *e.g.*, Augustine of Hippo. Later, when the Church had come to be tolerated and patronized by the State, her numbers increased, the rule that fixed certain days for baptism broke down, and it was impossible for bishops to attend every baptismal service. Thereupon East and West adopted different methods of meeting the difficulty. In the East greater emphasis was laid on the anointing with oil, which had long been an adjunct of the laying-on of hands: the oil was consecrated by the bishop, and the child anointed or "sealed" with it by the parish priest, and this was reckoned as its confirmation. With its baptism thus completed, the infant was held to be capable of receiving Holy Communion. And to this day in the Eastern Church the infant is baptized, anointed, and communicated by the parish priest in the course of a single service; and thus the bishop and the laying-on of hands have disappeared from the ordinary service of confirmation. The West, on the other hand, deferred confirmation, not at first till the child had reached years of discretion, though that afterwards became the theory, but from the necessities of the case. The child was baptized at once, that it might be admitted to the Church, while the completion of its baptism was put off till it could be brought to a bishop. Western Canons insist on both points at once; baptism is not to be deferred beyond a week, nor confirmation beyond seven years. And to give an historical example, Henry VIII. had his daughter, afterwards Queen Elizabeth, both baptized and confirmed when she was only a few days old. And still the rubrics of the English Prayer-Book direct that the person who is baptized as an adult is to "be confirmed by the bishop so soon after his baptism as conveniently may be."

But theologians in the West had elaborated a theory of the grace of confirmation, which made its severance from baptism seem natural; and at the time of the Reformation, while neither side favoured the Eastern practice, the Reformers, with their strong sense of the crucial importance of faith, emphasized the action of the individual in the service, and therefore laid it down as a rule that confirmation should be deferred till the child could learn a catechism on the fundamentals of the Christian faith, which Calvin thought he might do by the time he was ten. Many of the Protestant bodies have abandoned the rite, but it remains among the Lutherans (whether Episcopal or not), and in the group of churches in communion with the Church of England.

At the last revision of the Book of Common Prayer an addition was made to the service by prefixing to it a solemn renewal of their baptismal vows by the candidates in their own persons; and in the teeth of history and of the wording of the service, this has often been taken to be the essential feature of confirmation. Practically, the preparation of candidates for confirmation is the most important and exacting duty of the parish priest, as the administration of the rite is the most arduous of a bishop's tasks; and after a long period of slovenly neglect, these duties are now generally discharged with great care: classes are formed and instruction is given for several weeks before the coming of the bishop to lay on hands "after the example of the Holy Apostles" (prayer in the Confirmation Service). Of late years there has been a controversy among Anglican theologians as to the exact nature of the gift conveyed through confirmation, or in other words whether the Holy Spirit can be said to have come to dwell in those who have been baptized but not confirmed. The view that identifies confirmation rather than baptism with the Pentecostal outpouring of the Spirit on the Church has had to contend against a long-established tradition, but appeals to Scripture (Acts viii. 16) and to Patristic teaching.

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(W. O. B.)

**Confirmation of Bishops.**—In canon law, confirmation is the process by which the election of a new bishop receives the assent of the episcopate. This can be traced back to the 3rd century, and indeed may be said to be involved, in principle, in the fact of consecration. From the 4th century it has been regarded as the definite ratification of the election by the bishops of the province (*Conc. Nic.* can. iv.); and by degrees it has come to be made, as a rule, through the metropolitan, and very often at the will of the civil power. In the East it has to a large extent thrown the actual election into the shade. In the churches of the Roman communion the right of confirmation, like many other episcopal rights, has gradually been appropriated by the papacy. For a time indeed, from the 14th century onwards, the popes reserved to themselves the whole appointment of bishops. This is no longer the case, but the confirmation of bishops is still in their hands, however they may have been chosen. In England various attempts were made before the Reformation to resist this tendency. One of the demands of the English Embassy sent to Bruges in 1373 was that confirmation should remain in the hands of the metropolitan; and in 1415 an ordinance was passed, having the force of law, directing that during the voidance of the papal see bishops-elect should be confirmed by their metropolitan, according to ancient custom and the practice of foreign churches. In accordance with this, Chichele confirmed John Wakering, elect of Norwich, in 1416. At the Reformation the share of the papacy in appointing bishops was abolished, but the confirmation became almost formal in character. By 25 Hen. VIII. c. 20, s. 4, it is provided that after an episcopal election a royal mandate shall issue to the archbishop of the province "requiring him to confirm the said election," or, in case of an archbishop-elect, to one archbishop and two bishops, or to four bishops, "requiring and commanding" them "with all speed and celerity to confirm" it. This practice still prevails, in the case of dioceses which have chapters to elect. The confirmation has usually been performed by the archbishop's vicar-general, and, in the southern province, at the church of St Mary-le-Bow, London; but since 1901 it has been performed, in part, at the Church House, Westminster, in consequence of the disorder in the proceedings at Bow Church on the confirmation there of Dr Winnington Ingram as Bishop of London. All objectors are cited to appear on pain of contumacy after the old form; but although the knowledge that opposition might be offered

has been a safeguard against improper nominations, *e.g.*, in the case of Dr Clarke the Arian, confirmation has never been refused since the Reformation. In 1628 Dr Rives, acting for the vicar-general, declined to receive objections made to Richard Montague's election to the see of Chichester on the ground that they were not made in legal form. An informal protest against the confirmation of Dr Prince Lee of Manchester in 1848 was almost immediately followed by another in due form against that of Dr Hampden, elect of Hereford. The vicar-general refused to receive the objections, and an application to the Queen's Bench for a *mandamus* was unsuccessful, the judges being divided, two against two. In 1869, at the confirmation of Dr Temple's election as Bishop of Exeter, the vicar-general heard counsel on the question whether he could receive objections, and decided that he could not. When the same prelate was elected to Canterbury, the course here laid down was followed, as also at the confirmation of Dr Creighton's election to the see of London. Objections were again raised, in 1902, against Dr Gore, elect of Worcester; and an application was made to the King's Bench for a *mandamus* against the archbishop and his vicar-general when the latter declined to entertain them. By a unanimous judgment (10th February) the Court, consisting of the L. C. J. (Lord Alverstone) and Justices Wright and Ridley, refused the *mandamus*. Without deciding that objections (*e.g.*, to the identity of the elect, or the genuineness of documents) could never be investigated by the vicar-general or the archbishop, it held that they could not even entertain objections of the kind alleged. Formerly the archbishop had the right of *option*, *i.e.*, of choosing any one piece of preferment in the gift of a bishop confirmed by him, and bestowing it upon whom he would; but this has been held to be abolished by a clause in the Cathedral Act (3 & 4 Vict. c. 113, s. 42). And the election of a dean by a cathedral chapter used to receive the bishop's confirmation (Oughton, *Ordo Judiciorum*, No. cxxvii.).

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(W. E. CO)

**Congleton,** a municipal borough and market-town of England, on the Dane, 8 miles south-south-west of Macclesfield, in the Macclesfield parliamentary division of the county of Chester. Station on the North Staffordshire Railway, and situated on the Macclesfield Canal. The town is divided into three wards, under 6 aldermen and 18 councillors. There are four Ecclesiastical parish churches and a Roman Catholic church. A Congregational chapel was erected in 1877, and a Unitarian chapel in 1883. A Primitive Methodist chapel was rebuilt in 1890. There are Church of England, a Roman Catholic, and Wesleyan schools. The industries include fustian, towel, couch, chair, and nail factories, iron and brass foundries, stone quarries, and corn mills. Area of municipal borough, 2572 acres. Population (1881), 11,116; (1891), 10,744; (1901), 10,706.

**Congo,** formerly known also as ZAIRE, the largest and second in length of the rivers of Africa, and second in size of all the rivers of the world, with a length of probably at least 3000 miles, and a drainage area, according to the calculation of Dr Bludau, of 1,425,000 square miles. This vast area, measuring some 1400 miles in either diameter, falls from all sides to the Equatorial basin by which the interior plateaux of Africa are broken in the west, and which seems once to have been occupied by an inland sea, having its deepest part somewhat south of the Equator, and in about 17°–18° E. To the west and north this basin is bounded by comparatively narrow bands of higher ground, while to the east and south the drainage area of the river includes considerable portions of the high plateau lands of East and South Africa. The main drainage of the Congo system is thus to the north and west, and these two directions dominate the great sweep of the main stream before it is deflected south on approaching the western highlands, through which it finally forces a way to the Atlantic Ocean. From the high lands of the south and east the land falls in a succession of steps, generally marked by gorges or rapids in the course of the streams. Many of these occur along a line of broken country, sometimes known as the Mitumba Mountains, which previous to the cutting of the gorges may have held back a series of extensive lakes, now in great part drained, in the upper valleys of the separate streams.

*Head-Streams.*—The most remote of these, the Chambezi, rises, with the Chozi and other feeders, on the southern versant of the high plateau between Lakes Nyasa and Tanganyika, at an elevation of about 5000 feet above the sea. Its source is placed by Mr L. A. Wallace in about 9° 6′ S., 31° 20′ E., while the Chozi rises in the same latitude about half a degree to the east. After the junction of the two streams, the Chambezi skirts the southern borders of the Awemba country, receiving many tributaries, and soon becoming a wide river with steep wooded banks and many islands. The river enters Lake Bangweulu at its south-east corner, the actual mouth being apparently choked with aquatic vegetation, through which narrow channels admit the passage of canoes. When seen in 1899 by Codrington, about 15 miles from the lake, it had a width of 2 miles and a depth of 19 feet, the altitude being here 3800 feet. Near the south point of Bangweulu, in 11° 31′ S., the Luapula makes its exit through a vast marsh, with isolated lakelets, the whole of which was surveyed by Weatherley in 1896–99. In about $12\frac{1}{2}$° S. the Luapula, after receiving the Luombwa and Moengashe from the south, turns north and precipitates itself down the Mumbotuta Falls, the thunder of which can be heard on a still night 8 or 9 miles. The river, the width of which varies from 250 to 1200 yards, is almost unnavigable until below the Johnston Falls (Mambilima of the natives), a series of rapids extending from 10° 46′ to 10° 33′ S. Before entering Lake Mweru the Luapula again passes through a swampy region of deltaic character, the water escaping eastwards by various channels, and after spreading over a wide area, finally passing into Mweru by lagoon-like channels east of the main Luapula mouth. The most southerly portion of the lake, a shallow bay extending to south., lies west of the Luapula, from which it is separated by a tongue of land. Although generally deeper than Bangweulu, Mweru (2800 feet) seems to have decreased in extent, the cliffs to the west being bordered by a strip of low ground once covered with water. The Luapula (known also as the Lufira) makes its exit at the north-west corner of the lake, and bending westwards in a winding course, passes, with many rapids, across the zone of the Mitumba Mountains, falling during this interval nearly 1000 feet. Practically the whole course of the river has been explored by Captain Hinde, Lieutenant Brasseur, and others, with the result that the lake formerly marked on the maps as Lange or Ulenge is proved to be non-existent. In about 6° 40′ S. the Luapula joins the Kamolondo, the western main branch of the Upper Congo, which, as it flows in a broad level valley at a lower level than the eastern branch, is held by some to be the true head-stream. Four principal streams—the Kuleshe, Lubudi, Nzilo or Lualaba, and Lufira, all

rising on the southern limits of the Congo basin, between 11° and 12° S.—combine to form the Kamolondo, the valley of which contains many small lakes and backwaters. The Nzilo and Lufira pass through the Mitumba Mountains in deep gorges, their courses being broken by rapids for distances of 40 to 50 miles.

*The Upper Congo or Lualaba.*—During its northerly course to the Equator, the united stream of the Congo—after breaking through the ridge of the Bambara Hills in another series of rapids in 4½°–3½° S.—becomes a majestic river, often over a mile wide, with flat wooded banks, the only real impediment to navigation between 4½° and the Stanley Falls being the rapids near Nyangwe in 3° 55′, and at Ukassa in 3° 15′. Between the junction of the two main upper branches (about 1700 feet above the sea) and the first of the Stanley Falls (1520 feet) the fall of the river is less than 200 feet, in a distance of 500 miles. During the whole of this section the Lualaba receives most of its tributaries from the east. Of these, the Lukuga, the outflow from Lake Tanganyika, has been followed throughout its whole length, and has been found to be broken by rapids, falling 1000 feet during its course of some 300 miles. Farther north the streams which drain the forest region between 4° S. and the Equator have been only partially explored, the Elila or Lira, the Urindi, and the Lowa being the most important. Their sources lie on an upland region west of the Central African rift valley. The Urindi in its middle course has a general width of 60 to 100 yards, but the Lowa is larger, receiving two important affluents, the Ozo and Luvuto, both from the north. Its lower course is very tortuous.

*The Middle Congo.*—After passing the Stanley Falls,—7 in number besides minor rapids, with a total fall of some 200 feet,—the Congo enters, at an altitude of some 1320 feet, the great alluvial plain of West Equatorial Africa, assuming a westerly direction, and also changing its character. This section of the river, navigable for a distance of at least 1000 miles, may be designated the Middle Congo. Gradually widening out and becoming strewn with low alluvial islands, it forms great lacustrine expansions, sometimes (as, *e.g.*, in 21° and 22° 30′ E.) 16–20 miles wide, but is from time to time contracted by the approach of high ground on either side. The islands, like the banks, which appear to be often raised above the level of the surrounding country, are forest-clad, but are inundated at high water. In 22½° E. the river reaches its most northern point (about 2° 12′ N. on the north bank), beyond which its course gradually bends south, and in 2° 45′ S., on approaching the western continental highlands, it again contracts to a width of a mile and under, remaining, however, unbroken by rapids until after passing the lake-like expansion of Stanley Pool. Here its elevation above the sea is just over 1000 feet.

*Northern Tributaries.*—Of the right bank tributaries of the Middle Congo, the Chopo and Lindi, which enter by one mouth in about 25° 4′ E., are little known. Their basins do not extend to the Outer Congo watershed, but the next feeder, the great Aruwimi, was found by Stanley to rise, as the Ituri, in close proximity to Albert Nyanza, flowing generally from east to west. It is formed of many branches, including the Nepoko from the north, and its upper basin extends over 2½° of latitude. The upper river, to about 27° E., is much broken by rapids, but apart from those of Yambuya in 25°, which form the limit of navigation from the mouth, the lower section is generally navigable. The Aruwimi flows almost entirely through the great equatorial forest, which here seems to reach its maximum density. The next tributary, the Rubi, rises in about 26° E., and flowing generally west, joins the Congo by two mouths, 22° 40′–50′. Within the bend of the Ubangi, the greatest northern tributary, the Mongalla or Dua flows in a somewhat similar curve (on a smaller scale) from beyond 23° E. The identity of the Ubangi with the Welle of Schweinfurth was finally proved by Vangele in 1888, and its upper basin has since been explored by French and Belgian officers. Next to the Welle (principal tributary Bomokandi, from the south), its largest upper branch is the Mbomu, which, rising in 27° 12′ E., 4° 50′ S., on the confines of the Bahr-el-Ghazal region, itself receives two large streams, the Shinko and Bali, from the north. The junction of the Welle and Mbomu is in 22° 37′ E., and a short distance farther west the Kotto, coming from beyond 8° N., on the borders of Darfur, and forming the most northerly extension of the Congo basin, enters the united stream on the right bank. The remaining tributaries (still mostly coming in on the right bank) are smaller, but the Kemo, which joins the Ubangi near its most northern point (5° 8′ N.), is of some importance as offering water-communication within a short distance of the Shari basin. The Upper Ubangi is broken in many places by rapids, between which are navigable stretches in which the river is often (especially west of 25°) wide and strewn with islands. The Zongo series of rapids near the great bend of the Ubangi, do not form an insuperable obstruction at all states of the river, but navigation is quite blocked by the Mokwangu Falls in 23° 5′ E. (10 feet), by the rapids of Goie (the worst on the upper river) in 25°, and by those of Panga in 26° 40′. A little below the mouth of the Ubangi, the Sanga, a large stream flowing from north to south, enters the Congo. Its lower course is tortuous, as it flows across level, often swampy, plains; but though comparatively narrow, it is navigable for a long distance. The main northern branch rises in southern Adamawa in about 7° N., while an almost equally large western branch, the Ngoko, rises in the German territory of Cameroon (probably in about 12° 10′ E.), traversing a vast tract of uninhabited forest. It is navigable to about 13° 40′ E. The Likuala, Licona, and Alima, which all join the Congo within 30 miles of the mouth of the Sanga, are much smaller streams. The Licona is still almost unexplored.

*Southern Tributaries.*—The first of the southern tributaries of the Middle Congo, the Boloko or Lubilash of Grenfell, which enters in 24° 17′ E., has been proved to be identical with the Lomami of Cameron, rising in nearly 9° S., and thus flowing through more than nine degrees of latitude. Its course is generally parallel to the Upper Congo, which it approaches within 40 miles between 2° and 3° S. It is comparatively narrow and tortuous, but deep, with a strong current, and is hardly broken by rapids north of 4½° S. About 3° S. it traverses a region of swamps, which may have given rise to reports of a great lake in this locality. Below the mouth of the Lomami there is a long stretch with no southern tributary, as the great plain within the Congo bend is drained by streams flowing from east to west parallel to the main river. The northern branch of the Lulonga, which enters in 0° 40′ N., approaches the latter within 20 miles in its upper course. The main branch of the Ruki, which enters just north of the Equator, and the Lukenye or Lukeni, the northern unit of the great Kasai system, have their sources between 24° and 25° E. in the vicinity of the Lomami swamp above alluded to. These streams have tortuous courses, for the most part not broken by rapids, flowing across a level country once occupied by a lake, of which the present Lake Leopold II., connected with the lower course of the Lukenye, is the scanty remnant. Its shores are low and inundated in the rains, so that its outline is very ill-defined. Besides the Lukenye, the chief units of the Kasai system all flow north in parallel courses before acquiring the east to west

direction of the Lower Kasai on reaching the latitude of 3°–4° S. The most important in order from east to west are the Lubefu, Lubilash or Sankuru, Lulua; Upper Kasai, with its tributaries Luembo, Chihumbo, Luajimo, Chikapa, and Lowo; Loange, Juma or Kwilu, Wamba, and Kwango, the last three uniting before joining the Kasai. Most of these are broken by rapids along a line running from north-east to south-west between 5° and 8° S., which marks the descent from the higher to the lower plateau; but their lower courses are navigable. The Lulua, Kasai, Chihumbo, and Kwango all spring from the southern Congo water-shed, traced in 1899–1900 by the Belgian expedition under Lemaire, who showed the incorrectness of the old idea that the basins of the Congo and Zambezi are connected through Lake Dilolo. This small lake, though situated on the water-parting, was found to have normally no connexion with either system, though apparently sending water to the Zambezi after heavy rains. Near its mouth the Kasai, which in its lower course is generally a broad stream strewn with islands, is narrowed to about half a mile on passing through a gap in the first line of the West African highlands, by the cutting of which the old lake of the Kasai basin must have been drained.

*The Lower Congo.*—As already stated, the Congo is greatly narrowed on first reaching the more elevated ground in 2° 45′ S.; the actual rapids, however, begin only immediately below Stanley Pool. The whole system of highlands (sometimes known generally as the Serra do Crystal) seems to consist of two principal mountain zones with an intermediate zone of lower elevation. The passage of this last is marked by a more navigable stretch on the Lower Congo, extending from Manyanga to Isangila—a distance of 70 miles, during which the only serious rapids are those of Chumbo and Itunzima, the latter in 13° 54′ E.; while above and below, rapids succeed each other at short intervals. Some eighteen main rapids or falls occur during the upper section (87 miles), in the course of which the level drops about 500 feet; and about ten in the lower section (56 miles), during which the fall is about 300. The last rapid occurs a little above Matadi, beyond which the river is navigable for large vessels to the sea, a distance of about 85 miles. It gradually widens out into an estuary, bordered by creeks and islands of a deltaic character and traversed by a deep cañon, in which soundings of 900 feet have been obtained. This cañon or gully is continued into the open sea for over 100 miles, with depths as much as 4000 feet below the general level of the sea floor. Just below Matadi, where the width is about half a mile, depths of 276 and 360 feet have been found, the current here running at from 4 to 8 knots, according to the season; while the difference in level between high and low water (not in any way due to tidal action) is 20–25 feet. The tides are felt as far as Boma, but the rise is here not above 1 foot; while at the mouth of the river it is 6 feet. The investigations carried out by Commander Purey-Cust in 1899 showed that the cañon above mentioned is occupied by salt water, which is nearly motionless. Above it the fresh water runs with increasing velocity, but decreasing depth, so that just within the mouth of the river it reaches only a few feet from the surface. (E. He.)

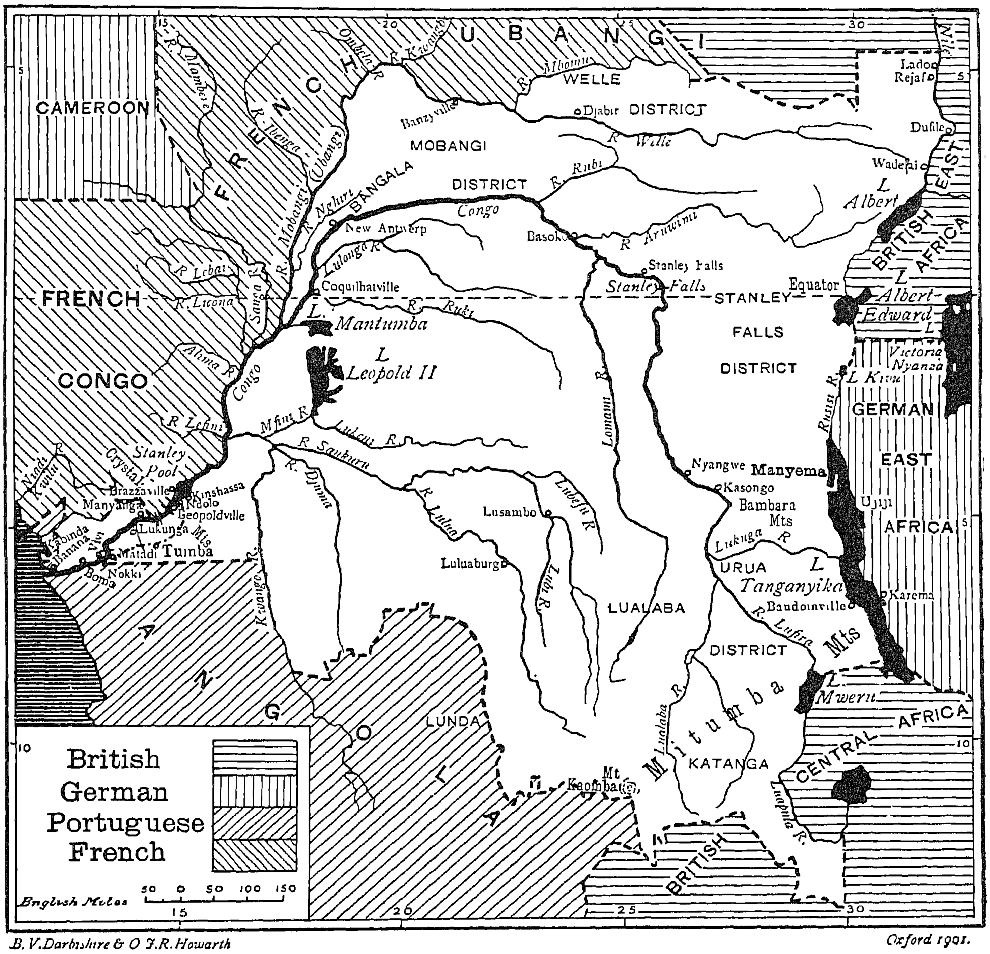
**Congo,** a Portuguese district on the west coast of Africa, comprising the territory of Kabinda on the north side of the Congo and the northern parts of the province of Angola on the south side of the river. Its exports embrace oil, india-rubber, coffee, cocoa-nuts, gums, and ivory; and the export trade increased from £149,100 in 1888 (the first full year of the Portuguese administration) to £222,000 in1896. The chief town is Kabinda, on the coast, 35 miles north of the mouth of the Congo.

**Congo Free State.**—The Congo Free State (*État Indépendant du Congo*) is one of the largest of the political divisions of Equatorial Africa. It occupies a unique position among modern states, as it may be said to owe its existence to the ambition and force of character of a single individual. It dates its formal inclusion among the independent states of the world from 1885, when its founder, Leopold II., king of the Belgians, became, its head. But to understand how it came into existence, a brief account is needed of its Sovereign's connexion with the African continent. In 1876 King Leopold summoned a conference at Brussels of the leading geographical experts in Europe, which resulted in the creation of "The International Association for the Exploration and Civilization of Africa." To carry out its objects an International Commission was founded, with Committees in the principal countries of Europe. Committees were in fact so established, but the Belgian Committee at Brussels, where also were the headquarters of the International Commission, displayed from the first greater activity than did any of the other committees. It turned its attention in the first place to East Africa, and several expeditions were sent out, which resulted in the founding of a Belgian station at Karema on Lake Tanganyika. But the return of Mr (afterwards Sir) H. M. Stanley from his great journey of exploration down the Congo, forcibly directed the attention of King Leopold to the possibilities for exploration and civilization offered by the Congo region. On the invitation of the king, Mr Stanley visited Brussels, and on November 25th 1878 a separate committee of the International Association was organized at Brussels, under the name "Comité d'Études du Haut Congo." Shortly afterwards this committee became the "International Association of the Congo," which in its turn was the forerunner of the Congo Free State. The Association was provided with a nominal capital of £40,000, but from the first its funds were largely supplemented from the private purse of King Leopold; and by a gradual process of evolution the work, which was originally, in name at least, international in character, became a purely Belgian enterprise. Mr Stanley, as agent of the Association, spent four years on the river, in exploring and concluding treaties with local chiefs. The first station was founded in February 1880 at Vivi, and before returning to Europe in August 1884 Mr Stanley had established twenty-two stations on the Congo and its tributaries. Numerous expeditions were organized by King Leopold in the Congo basin, and the activity of the International Association and its agents began seriously to engage the attention of the European Powers interested in Africa. On behalf of Portugal, claims were advanced to the Congo, based on the discovery of its mouth by Portuguese navigators centuries before. In the interests of France, M. de Brazza was actively exploring on the northern banks of the Congo, and had established various posts, including one where the important station of Brazzaville is now situated. The fact that the International Association of the Congo had no admitted status as a sovereign power rendered the tenure of its acquisition somewhat precarious, and induced King Leopold to make determined efforts to secure for his enterprise a recognized position. Early in 1884 a series of diplomatic events brought the question to a head. Lord Granville, then British Foreign Secretary, in February of that year concluded a convention with Portugal, recognizing both banks of the mouth of the Congo as Portuguese territory. This convention was never ratified, but it led directly to the summoning of the Berlin Congress of 1884–85, and to the recognition of the International Association as a sovereign state.

The United States of America was the first Great

Power, in a convention signed on the 22nd of April 1884, to recognize the Association as a properly constituted state. Simultaneously, King Leopold had been negotiating with the French Government, the Association's most serious rival, not only to obtain recognition but on various boundary questions, and on the 23rd April 1884 Colonel Strauch, the president of the Association, addressed to the French Minister for Foreign Affairs a Note in which he formally declared that the Association would not cede its possessions to any Power, "except in virtue of special conventions which may be concluded between France and the Association for fixing the limits and conditions of their respective action." The Note further declared that, as a fresh proof of its friendly feeling towards France, the Association engaged to give France the right of preference if, through unforeseen circumstances, it were compelled to sell its possessions. The right of pre-emption thus given to France was, by an exchange of Notes in April 1887, declared to be without prejudice to the right of Belgium to take over the possessions of the Congo Free State as a Belgian colony. Germany was the next Great Power to recognize the position of the Free State, on the 8th November 1884, and the same recognition was subsequently accorded by Great Britain on 16th December; Italy, 19th December; Austria-Hungary, 24th December; Holland, 27th December; Spain, 7th January, 1885; France and Russia, 5th February; Sweden and Norway, 10th February; Portugal, 14th February; and Denmark and Belgium, 23rd February. While negotiations with Germany for the recognition of

***Recognition by the Powers.***



B. V. Darbishire & O. J. R. Howarth Oxford 1901.

SKETCH MAP OF CONGO FREE STATE.

the status of the Congo Free State were in progress, Prince Bismarck issued invitations to the Powers to an International Conference at Berlin. The Conference assembled on the 15th of November 1884, and its deliberations ended on the 26th of February of the following year by the signature of a General Act, which dealt with the relations of the European Powers to other regions of Africa as well as the Congo basin. The provisions affecting the Congo may be briefly stated. A Conventional Basin of the Congo was defined, which comprised all the regions watered by the Congo and its affluents, including Lake Tanganyika, with its eastern tributaries, and in this Conventional Basin it was declared that "the trade of all nations shall enjoy complete freedom." Freedom of navigation of the Congo and all its affluents was also secured, and differential dues on vessels and merchandise were forbidden. Trade monopolies were prohibited, and provisions made for civilizing the natives, the suppression of the slave trade, and the protection of missionaries, scientists, and explorers. Provision was made for the Powers owning territory in the Conventional Basin to proclaim their neutrality. Only such taxes or duties were to be levied as had "the character of an equivalent for services rendered to navigation itself"; and it was further provided that (Article 16) "The roads, railways, or lateral canals which may be constructed with the special object of obviating the innavigability or correcting the imperfection of the river route on certain sections of the course of the Congo, its affluents, and other waterways, placed under a similar system as laid down in Article 15, shall be considered, in their quality of means of communication, as dependencies of this river and as equally open to the traffic of all nations. And as on the

river itself, so there shall be collected on these roads, railways, and canals only tolls calculated on the cost of construction, maintenance, and management, and on the profits due to the promoters"; while as regards the tariff of these tolls, strangers and natives of the respective territories were to be treated "on a footing of perfect equality." The International Association not having possessed, at the date of the assembling of the Conference, any recognized status, was not formally represented at Berlin, but the flag of the Association having, before the close of the Conference, been recognized as that of a sovereign state by all the Powers, with the exception of Turkey, the Association formally adhered to the General Act.

Thus early in 1885 King Leopold had secured the recognition of the Association as an independent state, but its limits were as yet not clearly defined. On the 5th of February, as the result of prolonged negotiations, France conceded the right of the Association to the course of the Lower Congo below Manyanga, and accepted the Chiloango river and the water-parting of the waters of the Niadi Kwilu and the Congo, as far as beyond the meridian of Manyanga, as the boundary between her possessions and those of the Association on the lower river. From Manyanga the frontier was to follow the Congo up to Stanley Pool, the median line of Stanley Pool, and the Congo again "up to a point to be settled above the river Licona-Nkundja," from which point a line was to be drawn to the 17th degree of longitude east of Greenwich, following as closely as possible the water-parting of the Licona-Nkundja basin. The identity of the Licona-Nkundja subsequently gave rise to considerable discussions with France, and eventually a protocol, signed at Brussels on the 29th of April 1887, continued the boundary along the Congo to its confluence with the Mobangi, whence it followed the *thalweg* of that river to its intersection with the 4th parallel of north latitude, below which parallel it was agreed that the northern boundary of the Congo Free State should in no case descend. In accepting this frontier King Leopold had to sacrifice all claims to the valley of the Niadi Kwilu, in which he had founded fourteen stations, and to the right bank of the Mobangi. With Portugal the Association concluded an agreement on the 14th of February 1885, by which the northern bank of the Congo was recognized as belonging to the Association, while Portugal retained the southern bank of the river as far as Nokki. North of the Congo Portugal retained the small *enclave* of Kabinda, while south of the river the frontier left the Congo at Nokki and followed the parallel of that place to the Kwango river.

***Agreements as to limits.***

In April 1885 the Belgian Chamber authorized King Leopold "to be the chief of the state founded in Africa by the International Association of the Congo," and declared that "the union between Belgium and the new State of the Congo shall be exclusively personal." This act of the Belgian Legislature regularized the position of King Leopold, who at once began the work of organizing an administration for the new state. In a circular-letter addressed to the Powers on the 1st of August 1885, His Majesty declared the neutrality of the "Independent State of the Congo," and set out the boundaries which were then claimed for the new state, but it was not until fifteen years later that the frontiers of the Free State were finally settled. At the date of the issue of the circular the agreements with France and Portugal had partially defined the Free State boundaries on the lower river, and the 30th degree of longitude east of Greenwich was recognized as the limit of its extension eastwards.

The following is a list of the agreements subsequently made with reference to the boundaries of the State (see also Africa, *Recent History*):—

1. 22nd November 1885, with France.—Protocol for delimitation of the Manyanga region.
2. 29th April 1887, with France.—Protocol for delimitation of the Mobangi region.
3. 25th May 1891, with Portugal.—Treaty for delimitation of the Lunda region, and Convention of even date for the settlement of frontiers on Lower Congo.
4. 24th March 1894, with Portugal.—Declaration approving delimitation of Lunda region.
5. 12th May 1894, with Great Britain.—Agreement as to Nile valley and boundaries with British Central Africa.
6. 14th August 1894, with France.—Agreement as to Mbomu river, and Congo and Nile basins.
7. 5th February 1895, with France.—Agreement as to Stanley Pool.

***History.***

The net result of the above agreements is to leave the Congo Free State with France, Portugal, and Great Britain as her neighbours on the north, with Great Britain and Germany as her neighbours on the east, and with Great Britain and Portugal on her southern frontier. The external history of the young state is traced in these agreements. The main object of King Leopold's ambition was to obtain an outlet on the Nile, and for the history of the incidents connected with the two important agreements made in 1894 with Great Britain and France reference must be made to the article Africa. The sacrifices made by the king to attain his object were great, and involved a heavy strain on the finances of the state, reacting on its internal policy. The avowed object of the Free State was to develop the resources of the territory with the aid of the natives, but it early became apparent that the Arab slave traders, who had established themselves in the country between Lake Tanganyika and Stanley Falls and on the upper river, offered an insuperable bar to the realization of this programme. The scanty resources at the disposal of the state imposed a policy of restraint on the officers who were brought into relations with the Arabs on the upper river, of whom Tippu Tib was the chief. In 1886 the Arabs had destroyed the state station at Stanley Falls, and it was apparent that a struggle for supremacy was inevitable. But the Free State was at that time ill prepared for a trial of strength, and at Mr Stanley's suggestion the bold course was taken of appointing Tippu Tip governor of Stanley Falls, as the representative of King Leopold. This was in 1887, and for five years the *modus vivendi* thus established continued in operation. During those years fortified camps were established by the Belgians on the Sankuru, the Lomami, and the Aruwimi, and the Arabs were quick to see that each year's delay increased the strength of the forces against which they would have to contend. In 1891 the imposition of an export duty on ivory excited much ill-will, and when it became known that, in his march towards the Nile, van Kerckhoven had defeated an Arab force, the Arabs on the Upper Congo determined to precipitate the conflict. In May 1892 the murder of M. Hodister, the representative of a Belgian trading company, and of ten other Belgians on the Upper Lomami, marked the beginning of the Arab war. When the news reached the lower river a Belgian expedition under the command of Commandant (afterwards Baron) Dhanis was making its way towards Katanga. This expedition was diverted to the east, and, after a campaign extending over several months, during which several battles were fought and the Arab strongholds of Nyangwe and Kasongo were captured, the Arab power was broken and many of the leading Arabs were killed. The political and commercial results of the victory of the Free State troops are thus described by Captain Hinde, who was Baron Dhanis's second in command:—"The political

geography of the Upper Congo basin has been completely changed, as a result of the Belgian campaign against the Arabs. It used to be a common saying in this part of Africa that all roads lead to Nyangwe. This town, visited by Livingstone, Stanley, and Cameron, until lately one of the greatest markets in Africa, has ceased to exist, and its site, when I last saw it, was occupied by a single house. Kasongo, a more recent though still larger centre, with perhaps 60,000 inhabitants, has also been swept away, and is now represented by a station of the Free State nine miles away on the river bank. In harmony with this political change the trade routes have been completely altered, and the traffic which used to follow the well-beaten track from Nyangwe and the Lualaba across Tanganyika to Ujiji, or round the lake to Zanzibar, now goes down the Congo to Stanley Pool and the Atlantic."

These results had been attained largely by the aid of native levies and allies, and a number of the men who had taken part in the Arab campaign were enlisted as permanent soldiers by the Belgians. Among these were some Batetelas, who in 1895 revolted in the Lulua and Lomami districts. The mutineers were eventually defeated; but in 1897, while Baron Dhanis was making his way with a large expedition towards the Nile, the Batetelas again revolted, murdered several of their white officers, and took possession of a large area of the eastern portions of the state. Although defeated on several occasions by the Free State forces, the mutineers were not finally dispersed until near the end of 1900, when the last remnants were reported to have crossed into German territory and surrendered their arms.

The international position of the Free State is a somewhat anomalous one. It is an independent state administered as if it were a colony. By his will dated the 2nd August 1889, King Leopold bequeathed to Belgium "all our sovereign rights over the Independent State of the Congo, as they are recognized by the declarations, conventions, and treaties concluded since 1884 between the foreign Powers on the one side, the International Association of the Congo and the Independent State of the Congo on the other, as well as all the benefits, rights, and advantages attached to that sovereignty." It was subsequent to the execution of this will that the Belgian State in July 1890 acquired the right, already referred to, of annexing the Free State in ten years and six months from that date. In the year 1895, owing to its financial difficulties, the Free State was obliged to ask the consent of the Belgian Government to a project for raising a further loan. The Belgian Ministry of that time believed the occasion opportune for advancing the date of the annexation of the Free State as a Belgian colony. A Bill was introduced with this object into the Belgian Legislature, but after long delays and a violent Press campaign the Ministry fell, the Bill was withdrawn, and the Chambers voted a further loan to the Free State to enable it to tide over its immediate difficulties. However, either on the decease of the sovereign, or at some earlier date, the Belgians must come to a decision whether or not they will accept the responsibility for King Leopold's African kingdom. In the event of their refusal, the right of pre-emption given to France by the International Association in 1884 might give rise to questions of a somewhat complicated and serious character.

***International position.***

Except for its short coast-line on the Atlantic, and for a small area on its north-eastern frontier, the Free State lies wholly within the geographical basin of the Congo. It may roughly be divided into three zones—(1) the small coast zone west of the Crystal Mountains, through which the Congo breaks in a succession of rapids to the Atlantic; (2) the great central zone bounded on the north by the Congo and the Mobangi river, on the east by the Mitumba range of mountains, and on the south by the Congo-Zambezi watershed and the Portuguese frontier; and (3) the smaller zone east of the Mitumba range, including the upper courses of some of the Congo tributaries which have forced their way through the mountains, and west of Lake Mweru and the upper course of the Luapula, as well as a small area which belongs geographically to the Nile valley. The Crystal Mountains form the western edge of the Great Central African plateau and run, roughly, parallel to the coast. The Mitumba range extends from Mount Kaomba, on the southern frontier of the Free State, in a north-easterly direction to Lake Tanganyika, and then strikes northwards along the western shore of that lake, past Lakes Kivu and Albert Edward to Albert Lake, forming the western edge of the Great Central African rift valley. This immense mountain chain has numerous subsidiary local names. It varies in altitude from 5000 to 10,000 feet. Baumann estimates its height where it forms the western limit of the Rusisi valley at the latter figure, while to the west of Lake Kivu von Götzen calculates it at 9000 feet. The eastern escarpment is precipitous, but on its western face it slopes more gently into the Congo basin. North of the Lukuga river the main chain throws out into the Central zone, in a north-westerly direction, a secondary range, known as the Bambara Mountains, which forms one of the boundaries of the Manyema country. The interior, or Lake, zone is a high plateau with an average elevation of 3000 feet above sea-level. The Central zone dips with a westerly inclination from the Mitumba Mountains towards the western edge of the plateau. It is described by Wauters as "a country of alluvial plains, without any marked mountain features, very well watered, covered with forests and wooded savannahs." The Coast zone is small in area, dipping down from the Crystal Mountains to the Atlantic, where the Free State frontier is reduced to some 20 miles of coast-line. The Congo and its tributary streams form, both from the point of view of the physical geography and the commercial development of the Congo Free State, its most important feature; but next in importance are the immense forests which clothe the banks of the rivers, the remains of the great forest which appears at one time to have covered the whole of the centre of the continent. The wooded savannahs, where it is anticipated that in the course of time numerous herds of cattle may be reared, are mostly situated on the higher lands of the Central zone, where the land dips down from the Mitumba Mountains to the Congo.

***Physical features.***

*Climate.*—Situated on the Equator, between about 5° N. and 11° S. lat., the Congo Free State shows only a slight variation of temperature all the year round. From July to August the heat increases slightly, with a more rapid rise to November. During December the thermometer remains stationary, and in January begins to rise again, reaching its maximum in February. March is also a month of great heat; in April there is a steady decline into May, with a more rapid decline in June, the minimum being reached again in July. There is a marked distinction between the wet and dry seasons in the western districts on the Lower Congo, where rains fall regularly from October to May, the dry season being from June to September. But nearer the centre of the continent the seasons are less clearly marked by the amount of precipitation, rain falling more or less regularly at all times of the year. The seasons of greatest heat and of the heavy rains are thus coincident on the lower river, where fever is much more prevalent than on the higher plateau lands nearer the centre of the continent. The amount of the rainfall shows great variations in different years, the records at Banana showing a total fall of 16 inches in 1890–91 and of 38 inches in 1893–94. Even in the rainy season on the lower river the rain does not fall continuously for a long period, the storms rarely lasting more than a few hours, but frequently attaining great violence. The greatest fall registered as occurring during a single tornado was 6 inches at Bolobo. In July grass fires are of common occurrence, and frequently sweep over a great expanse of country. Mons. A. Lancaster, the Belgian meteorologist, has formulated, as the result of a study of all the available data, the following rule:—That the rainfall increases in the Congo basin (1) in proportion as one nears the Equator from the south, (2) as one passes from the coast to the interior. On the Lower Congo the prevailing winds are from the west and the south-west, but this prevalence becomes less and less marked towards the interior, until on the upper river they come from the south-east. The wind, however, rarely attains any exceptional velocity. Storms of extreme violence, accompanied by torrential rain, and in rare instances by hailstones, are of not uncommon occurrence. On the coast and along the course of the lower river fogs are very rare, but in the interior early morning fogs are far from uncommon. Europeans are subject to the usual tropical diseases, and the country is not suited for European colonization.

*Area and Population.*—The area is roughly estimated at 900,000 square miles, and the native population is variously estimated at from 30,000,000 (Stanley) to 14,000,000 (Saint Martin). The

estimated area is probably above rather than below the proper figure. The vast bulk of the population belongs to the Bantu stock, but there are found, in the great forests along the river banks, sparsely distributed bands of the pigmy people, who probably represent the aboriginal inhabitants of Central Africa. In the north-eastern corner of the State, in the upper basin of the Welle and the Mbomu, the Azandé, a race of warriors and hunters with a social, political, and military organization superior to that of the Bantu tribes of the Congo basin, had intruded from the north, and were forcing their way southwards towards the Congo when the agents of the State appeared in that region and arrested their farther progress. Traces of Arab blood are still found in the districts where the slave traders from the east coast had established stations. The European population at the end of 1886 numbered 254, of whom 46 were Belgians. In 1890 there were 744 Europeans, of whom 338 were Belgians; in 1895, 1076, of whom 691 were Belgians. In January 1900 the European population was as follows:—Belgians, 1187; Italians, 176; British, 99; Dutch, 95; Swedes, 81; Portuguese, 72; French, 53; Germans, 42; Danish, 39; Americans, 33; Norwegians, 25; Swiss, 13; Austrians, 7; Spaniards, 6; and other nationalities, 30,—a total of 1958.

*Stations.*—There are no large towns in the European sense, but a number of stations have been established, some of which have acquired a certain importance and have become the centre of a comparatively large European population. Of these, *Boma* is the headquarters of the local administration, and the residence of a British vice-consul. It is situated on the right bank of the Lower Congo, about 60 miles from its mouth, is one of the principal ports of call for steamers, and the centre of a considerable trade. In 1899 the number of steamers entering the port of Boma was 84, of 164,035 tons, and the number of coasting vessels 196, of 6485 tons. *Banana*, close to the mouth of the Congo and Banana Point, possesses one of the best natural harbours on the west coast of Africa, and is capable of sheltering vessels of the largest tonnage. There are a number of European factories, some of them dating from very early days, and the place is still the centre of a considerable commerce. The French consulate is situated at Banana. In 1899 the number of seagoing vessels entering the port was 108, of 205,610 tons, and the number of coasting vessels 244, of 13,353 tons. *Matadi* is situated on the left bank of the Congo, at the highest point of the lower river which can be reached by seagoing vessels. It is the point of departure of the Congo Railway. The railway company has constructed two jetties at which steamers can discharge their cargo. Matadi is probably destined to eclipse both Boma and Banana as a port, but at present no statistics are available as to the number or tonnage of the vessels calling there. *Lukunga*, situated on the banks of the river of that name, a southern tributary of the Congo, about half-way between Matadi and Stanley Pool, was formerly the capital of the Falls district, and the chief recruiting station for porters on the Lower Congo. *Tumba*, the present capital of the district, is a station on the Congo Railway, the half-way house between Matadi and Stanley Pool, where the trains stop for the night. It is about 117 miles from Matadi and 143 from Ndolo, the terminus of the railway on Stanley Pool. *Ndolo* is situated a short distance from the Pool, and has two channels by which vessels can enter and leave the port. Extensive works have been undertaken, and it is intended to make Ndolo the headquarters of the steamers that ply on the inland waterways. Quays and a slip for launching vessels have been constructed. *Leopoldville* is the capital of the Stanley Pool district, and was one of the earliest stations founded by the Association. It is situated about 7 miles from Ndolo on the flanks of Mount Leopold, and it is considered probable that it may some day supplant Boma as the headquarters of the administration, when the increased importance of the middle and upper river regions makes it necessary to move the centre of administration from the lower river. Other places of importance are *Luluaburg*, on the Lulua river; *Lusambo*, the capital of the Lualaba-Kasai district, on the Sankuru river; *Coquilhatville*, the capital of the Equatorial district, at the mouth of the Ruki; *Stanley Falls*, the principal station of the district of that name; *New Antwerp*, a thriving little town, the capital of the Bangala district, situated on the right bank of the Congo close to the 19th parallel of east longitude; *Banzyville*, the capital of the Mobangi district, on the river of that name; *Basoko*, at the junction of the Aruwimi and the Congo; and *Nyangwe*, which is beginning to recover some of the importance it possessed before it was destroyed in the Arab campaign of 1892-93. *Djabir* is the capital of the Welle district, and in the leased territories on the Upper Nile valley the principal places are *Rejaf*, *Lado*, *Dufile*, and *Wadelai*.

*Constitution.*—The Free State is an absolute monarchy, but the Sovereign has never set foot in his African territory, which is administered from Brussels. There is no "constitution," but King Leopold's power is circumscribed in certain directions by the General Act of Berlin, to which the Free State adhered in 1885, by which freedom of trade and free navigation of the Congo and its affluents are secured. Civil and criminal codes have been promulgated by decrees, and in both cases the laws of Belgium have been adopted as the basis of legislation, and modified to suit the special requirements of the Free State. In addition to the decrees, which are signed by the Sovereign and countersigned by the Secretary of State, provision is made for the issue of Regulations and Ordinances by the Governor-General. The Governor-General may, in case of urgency, issue an Ordinance suspending for a limited period a Decree issued by the Sovereign. Ordinances issued by the Governor-General remain in force for six months, at the termination of which period they expire, unless they have in the meantime been superseded by Decree. All Decrees are published in the *Bulletin Officiel*, which is issued monthly at Brussels. The Sovereign is assisted in the task of government by a Secretary of State, whose duty it is not only to countersign all Decrees, but to superintend their execution. There are three Departments of State, each presided over by a Secretary-General in subordination to the Secretary of State. These departments are:—(1) Foreign Affairs, (2) Finance, (3) Interior. There is also a Treasurer-General, and a chief of the Cabinet of the Secretary of State. All these officials have their headquarters at Brussels.

**Administration.**

The headquarters of the local administration are at Boma, on the lower river, the King being represented by a Governor-General, who is the head both of the naval and military authorities. He is assisted by a Deputy Governor-General, by a number of Inspectors, a Secretary-General, and several Directors. A Consultative Committee or Council of the heads of the various departments and higher officials advises the Governor-General on all matters which he may lay before it. There are seven departments of the Administration:—(1) Justice, (2) Transports, Marine and Public Works, (3) Superintendence of State Lands, (4) Agriculture and Industry, (5) Defence, (6) Force Publique, and (7) Finance. For administrative purposes the Free State is divided into 14 districts, each of which is governed by a Commissary, with a staff of Assistant Commissaries, Sub-Commissaries, and clerks. The districts are Banana, Boma, Matadi, Falls, Stanley Pool, Kwango Oriental, Mobangi, Stanley Falls, Lualaba-Kasai, Lake Leopold II., Equator, Aruwimi, Bangala, and Welle. In 1898 the territory in the valley of the Upper Nile leased from Great Britain was placed for administrative purposes under the same régime as the districts.

*Judicial Machinery.*—Until May 1897 the Upper Congo was under military law, but from that date civil law has been administered throughout the State, wherever the authority of the State extended. Courts of First Instance have been instituted in the various districts, and there is a Court of Appeal at Boma which revises the decisions of the inferior tribunals. There is a further appeal, in all cases where the sum in dispute exceeds a thousand pounds, to a Superior Council at Brussels composed of a number of jurisconsults, who sit as a Cour de Cassation. In consequence of repeated charges of the ill-treatment of natives being made against officers of the Administration, King Leopold instituted a Commission for the Protection of Natives, and nominated several missionaries of different denominations to serve on it. It is the duty of the Commission to report to the judicial authorities, or to the Governor-General, any cases of the ill-treatment of the natives which may come to the knowledge of its members.

*Religion and Instruction.*—The native population are pagans, fetish worshippers, and on a very low plane of civilization. The State makes no provision for their religious teaching, but by the Berlin Act missionaries of all denominations are secured perfect freedom of action. The State has established three agricultural and technical colonies for lads up to the age of fourteen. Each of these colonies, which are situated at Boma, Leopoldville, and New Antwerp, makes provision for the training of five hundred boys, who are recruited from those rescued from slavery, from orphans, and from children abandoned or neglected by their parents. Practical instruction is given in various subjects, but the main object is to provide recruits for the armed force of the State, and only such lads as are unfitted to be soldiers are drafted into other occupations. A few native children are sent to Belgium to be educated. Missionaries have displayed great activity on the Congo, and are encouraged by the Administration. In 1900 there were 300 missionaries, of whom 180 were Roman Catholics and 120 Protestants, scattered among 76 mission stations. The missionaries do not confine themselves to religious instruction, but seek to raise the general level of the native population. In many districts cannibalism is rife, and degrading ceremonies are practised. There are two Roman Catholic bishops, one of whom resides at Leopoldville, the other at Baudouinville, and Roman Catholic churches for the European population are maintained at Boma and Matadi.

*Finance.*—In the years that preceded the founding of the Congo Free State the funds for carrying on the work of the International Association of the Congo were provided by King Leopold out of

His Majesty's privy purse, and for some time after the recognition of the Free State this system was continued. Mr Demetrius Boulger states that, in the first ten years of his work on the Congo, King Leopold spent £1,200,000 from his private fortune. The first five years of the existence of the new State were greatly hampered by the provision of the Berlin Act prohibiting the imposition of any duties on goods imported into the Congo region, but at the Brussels Conference, in the summer of 1890, a declaration was signed by the Powers signatory to the Berlin Act authorizing the imposition of import duties not exceeding 10 per cent. *ad valorem*, except in the case of spirits, which were to be subject to a higher duty. By agreement with France and Portugal, a common tariff was adopted by these Powers and the Congo Free State. In the same year the Belgian Government agreed to advance 25 millions of francs without interest, 5 millions to be paid at once and the balance in annual payments of 2 millions spread over ten years. At the end of that period Belgium acquired the option of taking over the Free State as a Belgian colony. At the same time the King undertook to make an annual contribution of a million francs out of his privy purse to the revenue of the State. In addition to the 2 million francs per annum received from Belgium, the 1 million francs from the King, and the proceeds of the Customs, the State derives a small portion of its revenues from direct taxation of the European population, but it is mainly dependent on the profits derived from the State domains. The Free State is in fact a great commercial undertaking as well as a governing body. It has established plantations in various parts of the State domains, or Crown lands, but these are mainly in the experimental stage, and the bulk of the revenue from the State domains is derived from the collection of caoutchouc, or rubber, from the forest, and the trade in ivory. In 1886 the total revenue of the State only amounted to 74,261 francs. The following table shows the revenue and expenditure as set forth in the Budgets in 1891, the first year in which complete figures are available, and at intervals since that year :—

| Year. | Revenue. | Expenditure. |
|---|---|---|
| | Francs. | Francs |
| 1891 | 4,554,931 | 4,554,931 |
| 1895 | 6,004,764 | 7,370,939 |
| 1898 | 14,765,050 | 17,251,975 |
| 1899 | 19,966,500 | 19,672,965 |
| 1900 | 26,256,500 | 27,731,254 |

The Budget for 1900 estimated the revenue and expenditure as follows :—

| Revenue | | Expenditure. | |
|---|---|---|---|
| | Francs. | | Francs. |
| Advance by Belgium | 2,000,000 | Central Office | 110,360 |
| Grant by King | 1,000,000 | Dept. of Interior | 11,050,013 |
| Customs | 4,680,000 | ,, Finance | 15,423,681 |
| Transport, &c. | 3,800,000 | ,, Foreign Affairs and Justice | 158,000 |
| State Domain, &c. | 11,200,000 | | |
| Portfolio | 2,950,000 | | |
| Various | 626,500 | Contingencies | 989,200 |
| | 26,256,500 | | 27,731,254 |

The following table shows the rapid advance made in the revenue derived from the State domains :—

| Year. | From State Domains. |
|---|---|
| | Francs. |
| 1886 | 74,261 |
| 1891 | 1,319,145 |
| 1896 | 5,887,404 |
| 1900 | 11,200,000 |

In July 1887 bonds bearing interest at $2\frac{1}{2}$ per cent. were issued to the amount of 11,087,000 francs to represent sums advanced to the old Committee and Association, the advantage of which was taken over by the Free State. The bulk of these bonds were issued to King Leopold, but in January 1895 His Majesty cancelled the bonds in his possession, and in 1901 there only remained an indebtedness of 422,200 francs in respect of this issue. In 1888 and 1889 bearer bonds to the amount of 70 million francs were issued out of an authorized issue of 150 million francs. These bonds are redeemable in 99 years by annual drawings, and are entitled to an addition of 5 per cent. per annum when drawn. The Redemption Fund is administered by a Committee representing the bondholders. The Belgian Government in 1890 advanced the 25 million francs already referred to, without interest, as well as two further sums of 5,287,415 francs and 1,517,000 francs, the former to enable the State to repay a loan and so prevent the forfeiture of an immense territory which had been pledged as security to an Antwerp banker, and the latter to balance the 1895 Budget. In October 1896 a small loan of 1,500,000 francs was raised at 4 per cent., and in June 1898 a further sum of 12,500,000 francs was raised at the same rate of interest. The Central Administration has experienced considerable difficulty in adjusting the State's revenue and expenditure, and, apart from other considerations, it is extremely probable that the increasing difficulty of providing funds will oblige the Belgian Government to assume direct responsibility for the Congo territories.

*Defence.*—The Administration was at first compelled to recruit soldiers among races outside the State territories, but in 1886 a small beginning was made in recruiting among the local tribes. The greater part of the army consisted in 1901 of locally-raised levies, recruited partly by voluntary enlistment and partly by the enforced enlistment of a certain number of men in each district, who are selected by the Commissary in conjunction with the local chiefs. In 1899 the effective force was fixed at 11,850 men, divided into 23 companies, and commanded by 200 European commissioned officers and 241 sergeants. The term of service for volunteers does not exceed seven years, while the militiamen raised by enforced enlistment serve for five years on active service, and for two years in the reserve. The men are armed with the Albani, the officers with the Mauser rifle. There are seven camps of instruction, and the artillery includes Krupps, Maxims, and Nordenfeldts. A fort has been erected at Chinkakassa near Boma, commanding the river below the Falls, and there is another fort at Kinshassa on Stanley Pool to protect Leopoldville and the railway terminus. The Governor-General is Commander-in-Chief of the armed forces of the State, and the Commissaries are in command of the military forces in their districts. In the 1891 Budget the expenditure on the army was given at 2,271,628 francs; in 1896 it had risen to 4,820,793 francs; in 1898, to 6,870,631 francs; and in 1900, to 7,803,408 francs.

*Land and Production.*—On the 1st of July 1885 it was decreed that "unoccupied lands are considered as belonging to the State." There are three forms of ownership recognized in the Free State—(1) the right of the natives to land in their actual occupation; (2) private ownership by Europeans of land which they have acquired, and of which they are the registered owners; and (3) State ownership of all the land not included in either of the two former categories. The system of land registration adopted was based on the Torrens system, and offers great facilities for easy transfer. There is a separate department for the management of the Domain or Crown lands. Plots for factories and blocks of agricultural land are sold at certain fixed rates, but the main contribution to the State revenue from the Domain lands is obtained, as has been seen, from the collection of rubber and ivory. In 1891 and 1892 the State endeavoured to obtain a monopoly of the rubber trade, and circulars were issued to the Commissaries in certain districts instructing them that not only was the collection of rubber by the natives to be regulated, but that in future the natives were to be compelled to sell their rubber to the State. Vigorous protests by the private trading companies were made against this attempted violation of the freedom of trade secured by the Berlin Act, and eventually the circulars were withdrawn and an arrangement made by which certain areas were reserved to the State and certain areas to private traders; while the question of the régime to be established in the basins of the Lualaba, the Upper Lomami, and in Urua and Katanga was reserved until such time as these districts were more effectually brought under control.

***Resources.***

*Minerals.*—Comparatively little is known of the mineral wealth of the country. Iron is widely distributed, and worked in a primitive fashion. It has been found in the Manyanga country, the Manyema country, on the Upper Congo, in the Urua country, in the basins of the Kasai and the Lualaba, and in Katanga. Immense ironstone hills, estimated to contain millions of tons of ironstone of superior quality, have been reported in the south-eastern region. The wealth of Katanga in copper has been described by several travellers, and the expedition sent out in 1891 reported that the richest deposits are to be found in the southern districts on the bank of the Lufira river. Copper is also reported in other districts, such as Mpala and Ulvira on Lake

Tanganyika. Gold has been discovered in Katanga, but before the advent of Europeans was held in less repute than copper. Lead, tin (Mobangi basin), sulphur, and mercury are also reported to exist, but until the introduction of European methods it is impossible to say what are the mineral resources of the Congo region, and whether they can be worked at a profit.

*Animal and Vegetable Products.*—Elephant and hippopotamus ivory formed for some years the most important article of export. When Europeans first entered the Congo basin the natives were found to have large stores of "dead ivory" in their possession. These stores are still being drawn on for export, supplemented by the "live ivory" obtained by the killing of elephants in the present day. In July 1889, as a precaution against the extermination of the elephant, the King issued a degree prohibiting the killing of elephants without special permission. Large herds still exist in the Congo forests, especially in the eastern and north-eastern districts. A reference to the commercial statistics will show that ivory is still the second most important export from the Free State. It is, however, a bad second to caoutchouc, the rubber of commerce, which is obtained from the rubber-bearing liana—*Landolphia florida*—which exists in practically inexhaustible quantities. [illegible] the value of the rubber exports only amounted to 159,000 francs. In 1900 the value had risen to 28,973,505 francs. Palm oil, palm nuts, gum copal, and timber are other natural products which swell the volume of exports, though not at present to any considerable extent. Timber is as yet only exported to the value of between £3000 and £4000, but the vast forests contain many trees, the wood of which is sufficiently valuable to pay the cost of transport to Europe. Ebony, teak, African cedar, mahogany are a few only of the woods that abound on the Congo. Coffee and tobacco are found in a wild state, and there is an immense number of fruit-bearing trees, and of plants yielding spices and essences which may in time be turned to profitable account.

*Agriculture.*—Until the advent of Europeans the natives, except in the immediate neighbourhood of some of the Arab settlements, did little more than cultivate small patches of land close to their villages. They grew bananas, manioc, the Spanish potato, the sugar cane, maize, sorghum, rice, millet, eleusine, and other fruits and vegetables, as well as tobacco, but the constant state of fear in which they lived, both from their neighbours and from the Arabs, offered small inducement to industry. Future agricultural development will depend on the success which attends the efforts to turn the native into a regular labourer. Plantations have been established both by the State and by private companies, and already small quantities of coffee, cocoa, tobacco, and maize have been exported. There are no statistics of the number of domestic animals in the country, but there is a number of horses, mules, donkeys, cattle and pigs, and it is believed that cattle-rearing may be profitably undertaken in the eastern portions where the country rises towards the Mitumba Range, when the political conditions and improved transport arrangements make such an experiment possible.

*Industries.*—In some districts the natives possess considerable skill in working in wood, ivory, and metals, but the Congo industries are at present purely local. Iron and copper are extracted by certain tribes, which enjoy a practical monopoly of this kind of work. The knives, spears, and shields of native workmanship frequently show both ingenuity and skill, alike in design and in execution. European fabrics have, among the tribes nearest the coast, already affected the weaving of cloths by the natives, but over a great part of the State territory the natives still manufacture cloth from vegetable fibres. They employ four different colours, yellow, the natural colour, black, red, and brown, which are obtained by dyeing, and these colours they combine into effective designs. In some tribes a rude form of printing designs on cloth is practised, and on the Sankuru and Lukenye a special kind of cloth, with a heavy pile resembling velvet, is made by the Basongo-Meno and other tribes.

*Commerce.*—The following table shows the total exports under the headings—(1) Special Commerce, which includes only such articles as originate from the Congo Free State; and (2) General Commerce, which includes exports of all kinds from the Free State, whatever their place of origin:—

| Year. | Special. | General. |
|---|---|---|
| 1887 . . . | 1,980,441 | 7,667,949 |
| 1890 . . . | 8,242,199 | 14,109,781 |
| 1895 . . . | 10,943,019 | 12,135,656 |
| 1898 . . . | 22,163,482 | 25,396,706 |
| 1899 . . . | 36,067,959 | 39,138,283 |

The following table shows the value of the principal products exported from the Free State (Special Commerce) at three periods:—

| Articles. | 1887. | 1895 | 1899. |
|---|---|---|---|
| | Francs. | Francs | Francs |
| Caoutchouc . . | 116,768 | 2,882,585 | 28,100,917 |
| Ivory . . . | 795,700 | 5,844,640 | 5,834,620 |
| Palm nuts . . | 590,781 | 1,242,898 | 1,293,413 |
| Palm oil . . | 462,609 | 935,658 | 734,511 |
| Timber . . | . . | 12,200 | 91,312 |
| Miscellaneous . | 14,583 | 25,038 | 13,186 |
| | 1,980,441 | 10,943,019 | 36,067,959 |

The increasing importance of the trade with Belgium is shown in the following table, in which will be found the value of the general exports to Belgium, Holland, and Great Britain at three periods:—

| Country. | 1890 | 1895. | 1899. |
|---|---|---|---|
| | Francs. | Francs | Francs. |
| Belgium . . | 2,217,599 | 8,999,660 | 32,367,828 |
| Holland . . | 8,073,208 | 885,405 | 1,656,561 |
| Great Britain . | 833,941 | 592,496 | 281,593 |

The first year for which full statistics of imports are available is 1893. The following table shows the Special and General Imports in that year and in two subsequent years. "Special" imports are goods intended for consumption immediately on their arrival, or on their being taken out of the entrepôt:—

| Year. | Special. | General. |
|---|---|---|
| | Francs. | Francs. |
| 1893 . . . | 9,175,103 | 10,148,418 |
| 1897 . . . | 22,181,462 | 23,427,197 |
| 1899 . . . | 22,325,846 | 27,102,581 |

Of the special imports in 1899, Belgium sent 15,592,745 francs; Great Britain, 2,922,739; Germany, 1,359,688; and Holland, 882,426. The principal articles imported in 1899 were textile fabrics and clothing, 5,147,610 francs; food substances, 3,887,912; steamers and machinery for steamers, 2,704,819; drinks, 1,718,627; metal and metal goods, 1,667,391; machinery other than for steamers, 1,492,310; arms, ammunition, &c., 932,073.

*Shipping and Navigation.*—There is a fortnightly service of steamers between Antwerp and Boma and Banana. There is also frequent steam communication with Liverpool, Hamburg, Rotterdam, and Lisbon. In 1899 there entered at Boma and Banana 192 seagoing vessels of 369,645 tons, and cleared 197 vessels of 375,715 tons. Of the tonnage entered, 191,843 was Belgian; 79,037, British; and 65,682, German. Of the tonnage cleared 189,933 was Belgian; 85,588 was British; and 67,113, German. During the same year 440 coasting vessels of 19,838 tons entered, and 451 vessels of 20,557 tons cleared from the same ports.

*Internal Communications.*—From the mouth of the Congo to the beginning of the rapids, which render the river unnavigable—a distance of about a hundred miles—the State maintains a fleet of seven steamers, in which passengers and goods are transported from the larger ocean-going steamers to Matadi, the point of departure of the railway. Matadi can, however, be approached by ships of considerable burden. Before the railway, all merchandise and goods for the interior had to be carried by porters from the coast to Stanley Pool. This method was both costly and inconvenient. The journey took three weeks. In 1887 the King granted to the Congo Industrial and Commercial Company a concession to construct a railway from the lower river to Stanley Pool, and, after a survey had been made, a Congo Railway Company was founded in Brussels in July 1889, with a capital of 25 million francs, of which the Belgian Government subscribed 10 millions. The moving spirit in this great enterprise was Colonel Thys. The work was begun almost immediately, but nearly insuperable difficulties were encountered, both engineering and financial. The line was finally completed in March 1898, and formally opened to traffic in the following July—nine years after its practical inception. The length of the line is 260 miles, and its inland terminus is at Ndolo on Stanley Pool, a short distance from Leopoldville. There

is a weekly service of three passenger trains in each direction, two days being occupied on the journey. The trains do not run during the night. The single through fare for Europeans is £20, and the freight charges are proportionately high, judged by European standards, though considerably below the charges which had to be paid before the railway was built. The cost of constructing and equipping the railway was 68 millions of francs. Other railways which are projected are a short line from Boma to the Lukulu river, for the purpose of opening up the Mayumbe province; a line or lines of railway between the navigable waters of the Upper Congo and Lake Tanganyika, with subsidiary lines which would develop the rich provinces of Manyema, Urua, and Katanga; and a railway in the Upper Welle district, for the purpose of opening up the north-eastern provinces and affording rapid access to the leased territories on the Upper Nile.

*Waterways.*—It is, however, in the splendid navigable waterways of the main Congo stream and its tributaries that the Free State has found, and will continue to find, its most powerful instrument in the development of its resources. For a full account of the river and its tributaries reference may be made to the article on the Congo River, but the following table, printed in the *Mouvement Géographique*, shows approximately the extent of the waterways open to navigation:—

| | | | |
|---|---|---|---|
| Congo (from Stanley Pool to Stanley Falls) | 990 miles | Lake Mantumba | 220 miles |
| Lefini | 70 ,, | Mobangi | 750 ,, |
| Kasai | 500 ,, | Nghiri | 140 ,, |
| Mfini Lukeyma | 680 ,, | Ibenga | 90 ,, |
| Lake Leopold II. | 590 ,, | Lebai | 60 , |
| Kwango | 220 ,, | Ombéla | 50 ,, |
| Juma | 400 ,, | Kuangu | 80 ., |
| Sankuru | 400 ,, | Ruki | 530 ,, |
| Lubefu | 140 ,, | Momboyo | 370 ,, |
| Lubi | 60 ,, | Lulonga | 400 ,, |
| Lulua | 160 ,, | Lopori | 280 ,, |
| Alima | 200 ,, | Mangala | 230 ,, |
| Dikwalea | 200 ,, | Rubi | 90 ,, |
| Sanga | 560 ,, | Aruwimi | 160 ,. |
| Goko | 100 ,, | Lomami | 470 ,, |
| Mambéré | 160 ,, | Total | 9350 miles |

The State maintains on these waterways a fleet of steamers which in 1900 numbered 26 vessels, for the purpose of preserving authority, provisioning the stations, promoting trade, and operating the postal service. Private trading companies, French, Belgian, and Dutch, and several Missionary Societies also maintain steamers on the inland waters, and the number is being rapidly increased since the docks have been built at Ndolo and the railway offers increased facilities for transport. Away from the railway and the waterways, transport is still mainly effected by porters.

*Posts and Telegraphs.*—The Free State is included in the Postal Union. There were in 1899, 20 post offices. Steamers leave Leopoldville at regular intervals with mails. In 1898 the postal authorities dealt with 103,032 letters, papers, and other postal matter in the internal service, and with 343,077 in the external service. There is not as yet any direct cable communication with Europe, messages being sent either *viâ* St Thomas or *viâ* St Paul de Loanda. In 1893 a Decree was issued authorizing the construction of a telegraph line from Boma to Lake Tanganyika. In 1895 the line had been made as far as Matadi, and in 1898 it reached Stanley Pool simultaneously with the railway. The line is an aërial one, and is now being carried up the banks of the river towards Stanley Falls, while an expedition under Mr Mohun, an ex-Consul of the United States, was in 1900 engaged in constructing the line from the Tanganyika end. In 1898 a Decree authorized the construction of two branch lines to Rejaf, in the Upper Nile valley, and to Katanga. There is a telephone from Matadi to Stanley Pool, following the railway line.

*Trading and Exploring Companies.*—There are no banks in the Free State, financial operations being conducted either by the State or by the private companies which have been founded principally by Belgian capitalists. Mr A. J. Wauters, Secretary-General of the Compagnie du Congo pour le Commerce et l'Industrie, which was established in December 1886, and has promoted several subsidiary companies, including the Congo Railway Company, says that in 1898 there were 25 companies represented in the Free State, which had been founded in Belgium, Holland, and Portugal, with a total capital of about 60 millions of francs. Half of this sum was represented by the capital of the railway company, the next largest companies in point of capital being the Belgian Company of the Upper Congo, with a capital of 5 millions of francs, and the Katanga Company with 3 millions. There were other five companies, with their headquarters in the Free State, which had been founded by virtue of special Decrees issued by King Leopold, and were subject to the law of the Congo Free State. The capital of two of these companies is not stated, but the other three have a joint capital of 6½ millions of francs. By a Decree issued on the 7th of February 1896 the King authorized the issue of State notes payable to bearer, and a first issue of 400,000 francs was sanctioned. These notes are payable at the State Treasury at Brussels, and are accepted by the State in payment of moneys due to it.

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## Congo (French). See French Congo.

**Congregationalism.**—Congregationalism as a designation of a Christian denomination has of late in some respects modified its significance. In Great Britain there is to be observed among Congregationalists a growing tendency towards a mutual connexion or combination of churches, as distinguished from a bare Independency. This movement is seen not only in the multiplying of conventions and conferences for religious and educational purposes, but also in more permanent forms of ecclesiastical federation. It appears in the increased vigour and influence of the Congregational Union of England and Wales, which are manifest, for example, in the series of volumes entitled *Congregational Lectures*, together with the Hymnals, all of which have been issued under its auspices. The merging of the Evangelical Union of Scotland in the Scottish Congregational Union is a circumstance illustrating the prevailing tendency. It may be added that the participation of the British Congregational

***Great Britain.***

churches with their foreign brethren of the same ecclesiastical form in two international councils, is one sign of the prevailing disposition to unite with the continued self-government of each local church a closer connexion with churches abroad as well as at home. The various local unions of Congregationalists in England likewise indicate a spirit which is in marked contrast with the isolation of earlier times. It is to be observed, however, that the system of councils, with their part not only in the adjustment of differences but also in the ordination and installation of ministers—the system which has been in America a distinguishing feature of Congregationalism,—has not gained a place in the British Congregational churches. The work accomplished by Congregationalists in England during the last few decades in providing new means of education, in particular for the education of ministers, is worthy of special remark. The establishment of Mansfield College at Oxford, by the transformation of Spring Hill College, Birmingham, through the act of Dr Dale and his co-trustees, was an event of much consequence in its direct effect in elevating the character of the ministry, not to dwell on its stimulating influence in other directions. The newly constituted University for London is of much service to Congregationalists, as well as to other Nonconformists, by having a Faculty of Theology, and by affiliating their theological colleges, all of whose professors are recognized as theological teachers. In 1870 there were 3069 Congregational churches in Great Britain and Ireland, in 1900, 4851; in 1870, 2468 ministers, in 1900, 3132: in the British colonies, in 1870, 296 churches, in 1900, 765; in 1870, 236 ministers, in 1900, 459. In 1900 in Great Britain and Ireland there were 1,733,065 church sittings, and 415,664 church members; 684,006 Sunday-school pupils, 64,334 teachers, and 5484 lay preachers.

Congregationalism in America has spread from New England, its primitive home, over the West to the Pacific, but has never had more than a slight foothold in the Southern States of the Union. The remarkable junction or fusion of the Independents or "Separatists" who emigrated from Leyden to Plymouth, Massachusetts, with the Puritan Nonconformists of Massachusetts Bay, modified Independency by the introduction of positive fraternal relations among the churches. This gave rise to Congregationalism in the more proper sense of the term. Beyond the limits of New England the progress of the denomination was a good deal hindered for a long period by the willingness of New Englanders going West either to join the Presbyterians, with whom they were substantially agreed in doctrine, or to combine with them in a mixed scheme of policy in which the Presbyterian element was uppermost. It was not until about 1850 that American Congregationalists began to draw more closely together, and to propagate in the Western States and Territories their own distinctive policy. They have since established not a few colleges and a number of well-organized theological seminaries, which have exerted much power in building up their communion. Meanwhile, without giving up the main principle of the autonomy of the local church, they have developed in various ways an active disposition to co-operate as a united religious body. This is seen in the organization of strong voluntary societies for the promotion of education and the increase of the ministry, and for the prosecution of missions. To these organizations a great deal of money is annually contributed. Their public services bring together large assemblies, which meet from year to year in different cities, often widely remote from each other. This tendency to denominational union is specially manifest in the institution of the National Council, which convenes at intervals of three years, and is composed of ministers and lay delegates, representing the churches. The Council, like minor councils which it is the old custom to call together to consider matters of local concern, is each time dissolved at its adjournment. It is possessed of no authority. Its function is to deliberate on subjects of common concern to the entire denomination, and to publish such opinions and counsels as a majority may see fit to send forth to the churches. The first of the National Councils (1865) issued a brief statement of doctrine, descriptive of the religious tenets generally accepted by the denomination. Later (1883) a large committee, previously appointed, framed a more full Confession of Faith, with the same end in view. Of course neither of these creeds was in the least binding upon ministers or upon churches, except so far as in each instance they might be adopted. The movement in the direction of union has been still further promoted by the two International Councils referred to above, in which the American Congregationalists have met the representatives of their brethren in Great Britain and its Colonies having the same faith and polity. In the different States, Conferences, composed likewise of representatives of the several churches and their pastors, have sprung up. These meet at stated intervals for the consideration of practical subjects of moment, and for the promotion of a religious spirit. There is a tendency, moreover, to accord to the Conferences the function of determining the tests of ministerial standing in the Congregational denomination. In some of the States the licensing of preachers, which was formerly left to the voluntary associations of ministers in the different localities, has been made a function of the State Conferences. At the very first, in New England, the theory was held that a minister, on ceasing to be the pastor of a particular church, falls into the rank of laymen. But the view was very soon adopted, and since has universally prevailed, that a minister in such cases still retains his clerical character. In later times the measure of authority conceded to a pastor as the shepherd of a flock has been much diminished in consequence of the gradual development of democratic feeling in both minister and congregation. This loss of clerical prestige has been in no small degree promoted by the increasing habit of dispensing with a form of installation, and of substituting for a permanent pastorate, instituted with the advice and consent of a council, an engagement to serve as a minister for a fixed term of one or more years. Under this custom of "stated supplies" ordination may be granted to those whose ministry in a particular church is made and dissolved by no other process than a mutual agreement. The Congregational churches, as distinct from the churches retaining the same polity, but separated by the adoption of Unitarian opinions, have in times past professed to be Calvinists of stricter or more moderate types. But as early as 1865, Arminians were welcomed to Congregational fellowship. In the last few decades, with the spread in the community of innovations in doctrinal and critical opinions, a wider diversity of belief has come to prevail, so that "Evangelical," in the popular sense of the term, rather than "Calvinistic," is the epithet more suitable to apply to the American Congregational preachers and churches. The *Year-Book* for 1900 reported the total number of communicants in all the States at 629,874, the number of Sunday-school scholars as 682,907, the total number of ministers as 5604, the amount of benevolent contributions by the churches as $2,110,413. Within the denomination are seven theological seminaries for the training of preachers.

***United States.***

The *Congregational Year-Book* for 1901 gave the following figures for Great Britain, Ireland, and the Channel Islands:—churches, branch churches, chapels, and mission stations, 4843; church members, 431,517; scholars, 693,347; ministers, 3123; evangelists

and lay pastors, 227; lay preachers, 5185. In comparing these figures with those for the preceding year, which are given in the body of this article, it must be borne in mind that in 1901 "99 churches in England and Wales have not made returns, and are not included in this summary," whereas in 1900 no less than 417 churches, including mission stations, were omitted; so that the figures for 1901 mark, if anything, a slight decline. The bulk of the foreign mission work of the British Congregationalists is done through the agency of the London Missionary Society. This society, although originally founded on an unsectarian basis by members of various denominations (including Churchmen), has become more and more closely connected with the Congregationalists, as other bodies came to have denominational societies of their own. In fact, at the present day the L.M.S. is "mainly dependent both for its missionaries and for its funds upon Congregationalists"; and a special responsibility for the society was formally recognized by the Congregational Union at the meeting held at Hull in the autumn of 1889. (G. P. F.)

**Congreve, Richard** (1818–1899), English Positivist, was born at Leamington, 4th September 1818, and was educated at Rugby under Dr Arnold, who is said to have expressed a higher opinion of him than of any other pupil. After taking first-class honours at Oxford and gaining a fellowship at Wadham, he spent some time as a master at Rugby, but returned to Oxford as a tutor, and there published a small work on the history of the Roman Empire of the West, and an annotated edition of Aristotle's Politics. About 1857 the attachment which he had conceived to the Positivist philosophy of Comte induced him to resign his fellowship, and the remainder of his life was devoted to the propagation of the Positive Philosophy. Unlike Mr Frederic Harrison, Professor Beesly, and Dr Bridges, he accepted Comte's teaching in its totality,—the worship and ritual, and the general philosophy,—and a split in the ranks of English Positivism was the result, Mr Harrison and his school setting up at Newton Hall on more independent lines than those of the complete surrender to Comte which Congreve inculcated. He translated several of Comte's works, and in 1874 published a large volume of essays, in which Comte's views as to the duty of Great Britain towards her foreign possessions, which usually consisted in renouncing them, were advocated with solemn earnestness, but without carrying conviction. In private life Mr Congreve was the most amiable and urbane of men. He died at Hampstead on the 5th of July 1899.

**Conjeeveram,** or **Kanchipur,** a town of British India, in the Chingleput district of Madras, 46 miles south-west of Madras by rail. Population (1881), 37,275; (1891), 42,548; (1901), 46,140, showing an increase of 8 per cent. The municipal income in 1897–98 was Rs.48,000. It has two high schools, two printing-presses, and several literary institutions.

**Conjuring.** See Magic.

**Conkling, Roscoe** (1829-1888), American senator and lawyer, was born in Albany, N.Y., on the 30th of October 1829. He was admitted to the Bar in 1850, and in 1858 was elected as a republican representative in Congress. Except during the years 1863 and 1864 he remained in the House until 1867, when he was chosen for the Senate. His abilities, aggressive leadership, and a haughty bearing always attracted much attention. In the republican national convention of 1876 he was a candidate for nomination for the Presidency. In 1881 he resigned his senatorship and sought re-election by the state legislature as a personal vindication, because President Garfield, without consulting him, had appointed a political opponent as collector of the port of New York. Being unsuccessful, he took up the practice of law in New York City, and appeared in some very important cases. He died in New York City, 18th April 1888.

**Connaught, H.R.H. Arthur William Patrick Albert,** Duke of, (1850– ——), third son and seventh child of Queen Victoria, was born at Buckingham Palace on 1st May 1850. Being destined for the army, the young prince was entered at the Royal Military College, Woolwich, in 1866. He received his commission on the 19th June 1868, being gazetted to the Royal Engineers. In the following November he was transferred to the Royal Artillery, and on the 3rd August 1869 to the Rifle Brigade. He got his company in 1871, and changed to the 7th Hussars in 1874; was promoted major in 1875, and returned to the Rifle Brigade as lieutenant-colonel in September 1876. He was promoted colonel and major-general in 1880, lieutenant-general in 1889, and general in 1893. He accompanied the expeditionary force to Egypt in 1882, and commanded the Brigade of Guards at the battle of Tel-el-Kebir (medal and clasp); he was mentioned three times in despatches, received the C.B., and was thanked by Parliament. In 1886 the duke went to India and commanded the Bombay army until 1890, when he returned home and was appointed to the command of the Southern District from 1890 to 1893, and to that of Aldershot from 1893 to 1898. On the departure of Lord Roberts for South Africa, the duke succeeded him as Commander-in-Chief of the forces in Ireland, 9th January 1900; and in 1901 was given the command of the Third Army Corps. On attaining his majority in 1871, an annuity of £15,000 was granted to Prince Arthur by Parliament, and in 1874 he was created Duke of Connaught and Strathearn and Earl of Sussex. On 13th March 1879 he married H.R.H. Princess Louise Marguerite of Prussia, third daughter of Prince Frederick Charles, and received an additional annuity of £10,000. The marriage at Windsor Castle was the most magnificent that had taken place there since the wedding of the Princess Royal in 1858. The Duke and Duchess represented Queen Victoria at the coronation of the Czar Nicholas II. at Moscow, in May 1896, when eight-and-twenty foreign princes were present.

**Conneaut,** a village of Ashtabula county, Ohio, U.S.A., on the shore of Lake Erie, on three railways. It has a good harbour and is a shipping-point of some importance. It was the first settlement in the Western Reserve. Population (1890), 3241; (1900), 7133.

**Connecticut.**—One of the New England States of the American Union, with a land area (according to the Census Bulletin) of 4845 square miles, or of 5004 according to the official survey of 1893. The highest land is the summit of Bear Mount in Salisbury, Litchfield county, 2355 feet above the mean high tide point at the sea. The highest elevation reached by any railway in the State is 1335 feet, about two miles east of Norfolk. According to the official survey (1893), 38½ per cent. of the State was in woodland. Population (1870), 537,454; (1880), 622,700; (1890), 746,258; (1900), 908,420. Of the total population in 1900, 454,294 were males and 454,126 females; 238,210 were foreign-born and 15,996 coloured (including 15,226 negroes, 599 Chinese, 18 Japanese, and 153 Indians). Out of 280,340 adult males 18,984 were illiterate; 16,696 of these being foreign-born. The death-rate in 1900 was 17 per thousand; (1890), 18·6. The average number of persons to the square mile in 1900 was 187·4. The State contains 24 incorporated cities or boroughs, with a population of over 5000 and with an aggregate population of 532,123. These figures show that 58·58 per cent. of the total population was urban. There were 5 cities with a population of 25,000 or over, namely, New Haven, Hartford, Bridgeport, Waterbury, and New Britain.

The General Assembly (Senate and House) is elected

biennially by a plurality vote, and meets at Hartford. There are 24 Senators and 255 members of the Lower House, making 279 in all: 87 towns have 2 members of the House each, and 81 have 1 each. This difference in membership is of historic origin, depending on the establishment of the town, except that every town which the decennial census shows to have 5000 inhabitants is entitled to 2 members. With the shifting of population, many old towns with two members each are now smaller than younger towns, allowed only one each. The result has been a demand from the larger towns for more representation. On the other hand, it has been contended that the town is the political unit under the Connecticut scheme of government, that one body is designed to be popular and the other representative, and that the two Houses of the National Congress, agreed upon in the Constitutional Convention of 1787 under the "Connecticut Compromise," illustrate the same scheme with the titles reversed. Several constitutional amendments have accordingly been proposed, including one for the plurality election of State officers. To elect these a clear majority of the votes cast was, in 1901, still required. Otherwise the General Assembly selects one from the two highest candidates for each position. Woman suffrage is permitted in school matters, but very few women vote. Local option prevails as to liquor-selling, and in 1899 there were 79 licence and 89 no-licence towns. The executive officers of the State, chosen biennially, are governor, lieutenant-governor, secretary, treasurer, comptroller. There is also an attorney-general, elected once in four years. This office was established in 1898. State supervision is very general; 21 State boards and commissions having offices in the State House. In 1883 a State board of pardons was established; up to that time pardons had been granted by the General Assembly.

*Finance.*—The funded debt in 1901 was $2,131,100, of which $495,000 was at 3½ per cent. and $1,636,300 at 3 per cent. From this should be deducted the cash in hand, usually from $500,000 to $750,000. Except for the military commutation tax of $2 per caput on male citizens between 21 and 45 years of age, the revenue of the State since 1890 has been collected by indirect taxation and almost entirely from corporations. The receipts for the year ending September 30, 1899, were $2,749,273, which, however, included the income of various funds. The direct tax laid upon the towns was suspended in 1891. A rapid increase followed in State expenditures, from $1,757,512 in 1891 to $2,550,080 in 1897—an increase of 50 per cent., while the income increased only about 30 per cent. In 1898 and 1899, however, the income exceeded the receipts by ample margins. While there is no direct State tax, citizens are taxed locally by the county, the town, the city, or the borough, and the school district. Many of the tax laws are antiquated, and the need of general revision has long been urged.

*Roads.*—In 1895 a "good roads movement" began, under which in the first six years the State expended about $700,000, contingent upon contributions of about $500,000 from town and county treasuries. When the work began the highway commission reported 5558 miles of main roads and 8530 of side roads in the State—total, 14,088 miles. About 250 miles were improved between 1895 and 1901.

*Railways.*—There are 1013·35 miles of steam railway. Of these all but the New London Northern, from New London to Brattleboro, Vt. (56·1 miles in Connecticut); the Central New England, from Hartford to the Hudson (67·25 miles in Connecticut); and the South Manchester, from South Manchester to Manchester (2·25 miles), are included in the system of the New York, New Haven, and Hartford Railroad Company, which controls 2047·19 miles, of which 887·75 are in Connecticut. It controls all the rail routes between New York and Boston, and the entire Old Colony system in Massachusetts, and also practically all the steamboat lines on Long Island Sound. Between New Haven and New Rochelle, N.Y., where the line divides, the company has four tracks. The company has an authorized capital of $100,000,000, of which in 1899 about $55,000,000 had been issued. It had then 8654 stockholders, of whom 2620, holding $16,036,500 of the stock, were residents of Connecticut. The majority of its board of directors must be citizens of Connecticut. It reported 28,211 employees in 1899. In that year the railways of the State carried 50,269,468 passengers and 15,891,642 tons of freight. Efforts have been made for several years to abolish grade crossings of rail and waggon roads, but in 1899 there still remained 988 of these death-traps.

*Other Means of Communication.*—The first successful trolley road was established in Connecticut in 1885. In 1899 there were 31 companies working 462·92 miles of trolley, not counting sidings, and these roads carried that year 59,084,702 passengers. Their capital stock aggregated $12,715,948, and their bonded debt $10,608,800. They had 2465 employees. During 1899 the trolley roads injured 324 persons, and the steam roads 327. The trolley has brought wide outlying rural districts into close touch with the cities, and has connected centres of population, so as to make them practically one community. The store, the church, the theatre, and the farm have all received a new impulse from the movement. Besides the trolley, a "third rail" electric system is being developed in Connecticut. The New York, New Haven, and Hartford Railway, at a power-house at Berlin, produces electricity, which is carried on a central rail between the rails of the road bed of one of its regular tracks. The power is taken up by a shoe that travels along the third or middle rail, and heavy cars on the solid road bed can make very fast time. The third rail operates between New Britain and Berlin, 3 miles, and between Hartford and Bristol, through New Britain, 17 miles. Electric lighting is very general, and in many instances water-power is utilized for this purpose.

*Manufactures.*—The great demand for copper wire and for other parts of electric outfit has given an immense impetus to the copper and brass mills, which are the largest consumers of copper in the world, and are situated chiefly in the Naugatuck Valley in Waterbury, Torrington, and Ansonia. The State holds a leading place in the production of silk, woollen, and cotton goods, fire-arms and ammunition, edge tools, hardware, needles, bicycles, motor-carriages, rubber goods, thread, sewing machines, clocks, hats, silverware, knit goods, &c. Connecticut maintains its reputation for inventions, and for the skill of its mechanics. In 1900 the number of manufacturing establishments in the State (excluding 977 having a product of less than $500 each, but including 4630 classified as hand-trades) was 9128, with a total capital (including land, buildings, machinery, &c., but not capital stock) of $314,696,736. There were 9981 salaried employees receiving salaries amounting to $12,286,050; an average number of 176,694 wage-earners, receiving total wages of $82,767,725; and 9381 proprietors and firm members. The cost of materials (including mill supplies, freight, fuel, &c.) was $185,641,219. The added values of the products in the different establishments amounted to $352,824,106. If from this gross value be deducted, in order to avoid duplication, the value ($144,809,525) of materials purchased in a partly manufactured form—where the finished product of one industry is used later as the raw material for another, the total net value of the products is found to be $208,014,581. The most important industries and the value of their products were: textile manufactures, $49,265,752; brass manufactures (including rolled brass and copper), $48,526,868; foundry and machine shops products, $18,991,079; hardware, $16,301,198; plated and britannia ware, $9,538,397.

*Banks.*—There were, in 1899, 88 mutual savings banks, with deposits of $174,135,195 belonging to 393,137 depositors. Of these depositors 341,362 had each less than $1000 on deposit, whose total deposits amounted to $68,420,853. These banks do much to encourage thrift. They pay as a rule 4 per cent. interest on the deposits. In June 1900 there were 81 national banks in the State; capital, $20,747,070; surplus and undivided profits, about $11,000,000; deposits, $42,700,000. There were also 8 State banks; capital, $2,240,000; surplus, &c., $864,000; deposits, $6,726,563; and thirteen trust companies; capital, $1,317,800; surplus, $880,000, deposits, $7,420,608. The total deposits of all the banking interests were thus $230,982,366.

*Insurance.*—The 8 stock fire insurance companies had in 1900 $10,250,000 of capital, $13,895,791 of net surplus, and $41,956,826 of assets, and insured about $2,700,000,000 of property. Besides these were 17 mutual companies with $2,000,000 of assets and $111,500,000 of risks. The fire losses paid by Connecticut companies in 1899 were $12,417,000. In life insurance, 6 companies with assets of $156,972,000, including $15,656,721 of surplus, were in 1900 insuring 356,661 persons for a total of $507,245,300. The assets of the fire and life companies of the State together exceed $200,000,000. It was in Connecticut that accident insurance was first undertaken in the United States. The deposits of the banks and the assets of the life and fire insurance companies aggregate nearly $475,000,000.

*Education.*—Almost every town grew up around a church, and every town has also its school. Education has been an object of concern from the founding of the colony, and the State ranks among the first in this respect. Yale University, at New Haven, founded in 1701, has a total of 2542 students and a faculty of 271. Trinity College at Hartford, founded in 1823, reported for 1900, 137 students and 24 instructors. Wesleyan University at Middletown, founded in 1829, had 339 students and a faculty of 26. Common school education is compulsory between the ages of

7 and 16. In 1899 there were 1546 public schools, 76 high schools, 77 kindergartens, and 19 evening schools; also 177 private schools, with 30,083 registered scholars. The State furnishes $200 to establish, and up to $100 a year to maintain, a free public library in any town that will contribute an equal sum. In 1899, 6 years after the passage of the law, 51 towns had established free libraries under its provision, and there were 40 others, making 91 free public libraries in the State, with 566,706 volumes and a yearly circulation of 1,609,788 volumes. There were also 43 "travelling libraries," which move from one town to another, the gifts of individuals or associations. (C. H. CL.)

**Connellsville,** a borough of Fayette county, Pennsylvania, U.S.A., situated in the south-western part of the state, on Youghiogheny river and on branches of the Pennsylvania and the Baltimore and Ohio Railways, at an altitude of 915 feet. It is the centre of the well-known Connellsville coking coal region, in which most of the coking coal used in iron-smelting in the United States is produced. Out of 47,142 coking ovens in the United States in 1899, 19,294 are in this district; while of the total amount of coke produced in the Union (19,640,798 tons), not less than 10,389,335 tons were made in this district. Population (1880), 3609; (1890), 5629; (1900), 7160.

**Connersville,** capital of Fayette county, Indiana, U.S.A., situated on Whitewater river, in the eastern part of the state, at an altitude of 828 feet. It is at the intersection of the Cincinnati, Hamilton, and Dayton, the Cleveland, Cincinnati, Chicago, and St Louis, and the Fort Wayne, Cincinnati, and Louisville Railways. Population (1880), 3228; (1890), 4548; (1900), 6836.

**Conscience, Hendrik** (1812–1883), the most eminent of modern Flemish writers, was born at Antwerp on the 3rd of December 1812. Although he invariably signed his name Hendrik, his baptismal name was Henri. He was the son of a Frenchman, Pierre Conscience, from Besançon, who had been *chef de timonerie* in the navy of Napoleon, and who was appointed under-harbourmaster at Antwerp in 1811, when that city formed part of France. Hendrik's mother was a Fleming, Cornelia Balieu. When, in 1815, the French abandoned Antwerp after the Congress of Vienna, they left Pierre Conscience behind them. He was a very eccentric person, and he took up the business of buying and breaking-up worn-out vessels, of which the port of Antwerp was full after the peace. The child grew up in an old shop stocked with marine stores, to which the father afterwards added a collection of unsaleable books; among them were old romances which inflamed the fancy of the child. His mother died in 1820, and the boy and his younger brother had no other companion than their grim and somewhat sinister father. In 1826 Pierre Conscience married again, this time a widow much younger than himself, Anna Catherina Bogaerts. Hendrik had long before this developed an insatiable passion for reading, and revelled all day long among the ancient, torn, and dusty tomes which passed through the garret of "The Green Corner" on their way to destruction. Soon after his second marriage Pierre took a violent dislike to the town, sold the shop, and retired to that Kempen or Campine which Hendrik Conscience so often describes in his books—the desolate flat land that stretches between Antwerp and Venloo. Here Pierre bought a little farm, with a great garden round it, and here, while their father was buying ships in distant havens, the boys would spend weeks, and even months, with no companion but their stepmother. At the age of seventeen Hendrik left the paternal house in Kempen to become a tutor in Antwerp, and to prosecute his studies, which were soon broken in upon by the revolution of 1830. He volunteered as a private in the new Belgian army, and served in barracks at Venloo, and afterwards at Dendermonde, until 1837, when he retired with the grade of sergeant-major. Thrown in this way with Flemings of every class, and made a close observer of their mental habits, the young man formed the idea of writing in the despised idiom of the country, an idiom which was then considered too vulgar to be spoken, and much less written in, by educated Belgians. Although, close by, across the Scheldt, the Dutch possessed a rich and honoured literature, many centuries old, written in a language scarcely to be distinguished from Flemish, a foolish prejudice denied recognition to the language of the Flemish provinces of Belgium. As a matter of fact, nothing had been written in it for many years, when the separation in 1831 served to make the chasm between the nations and the languages one which could never be bridged over. It was therefore with the foresight of a prophet that Conscience wrote, in 1830 itself, "I do not know how it is, but I confess I find in the real Flemish something indescribably romantic, mysterious, profound, energetic, even savage. If I ever gain the power to write, I shall throw myself head over ears into Flemish composition." His poems, however, written while he was a soldier, were all in French. He received no pension when he was discharged, and going back idle to his father's house, he determined to do the impossible, and write a Flemish book for sale. A passage in Guicciardini fired his fancy, and straightway he wrote off that series of scenes in the war of Dutch Independence which lives in Belgian literature under the title of *In't Wonderjaar 1566*; this was published in Ghent in 1837. His father thought it so vulgar of his son to write a book in Flemish that he turned him out of doors, and the celebrated novelist of the future started for Antwerp, with a fortune which was strictly confined to two francs and a bundle of clothes. An old schoolfellow found him in the street and took him to his home; and soon various people of position, amongst them the eminent painter, Wappers, interested themselves in the brilliant and unfortunate young man. Wappers even gave him a suit of clothes, and presented him to the King, who expressed a wish, which was not immediately carried out in consequence of some red tape, that the *Wonderjaar* should be added to the library of every Belgian school. But it was under the patronage of Leopold I. that Conscience published his second work, *Fantasy*, in the same year, 1837. A small appointment in the Provincial Archives relieved him from the actual pressure of want, and in 1838 he made his first great success with the historical romance called *The Lion of Flanders*, which still holds its place as one of his masterpieces. To this followed *How to become a Painter*, 1843; *What a Mother can Suffer*, 1843; *Siska van Roosemael*, 1844; *Lambrecht Hensmans*, 1847; *Jacob van Artevelde*, 1849; and *The Conscript*, 1850. During these years he lived a variegated existence, for some thirteen months actually as an under-gardener in a country house, but finally as Secretary to the Academy of Fine Arts in Antwerp. It was long before the sale of his books, greatly praised but seldom bought, made him in any degree independent. His ideas, however, began to be generally accepted. At a Flemish Congress which met at Ghent so early as 1841, the writings of Conscience were mentioned as the seed which was most likely to yield a crop of national literature. Accordingly the patriotic party undertook to encourage their circulation, and each fresh contribution from the pen of Conscience was welcomed as an honour to Belgium. In 1845 Conscience was made a Knight of the Order of Leopold. To write in Flemish had now ceased to be regarded as a proof of vulgarity; on the contrary, the tongue of the common people became almost fashionable. The poet K. L. Ledeganck (1805–1849), who celebrated the "Three Sister-Cities" of Ghent, Bruges, and Antwerp, was the

first to follow in the steps of Conscience. Another national writer who, though much older than the novelist, became his eager disciple, was J. F. Willems (1793–1846), and Flemish literature began to live. In 1845 Conscience published a *History of Belgium*, but he was well advised to return to those exquisite pictures of Flemish home-life which must always form the most valuable portion of his repertory. He was now at the height of his genius, and *Blind Rosa*, 1850; *Rikketikketak*, 1851; *The Decayed Gentleman*, 1851; and *The Miser*, 1853, rank among the most important of the long list of his novels. These had an instant effect upon contemporary fiction, and Conscience had many imitators. Nevertheless, not one of the latter has approached Conscience in popularity, or has deserved to approach him. In 1855 the earliest translations of his tales began to appear in English, French, German, and Italian, and his fame became universal. In 1867 the post of Keeper of the Royal Belgian Museums was created, and this important sinecure was given to Conscience. He continued to produce novels with great regularity, and his separate publications amounted at last to nearly eighty in number. He was now the most eminent of the citizens of Antwerp, and his seventieth birthday was celebrated by public festivities. After a long illness he died, in his house in Antwerp, on the 10th of September 1883; he was awarded a public funeral. The portraits of Conscience present to us a countenance rather French than Flemish in type, with long smooth hair, contemplative dark eyes under heavy brows, a pointed nose, and a humorous broad mouth; in late life he wore the ornament of a long white beard. Whether the historical romances of Conscience will retain the enormous popularity which they have enjoyed is much less than certain, but far more likely to live are the novels in which he undertook to be the genre-painter of the life of his own day. In spite of too rhetorical a use of soliloquizing, and of a key of sentiment often pitched too high for modern taste, the stories of Conscience are animated by a real spirit of genius, mildly lustrous, perhaps, rather than startlingly brilliant. Whatever glories may be in store for the literature of Flanders, Conscience is always sure of a distinguished place as its forerunner and its earliest classic. (E. G.)

**Consett,** a town and railway station in the north-western parliamentary division of Durham, England, 12 miles north-west of Durham city and 14 south-west of Newcastle. Besides the parish church there are Baptist, Wesleyan, and other chapels; also a town-hall. There are extensive collieries in the district, and large ironworks. Area of urban district, 1024 acres. Population (1891), 8460; (1901), 9694.

**Conshohocken,** a borough of Montgomery county, Pennsylvania, U.S.A., situated in 40° 04′ N. lat. and 75° 18′ W. long., on the north bank of Schuylkill river, 13 miles north-west of Philadelphia, in the south-east part of the state. It is entered by the Pennsylvania and the Philadelphia and Reading Railways. Population (1880), 4561; (1890), 5470; (1900), 5762.

**Constance,** a city in the grand duchy of Baden, on the south bank of the Rhine at its exit from the Lake of Constance, and 30 miles from Schaffhausen by rail. It stands at a height of 1316 feet above the level of the sea. The Vincent collection of painted glass in the chapter-house has now been sold. The Dominican convent has been converted into a hotel; in its tower John Hus was confined for three months, before he was burnt on 6th July 1415 on a field in the suburb of Brühl. In the market-place are two historical houses—one wherein Barbarossa signed the peace of Constance with the Lombard cities in 1183, and the other in which Frederick of Hohenzollern was in 1417 invested with the March of Brandenburg. The population of Constance was 21,363 in 1901.

S. J. Capper, *The Shores and Cities of the Bodensee.* London, 1881.—G. Gsell-Fels. *Der Bodensee.* Munich, 1893 (Bruckmann's illustrierter Reiseführer).—E. Issel. *Die Reformation in Konstanz.* Freiburg i/B., 1898.—F. X. Kraus. *Die Kunstdenkmaler des Kreises Konstanz.* Freiburg i/B., 1887.—J. Laible. *Geschichte der Stadt Konstanz.* Konstanz, 1896.

**Constance, Lake of,** or the "Swabian Sea," on the north-east frontier of Switzerland. According to the latest measurements, its area is 207 square miles (of which $81\frac{1}{4}$ square miles belonged to Switzerland, viz., $59\frac{3}{4}$ square miles to Canton Thurgau, and $21\frac{1}{2}$ square miles to Canton St Gall), its height above the sea-level 1309 feet, its greatest length 40 miles, its greatest depth 1014 feet, and its greatest width $7\frac{1}{2}$ miles.

**Constant, Benjamin** (1845–1902), French painter. See Schools of Painting (*France*).

**Constanța** (or Kustendji), a town and seaport of Rumania on the Black Sea, 140 miles by rail from Bucharest. The bridge at Cernavoda across the river Danube was opened by the king in 1896. A line of fast passenger steamers, owned by the Rumanian Government, in connexion with the Orient express and Ostend express, conveys passengers and mails to Constantinople. The town has greatly developed of late years, owing to its improved communications by land and sea, and is now much used as a summer bathing resort. The streets are clean and well kept. Constanța is on the site of the ancient Tomi, where Ovid lived and died in exile. There is a statue erected to his memory in the chief square of the town. Population (1895), 10,607; (1900), 12,725, about one-half of whom are of the Orthodox faith, and the remainder pretty equally divided between Roman Catholics, Moslems, Armenians, and Jews.

**Constantina,** a town and railway station of Spain, in the north of the province of Seville. Population in 1897, 9983. The neighbourhood is chiefly agricultural, with some mines, lead and iron, in the sierra not far off. The local industries are those connected with cork, wood, alcohol, and tanneries, and the market days every week are very animated. It is one of the most important towns of the province, though its public buildings offer nothing worthy of notice.

**Constantine,** capital of the department of the same name in the east of Algeria, picturesquely perched, 2130 feet above the sea, on a rock rising perpendicularly nearly 1000 feet from the bed of the Rummel, which surrounds it on the north and the east, while on the west the city is connected by an isthmus with the mainland. It is 54 miles by rail south by west of Philippeville, its seaport, and has railway connexion also with Algiers, Bona, Tunis, and Biskra. Important strategically, Constantine by its beauty of situation annually attracts crowds of visitors. There are no important buildings of recent erection. Railways have taken away from the city its monopoly of the traffic in wheat, though its share in that trade still amounts to from 10 to 12 million francs (£400,000–£480,000) a year. Its industry also is considerable, its peltry business employing 1000 persons and supplying the wants of 2 millions. It also manufactures woollen stuffs. There is a project to surround the city with capacious reservoirs, such as would transform the face of the country. The population in 1891 was 46,580, and in 1900 it was 51,997, of whom 18,387 were French. The indigenous element, numbering 28,000, grows faster than the colonial.

**Constantinople,** the capital of the Turkish Empire, situated on the strait between the Black Sea and the Sea of Marmora. The last quarter of the 19th

century wrought little change in the outward aspect of the city, but throughout that period, during the reign of Sultan Abdul Hamid II., many of the conditions of life in the Turkish capital underwent considerable alteration. This arises from the fact that Sultan Abdul Hamid's mode of life and method of government were wholly different from those of his predecessors. Constantly preoccupied with apprehension for his personal security, he transferred his abode, shortly after coming to the throne, from the palace of Dolma Baghtché, on the bank of the Golden Horn, where he did not feel safe, to Yildiz Kiosk, a pleasure resort of his predecessors on a hill behind Beshiktash, overlooking Pera, Stamboul, the lower Bosphorus, and the Sea of Marmora. The park is surrounded by a great wall, in some parts 50 feet high, and contains two small lakes, the one natural and the other artificial. Early in 1901 the Sultan, in order to extend the park towards Ortakeui, bought a large adjacent estate, consisting of a mansion and extensive grounds, which are now enclosed within the mural fence of Yildiz. Within this carefully guarded enclosure are numerous buildings, which include an observatory, baths, a museum of arms, a porcelain factory, a furniture manufactory, armouries, stabling for 150 horses, and a harness factory, besides a number of châlets and other fanciful edifices. The most conspicuous amongst these latter is the Merassim Kiosk, built specially for the occupation of the German Emperor on his first visit in 1889, and enlarged for his later visit in 1898. Some of the smaller châlets are used as prisons for political prisoners, or as houses of detention for persons undergoing


B. V. Darbishire & O. J. R. Howarth. Oxford, 1901.

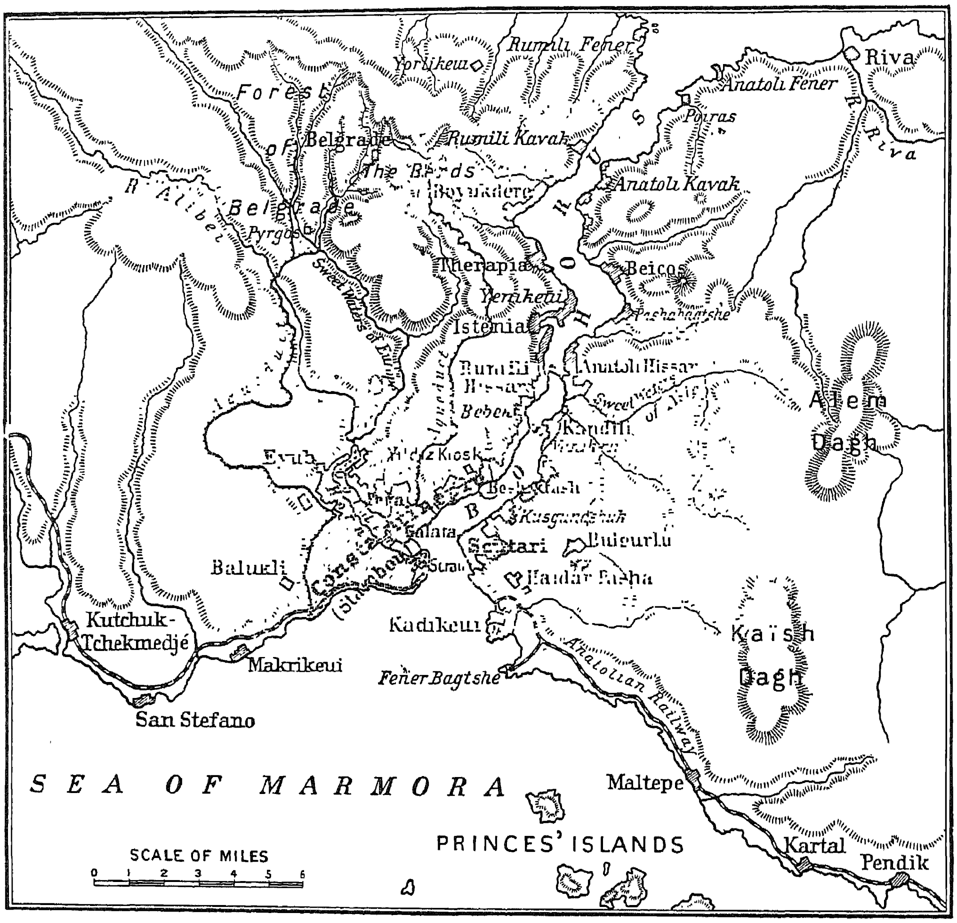
PLAN OF ANCIENT AND MODERN CONSTANTINOPLE.

inquisitorial treatment. Within the main enclosure, a second wall surrounds the kiosk which the Sultan, with his four principal wives, inhabits, and which he himself designed. About it are grouped smaller kiosks in which the other ladies of the harem reside. The doors of this inner barrier are all locked at sunset, and therein, protected by his bodyguard, the Sultan passes his nights in assured security. In March 1901 the Offices of the Privy Purse, from the windows of which—commanding a view of the road between the palace gateway and the Hamidieh Mosque—approved visitors witnessed the Selamlik procession on Fridays, were demolished by Imperial order, called forth by the Sultan's ever-increasing fear of assassination. The palace domain is guarded by two batteries of artillery, and by the whole of the 2nd division of the First Army Corps, composed of 12 battalions, each 600 strong. These are lodged in spacious barracks built on the outer side of the park wall, with a mosque adjacent thereto for the special use of the troops. The Sultan's guard consists of (1) the "Tufenkdjis," or bodyguard, of whom there are 94, Albanians and Circassians; (2) the "Silahsors," drilled soldiers, numbering about 300, Albanians and Bosniaks; (3) the "Hademés" (*garde de luxe*), employed only on State occasions, and comprising the musicians of the Palace, about 500 in number; (4) the "Tchaush," of whom there are between 50 and 60, and who are messengers as well as guards; (5) the Bekdjis or watchmen, numbering 200, who keep watch by relays all over the park by day and night.

The most important of the material changes since 1880

is the construction of the quays on each side of the Golden Horn. Begun in 1891 by a French company with a capital of nearly a million sterling, the quay was completed in 1899 on the Galata side to its full length of 756 metres, with a breadth of 20 metres; and the portion on the Stamboul side, of which the total length is 378 metres, was finished and opened in 1900. The appearance of the port is much improved by the demolition of the dilapidated structures which previously bordered either shore, and which are replaced by substantial buildings. Tramways have also conduced to the embellishment of the city, for—besides causing improvement in the streets they traverse—they have promoted much new building in salubrious localities, commanding fine prospects, which were previously out of reach. On both sides of the line, extending north-west of Pera, a large number of detached houses with gardens have been built, forming a new and extensive faubourg, which on one side reaches out in the direction of Eyub and the Sweet Waters of Europe, and on the other along the heights overlooking the lower Bosphorus and the Marmora. Excepting the streets traversed by the tramways, a few of those in which the departments of State are situated, and some of the suburban roads, the other highways and byways remain unimproved, wearing the old ragged pavement, destitute of footways, and flanked by buildings, mostly wooden, of mean design and more or less decayed.

The ravages of the great fire of 1870, which consumed 5000 buildings in Pera, have been almost, though not yet completely, made good. In the renovated quarters stone




SKETCH MAP OF THE ENVIRONS OF CONSTANTINOPLE.

buildings mostly replace the wooden structures which the conflagration swept away. All the dwelling-houses are stone-built, and of late the fashion has set in of building large and lofty blocks divided into suites of apartments. This tendency to erect costly and substantial buildings has been promoted by the increased facilities for insuring against fire. Year by year new insurance agencies have been established, and by 1900 no less than forty-three companies (about half of them British) were represented in Constantinople. Some new public buildings in conspicuous positions fix the eye in viewing the city from the sea. Such are the Armoury at Matchka, on the heights of Nishan-Tash, above Dolma Baghtché; the Imperial Ottoman Bank, in Galata; the offices of the Public Debt, in Stamboul; and the School of Medicine, between Scutari and Haidar Pasha.

The appearance of the Bosphorus has greatly faded in recent years, owing to the large number of *yalis* and *konaks* which, through the dispersal of many old Turkish families, have been left empty and become dilapidated. The new generation eschews the Bosphorus,—where the price of land is still nominally high, although there is no demand for it,—and has bought ground largely along the course of the Anatolian Railway, between the terminus at Haidar Pasha and the station of Pendik on the Marmora. This region, which is mild, picturesque, and well wooded and watered, with a very productive soil, is now overspread with newly-built houses of the better sort in more or less spacious gardens, all occupied by the Turks who built them. Since 1855, when Constantinople was much shaken and somewhat damaged by the earthquake which destroyed Brusa, the Turkish capital had not ex-

perienced any severe seismic convulsion until July 10, 1894. On that day there was a violent shock lasting nearly twenty seconds. The damage wrought by it was chiefly in the quarters lying between the Mosque of Sultan Ahmed and the Adrianople Gate. All the damage has been repaired, and the ruined part of the grand Bazaar has been rebuilt on a much better plan.

*Trade.*—The diminution of the trade of Constantinople caused by the territorial changes prescribed by the Congress of Berlin was heavily supplemented by that produced by the annexation of Eastern Rumelia to Bulgaria in 1885, as that province drew all its supplies of foreign merchandise from the capital from which a customs frontier now divides it. Of recent years, moreover, mainly owing to governmental interference with the passenger traffic between the capital and the Asiatic provinces, a large proportion of the provincial dealers now import for themselves by Ismid, Trebizond, Samsun, or Kerasund, instead of buying their supplies in Constantinople. About forty per cent. of the import trade of Constantinople is British; France, Germany, Austria, Belgium, and Italy share the balance, in proportions following the order in which they are mentioned. Constantinople produces nothing, and consequently exports nothing but waste products, but it receives much merchandise in transit. Latterly, however, a large proportion of it has been diverted—like the import trade, and for the same reasons—to the ports of the Black Sea and to Ismid, which latter as a shipping-port is much assisted in its competition with Constantinople by the Anatolian Railway. The transit trade of Constantinople included, until quite recent years, yellow-berries, gall-nuts, madder-roots, and other colouring matters; but these products have been superseded by the aniline dyes. In connexion with this decrease of trade it is noteworthy that several joint-stock banks have liquidated. Only the Imperial Ottoman Bank and a branch of the Crédit Lyonnais remain.

As far as can be ascertained, the average annual value of the goods passing through the port was, at the opening of the twentieth century, about £T11,000,000 (a Turkish lira = 18s.). It is, however, impossible to obtain exact figures, and it should be clearly understood that this is only an estimate, arrived at indirectly from a study of the custom receipts. The total given is made up as follows:—

| *Imports.* | £T | *Exports.* | £T |
|---|---|---|---|
| Manufactured goods—cotton, woollen, silk, &c. | 3,500,000 | Cereals | 1,000,000 |
| Haberdashery, iron-mongery | 700,000 | Mohair | 800,000 |
| Sugar | 500,000 | Carpets | 700,000 |
| Petroleum | 400,000 | Silk and cocoons | 500,000 |
| Flour | 400,000 | Opium | 400,000 |
| Coffee | 300,000 | Gum tragacanth | 150,000 |
| Rice | 250,000 | Wool | 100,000 |
| Cattle | 100,000 | Hides | 100,000 |
| Various | 850,000 | Various | 350,000 |
| Total | 7,000,000 | Total | 4,100,000 |

The shipping visiting the port, counting all seagoing craft (including liners) other than coasters, numbered 13,357 vessels of 11,453,332 tons in 1893, 14,387 vessels of 12,501,102 tons in 1896, and 10,777 vessels of 10,288,091 tons in 1900.

The minor industries in Constantinople, never very important, are declining, and foreign industrial undertakings have had little success.

*Education.*—In the department of Education the only important fact is that the Turkish School of Arts and Crafts has been rebuilt and reorganized. Otherwise the educational record of the years 1885 to 1900 is limited to the opening of a few schools of the more elementary sort. There are thirty-two foreign schools, one only of which is British. Two new charitable institutions, founded by the Sultan and supported by the Civil List, claim notice, namely, the Asylum for the Poor and the Hamidieh Hospital for Children. The Imperial Museum of Antiquities, opened in 1892, contains the celebrated Greek Sarcophagi, twenty-one in number, discovered at Saida, the ancient Sidon, in 1888.

*Local Government.*—Constantinople contains four districts or "divisions" (*Belad-i-Selessi*), namely, Stamboul, Pera-Galata, Beshiktash, and Scutari, of which the Government is in the hands of the Minister of Police, who is *ex officio* Governor of Stamboul. The other three districts have each their Governor (*mutessarif*), who is appointed by the Sultan, and is subordinate to the Minister of Police. All matters concerning public order and security are controlled by these four Governors, each of whom is provided with a separate staff of police and gendarmery, each district having its own police court, of which the Governor is the presiding magistrate. The municipal government of the four metropolitan divisions is vested in the Prefect of Stamboul, who is appointed by the Sultan He is the President of a Council of twenty-four members, who are appointed either by the Sultan, or by the Minister of the Interior in cases where there is no Palace candidate. The Prefecture has charge of all that concerns the streets, the markets, and the bazaars, including the street porters and the public weighers. It has also control over the public baths and the hospitals, of which latter there are three; and is charged with the collection of all city dues, including the *Verghi* (Property Tax). The Prefecture is divided into ten *cercles*, or wards, each of which has a president, vice-president, secretary, engineer, and physician, all of whom are appointed by the Council of the Prefecture. The Prefect is immediately subordinate to the Minister of the Interior. A military commandant, having under his orders a detachment of the garrison of Stamboul, is appointed to each of the four districts, the supreme military commander being the *Dersaadet Merkez Commandani—i.e., Commandant de la Place*—Commander of the Garrison of Constantinople.

The outlying parts of the city are divided into six districts (*Cazas*), namely, Princes' Islands, Guebzeh, Beicos, Kartal, Kutchuk-Tchekmedjé, and Shilé—each of which has its Governor (*kaimakam*), who is usually chosen by the Palace. These districts are dependencies of the Ministry of the Interior, and their municipal affairs are directed by agents of the Prefecture.

*Population.*—The city population, according to official estimate, numbers 880,000; the aggregate population of the six suburban districts is officially estimated at 320,000; giving a grand total of 1,200,000, which is the official estimate of the entire population of the city of Constantinople and its faubourgs. The Armenian element of the population was appreciably reduced by the events of 1895–96; but no trustworthy figures in connexion with this diminution are obtainable.

In the four central districts of the city the first-class thoroughfares and a considerable proportion of those of the second and third order are now fairly well lighted with gas.

*Water Supply.*—From the time of the conquest of Constantinople by the Turks up to the year 1882 one method of obtaining water for the city was followed to the exclusion of all others. This method was to trap the rain in the natural hollows of the forest of Belgrade (about 18 miles north-east of Constantinople), together with the water of the rivulets which trickle through some of them. It was effected by throwing a dam across the lowest end of each depression, thus stopping the outflow of water, and forming a reservoir called *Bend* in Turkish. There are nine of these "Bends." The water from the "Bends" is conveyed to its destination in earthenware pipes set in cement, and laid underground except in places where depressions of the soil necessitate an aqueduct. In several cases where that occurs the remains of the ancient aqueducts are utilized. The pipes convey the water to the public fountains, from which the poorer classes take it as they require, and it is distributed by the corporation of water-carriers (*sakka*) to those who can afford to pay the cost of delivery. This was the only water system of Constantinople up to the year 1885. The radical defects of this system suggested to Kiamil Bey, Grand Master of Ceremonies at the Court of the Sultan, in conjunction with a foreigner residing in Constantinople, to apply for a concession to bring water from Lake Derkos, which is about 28 miles west of the Black Sea mouth of the Bosphorus, and about 3 miles from the Black Sea shore. The application was finally granted in 1881 to the associate of Kiamil Bey, who had himself died in the meanwhile. A French company was formed, with a capital of twenty million francs, to carry out the undertaking; the works were begun in 1882, and on 1st July 1885 the new water supply was inaugurated. Lake Derkos has a total length of 8 miles, and a mean breadth of 2 miles. It is abundantly supplied by the river Karaman and its tributaries flowing down from the Strandja Dagh. The water, when taken from the lake, is first filtered, and then raised by a steam elevator (600 h.p.) to a height of 365 feet, where it enters the main conduit, 29 miles long, and is thence distributed by the delivery-pipes, of which the total length at the present time is 165 miles. The quality of the Derkos water is excellent, and the service is thoroughly well conducted. Until the year 1893 the Asiatic suburbs had no water supply but such as individual families obtained by cisterns, wells, &c. In 1888 a German firm obtained a concession for establishing water-works at the Sweet Waters of Asia—a lake lying between the villages of Kandili and Anatoli-Hissar, which is fed by mountain streams from the Kaïsh-Dagh and Alem-Dagh. A company called the *Compagnie des Eaux de Scutari-Kadikeui* was formed in 1890, with a share capital of £144,000 and a debenture capital of £160,000. The works were commenced in January 1891, and the supply service began in October 1893.

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(E. W*.)

### *Archæology.*

Considerable attention has been devoted in recent years to the archæology of Constantinople, and although the study is seriously hampered by the impossibility of making excavations, a real advance has been made in this department of knowledge. Many mistakes have been corrected, important facts have been discovered, and problems remaining to be solved have been more clearly recognized and more precisely stated than heretofore. The city of Byzantium, out of which Constantinople sprang, and from which it inherited characteristic features, occupied, when it reached its greatest extent, most of the territory comprised by the two hills nearest the apex of the promontory and by the level ground at their base. The western wall of the city started from a point near the Stamboul Custom House and reached the ridge of the Second Hill, a short distance to the east of the column popularly named Tchemberli Tash and the Burnt Column. There stood the principal gateway of the city, opening upon the Egnatian Road. From that point the wall ran southwards for some distance towards the Sea of Marmora, and then turned eastwards until it reached that sea in the neighbourhood of the present Seraglio Lighthouse. The Acropolis was situated on the summit of the First Hill, where the courts of the Old Palace of the Sultans are found; and within the citadel stood, as was customary, the chief temples of the city—the Temples of Artemis, Aphrodite, Apollo, Zeus, Poseidon, and Demeter. The harbours of the city were upon the Golden Horn—one, the Portus Prosforianus, in the bay indenting the shore in front of the station of the Chemins de Fer Orientaux; the other, the Neorium, in the bay before the Stamboul Custom House. On the level tract behind the former was the Strategion, the Champs de Mars of the city; while another public square, known as the Tetrastoon, because surrounded by four porticos, is represented by the open space between S. Sophia and the Hippodrome. There stood the Baths of Zeuxippus. Two theatres were built against the steep eastern side of the Acropolis Hill, and a Stadium stood on the level ground at the foot of the Acropolis beside the Golden Horn. A large portion of the Hippodrome, so famous in the history of Constantinople, was constructed by Septimius Severus for the benefit of the citizens of Byzantium, when he rebuilt the city in A.D. 196. The graceful granite column which stands on the high ground near the apex of the promontory is a monument erected by Byzantium in honour of the victory of Claudius Gothicus over the Goths. It still bears most of the original inscription

REDUCI FORTUNÆ OB DEVICTOS GOTHOS.

According to the measurements given by Zosimus and the Notitia, it would appear that the walls of Constantinople, as built by the founder of the city in 328, ran across the promontory from the neighbourhood of Daoud Pasha Kapoussi (Porta S. Aemiliani) on the Sea of Marmora to Oun-Kapan Kapoussi (Porta Platæa) on the Golden Horn, near the Stamboul head of the inner bridge, traversing in their course the seventh, fourth, and fifth hills of the promontory. By extending the old seaward walls of Byzantium to the extremities of the new western fortifications, the capital was placed within strong bulwarks. The only vestige of the western walls is found in the name Isa Kapoussi (Gate of Jesus), attached to a locality on the heights above the quarter of Psamathia. An ancient city gate which stood there as late as 1508, when it was overthrown by an earthquake, marked a point in the Constantinian line of fortifications, exactly as Temple Bar indicated a point in the old walls of London long after they had otherwise disappeared. Possibly a portion of the seaward walls bounding the old harbour, which is now converted into the vegetable gardens of Vlanga Bostan, may date from the time of Constantine. Two suburbs outside the walls were considered as parts of the city—the suburb of Sycae (Galata), and the suburb of Blachernae, now the quarters of Aivan Serai and Egri Kapou. The latter suburb stood within fortifications of its own. For municipal purposes the city was divided into fourteen Regions, on the model of Rome. But ere a century had passed, the growth of the new metropolis on the one hand, and military considerations in view of the threatening attitude of the Barbarians on the other, demanded the enlargement of the city's bounds and the erection of stronger defences. Accordingly, in 413, in the reign of Theodosius II., under the direction of Anthemius, Praetorian Prefect of the East and Regent during the emperor's minority, the landward fortifications were carried farther west, to the line of the inner wall in the crumbling but picturesque ramparts which extend from the Sea of Marmora, a short distance south of the Seven Towers (Yedi Koulé), to the old Byzantine Palace (Tekfour Serai), above the quarter of Egri Kapou. Authorities differ on the question how the city was then defended from the last-named point to the Golden Horn; some maintaining that the Theodosian Walls turned north-eastwards and reached the Golden Horn near Balat Kapoussi, others being of the opinion that the new walls joined the old fortifications which protected the suburb of Blachernae. On the whole, the latter view seems the more probable. The seaward walls required by this enlargement of the city were built in 439, during the administration of the Prefect Cyrus.

The wall of Anthemius was, however, terribly injured by a severe earthquake which shook the city in 447, while Theodosius II. was still upon the throne. The disaster was the more serious because Attila and his Huns were then carrying everything before them in the Balkan Peninsula; but the desperateness of the situation roused the energies of the Roman Government to the highest pitch, and in less than two months, if we may trust inscriptions to that effect, the city was again fully armed, and even more secure than before the catastrophe. The Praetorian Prefect Constantine, whom some authorities identify with the Prefect Cyrus named above, not only repaired the wall of Anthemius, but placed another wall in front of it, and protected this double line of fortifications by a moat, with a battlement along its inner margin. Each wall was flanked by ninety-six towers, while the terrace between the two walls, and the terrace between the outer wall and the moat, allowed room for the action of large bodies of troops, in addition to the troops upon the walls themselves. Comparatively slight changes were made in the boundaries of the city after the reign of Theodosius II. The lower portion of the suburb of Blachernae, namely, the plain to the north of the Sixth Hill, was enclosed within fortifications in 627, after the siege of the city by the Avars in the reign of Heraclius; in 813 Leo the Armenian strengthened the wall of Heraclius by constructing a wall and a moat in front of it, thus to withstand better an expected assault by the Bulgarians under Crum; lastly, in the reign of Manuel Comnenus the wall extending from the north-western corner of the court of Tekfour Serai to the square tower below Egri Kapou was erected to defend more effectively the Palace of Blachernae, on the Sixth Hill, which had become the favourite residence of the Byzantine emperors. Of course all these fortifications were frequently repaired (*e.g.,* the seaward walls by the Emperor Theophilus), and to them Constantinople owed her long life and her ability to repel, for more than a thousand years, the assaults of barbarism upon the civilization of Christendom. They present to the archæologist a splendid specimen of mediæval fortifications constructed under the strong influence of old Roman military traditions, and they afford endless interest to the student of history on account of the events associated with them.

The most noteworthy points in the circuit of the walls are: the Golden Gate, in the form of a triumphal arch with three archways, erected (before the Theodosian Walls were built) in honour of the victory of Theodosius the Great over the usurper Maximus; the Gate of S. Romanus (Top Kapoussi), memorable as the gate near which Constantine Dragases fell, and through which Sultan Mahomet II. rode into the captured capital in 1453; the great breach in the valley of the Lycus, through which the Turks entered the city; Tekfour Serai, long erroneously identified with the Palace of the Hebdomon, the finest specimen of Byzantine civil architecture left in the city; the two Towers commonly known respectively as the Towers of Anemas and Isaac Angelus, with the chambers in the body of the wall to the north; the wall of Leo the Armenian, the point at which the army of the Fourth Crusade, which had its camp on the hill opposite, delivered the chief attack in 1203; the wall protecting the quarters of Phanar and Petri Kapou, where the fleet and troops of the Fourth Crusade assaulted and carried the city in 1204, to found the Latin Empire of Constantinople; Yali Kiosk Kapoussi, the point to which the northern end of the chain drawn across the harbour in time of siege was attached; the ruins of the Palace of Hormisdas, once the residence of Justinian the Great and Theodora, known in later times as the Bucoleon, near Tchatlady Kapou; the sites of the old harbours between that gate and Daoud Pasha Kapoussi; the fine Marble Tower near the junction of the Land Walls with the walls along the Sea of Marmora.

The interior arrangements of the city were largely determined by the configuration of its site, which falls naturally into three divisions: the level ground and the slopes towards the Sea of Marmora, the range of hills running through the midland portion of the promontory, the slopes and level ground towards the Golden Horn. In each of these divisions a great street ran from one end of the city to the other, generally lined with arcades on one side, but sometimes, when passing through the busier and the finer parts of the city, on both sides. The street on the ridge of the hills formed the principal thoroughfare, and owing to its central position was known as the Mesé. It connected the principal Fora of the city: the Augustaion (to the south of S. Sophia); the Forum of Constantine (on the summit of the Second Hill); the Forum of Theodosius the Great, or of Taurus (on the summit of the Third Hill, beside the present War Office); the Forum of the Amastrianou

(near the Mosque Shah Zadé); the Forum of the Bous (at Ak Serai); the Forum of Arcadius, or of Theodosius II. (on the summit of the Seventh Hill, at Avret Bazaar). A branch of the Mesé led to the Church of the Holy Apostles, on the summit of the Fourth Hill, and to the Gate of Adrianople (Gate of Charisius) in the city walls.

Of the edifices and monuments which adorned the Fora just mentioned, it must here suffice to say that the Augustaion (so named in honour of Augusta Helena, the mother of Constantine the Great) was the heart of the city's political and ecclesiastical life. The great cathedral of Eastern Christendom rose on the north side of the square; the splendid gateway of the Chalcé, leading to the Imperial Palace, the Baths of Zeuxippus, with the Hippodrome behind them, stood on the south; the Senate House was on the east; while to the west, at a short distance off the Mesé, which issued from the square, were the Law Courts. In the area of the square stood the Milion, whence distances from Constantinople were measured; the equestrian statue of Justinian the Great, on a lofty column; the statue of the Empress Eudoxia, famous in the history of Chrysostom, and the inscribed pedestal of which remains. With the Forum of Constantine the Great the commercial activity of the city was closely associated, the most remarkable monument in the forum being the porphyry column which still stands there, and which carried aloft the statue of that emperor. In the Forum of Theodosius I. rose a column in his honour, constructed on the model of the hollow column of Trajan at Rome; there also stood the Anemodoulion, a beautiful structure surmounted by a vane to indicate the direction of the wind; and close to the Forum, if not within its precints, was the Capitol, in which the University of Constantinople was established. The most conspicuous object in the Forum of the Bous was an ancient bronze figure of an ox, which gave name to the Forum, and beside which criminals were sometimes burned to death. Another hollow column, the pedestal of which still remains, rose in the Forum of Arcadius in honour of that emperor. The city possessed also a column in honour of the Emperor Marcian, which still stands in the valley of the Lycus, below the Mosque of Sultan Mahomet II. In the decoration of the Fora and streets of the city there was a strange mingling of works belonging to good periods of Greek and Roman Art, with works made when Art had fallen on evil days.

An immense number of churches, enriched by the reputed relics of saints, prophets, and martyrs, made Constantinople a holy city, attracting to its shrines devout pilgrims from every part of the empire. Only some twenty of these sanctuaries survive, and most of them are now used as mosques for Moslem worship, exhibiting few traces of the beauty created by the combination of dome and arch, of marble revetment and mosaics. But S. Sophia still impresses the mind as one of the grandest buildings ever reared by human hands, while the Churches of S. Irene, SS. Sergius and Bacchus (Kutchuk Aya Sofia), S. Mary Diaconissa (Kalender Djamissi), S. Saviour of the Chora (Kahriyeh Djamissi), and S. Saviour Pantocrator (Klissé Djamissi) are interesting monuments of Byzantine art. The Church of the Holy Apostles, to which the Imperial Cemetery was attached, on the summit of the Fourth Hill, has been replaced by the Mosque of Sultan Mahomet II., the conqueror of the city.

Of the imperial palaces in and around the city we can mention only the Great Palace, a group of detached edifices scattered over the ground descending to the Sea of Marmora from the Hippodrome and the eastern side of the Augustaion; the Palace of Hormisdas, or of the Bucoleon, near Tchatlady Kapou; the Palace of the Porphyrogenitus, Tekfour Serai; the Palace of Blachernae, in the quarters of Egri Kapou and Aivas Effendi; the suburban Palace of Pegé, at Balukli; the Palace of the Hebdomon, at Makrikeui. The last has generally been identified with Tekfour Serai, but the fact that the suburb and palace at the Hebdomon stood at Makrikeui, beside the Sea of Marmora, at the seventh milestone from the Milion, is one of the surest results of recent archæological investigations. The fortress of the Cyclobion was in the same vicinity.

The Hippodrome, which entered so much into the life of the city, is represented by the large open space to the west of the Mosque of Sultan Achmet. An Egyptian obelisk on a pedestal covered with sculptured work portraying Theodosius I., sometimes accompanied by his empress and his sons, presiding at scenes in the Hippodrome; the Serpent Column, which stood originally at Delphi, in commemoration of the battle of Plataea; and a lofty pile of masonry in the form of an obelisk, once covered with gilded plates of bronze, indicate the line of the Spina; while under the prison and offices along the western side of the area arches are visible, against which seats for the spectators were built.

Water was brought to the city from the country to the west and north-west by aqueducts, sometimes above and sometimes under ground, and was stored within the city in large open reservoirs (now changed into vegetable gardens) and in cisterns covered with vaulted roofs supported on columns. They are important specimens of Byzantine architecture, as the works of Andréossy (*Constantinople et le Bosphore*), of Forchheimer and Strzygowski (*Die Byzantinischen Wasserbehälter von K[illegible]*), and of Choisy (*L'Art de Bâtir chez les Byzantins*) testify. The Aqueduct of Valens spans the valley between the Fourth Hill and the Third Hill of the city, and still carries on its beneficent work. The Cistern of Bin-Bir-Derek (Cistern of Illus) and the Cistern of Yeri-Batan-Serai (Cisterna Basilica) are noteworthy. Much of the water introduced into the city was used in the public baths and fountains, which formed as characteristic a feature of Byzantine Constantinople as similar erections do of Stamboul.

Byzantine Constantinople was a great emporium of trade, and a striking evidence of its commercial activity is seen in the number of harbours with which the city was provided. In addition to the Golden Horn and its bays, several artificial harbours, traces of which remain, were constructed on the shore of the city beside the Sea of Marmora. First (beginning from the east) came the Harbour of the Bucoleon, attached to the palace of that name, for the service of the Imperial Court. Then, at a short distance to the west of Tchatlady Kapou, came the Harbour of the Emperor Julian (Kadriga Limani), or of Sophia, as it was called after its reconstruction by the empress of Justin II.; the Harbour of Condoscalion (Koum Kapou) followed; next came (a little to the east of Yeni Kapou) the Harbour of Kaisarius, or the Heptascalon; then, the Harbour of Theodosius I., or of Eleutherius (Vlanga Bostan); and lastly, the Harbour of the Golden Gate, on the shore south of that entrance.

Besides the works mentioned above, the following will assist the student of the archæology of the city:—PETRUS GYLLIUS. *De Topographia Constantinopoleos et de illius Antiquitatibus.*—DU CANGE. *Constantinopolis Christiana.*—PASPATES. *Βυζαντιναὶ Μελέται.*—SALZENBERG. *Altchristliche Baudenkmale von Konstantinopel*—LETHABY and SWAINSON. *The Church of Sancta Sophia.*—PULGHER. *Les Anciennes Églises Byzantines de Constantinople.*—LABARTE. *Le Palais Impérial de Constantinople et ses Abords.*—MORDTMANN. *Esquisse Topographique de Constantinople.*

(A. VAN M.)

**Contract.**—The purpose of this article is not to give technical details and authorities for professional use, but to exhibit the characteristic features of English law in connexion with their historical and rational grounds. Enforcement of good faith in matters of bargain and promise is among the most important functions of legal justice in modern civilized countries. It might not be too much to say that, next after keeping the peace and securing property against violence and fraud so that business may be possible, it is the most important. Yet we shall find that the importance of contract is developed comparatively late in the history of law. The commonwealth needs elaborate rules about contracts only when it is advanced enough in civilization and trade to have an elaborate system of credit. The Roman law of the empire dealt with contract, indeed, in a fairly adequate manner, though it never had a complete or uniform theory; and the Roman law, as settled by Justinian, appears to have satisfied the Eastern empire long after the Western nations had begun to recast their institutions, and the traders of the Mediterranean had struck out a cosmopolitan body of rules, known as the Law Merchant, which claimed acceptance in the name neither of Justinian nor of the Church, but of universal reason. It was amply proved afterwards that the foundations of the Roman system were strong enough to carry the fabric of modern legislation. But the collapse of the Roman power in western Christendom threw society back into chaos, and reduced men's ideas of ordered justice and law to a condition compared with which the earliest Roman law known to us is modern.

In this condition of legal ideas, which it would be absurd to call jurisprudence, the general duty of keeping faith is not recognized except as a matter of religious or social observance. Those who desire to be assured of anything that lies in promise must exact an oath, or a pledge, or personal sureties; and even then the court of their people—in England the Hundred Court in the first instance—will do nothing for them in the first case, and not much in the two latter. It is more a question of acquiring a good title to help one's self than of becoming entitled to active assistance from any person in authority.

Probably the settlement of a blood-feud, with provisions for the payment of the fine by instalments, was the nearest approach to a continuing contract, as we now understand the term, which the experience of Germanic antiquity could furnish. It is also probable that the performance of such undertakings, as it concerned the general peace, was at an early time regarded as material to the commonweal; and that these covenants of peace, rather than the rudimentary selling and bartering of their day, first caused our Germanic ancestors to realize the importance of putting some promises at any rate under public sanction. We have not now to attempt any reconstruction of archaic judgment and justice, or the lack of either, at any period of the darkness and twilight which precede the history of the Middle Ages. But the history of the law, and even the present form of much law still common to almost all the English-speaking world, can be understood only when we bear in mind that our forefathers did not start from any general conception of the State's duty to enforce private agreements, but, on the contrary, the State's powers and functions in this regard were extended gradually, unsystematically, and by shifts and devices of ingenious suitors and counsel, aided by judges, rather than by any direct provisions of princes and rulers. Money debts, it is true, were recoverable from an early time. But this was not because the debtor had promised to repay the loan; it was because the money was deemed still to belong to the creditor, as if the identical coins were merely in the debtor's custody. The creditor sued to recover money, for centuries after the Norman Conquest, in exactly the same form which he would have used to demand possession of land; the action of debt closely resembled the "real actions," and, like them, might be finally determined by a judicial combat; and down to Blackstone's time the creditor was said to have a property in the debt—property which the debtor had "granted" him. Giving credit, in this way of thinking, is not reliance on the right to call hereafter for an act, the payment of so much current money or its equivalent, to be performed by the debtor, but merely suspension of the immediate right to possess one's own particular money, as the owner of a house let for a term suspends his right to occupy it. This was no road to the modern doctrine of contract, and the passage had to be made another way.

***Action for debt.***

In fact the old action of debt covered part of the ground of contract only by accident. It was really an action to recover any property that was not land; for the remedy of a dispossessed owner of chattels, afterwards known as Detinue, was only a slightly varying form of it. If the property claimed was a certain sum of money, it might be due because the defendant had received money on loan, or because he had received goods of which the agreed price remained unpaid; or, in later times at any rate, because he had become liable in some way by judgment, statute, or other authority of law, to pay a fine or fixed penalty to the plaintiff. Here the person recovering might be as considerable as the lord of a manor, or as mean as a "common informer"; the principle was the same. In every case outside this last class, that is to say, whenever there was a debt in the popular sense of the word, it had to be shown that the defendant had actually received the money or goods; this value received came to be called *quid pro quo*—a term unknown, to all appearance, out of England. Nevertheless the foundation of the plaintiff's right was not bargain or promise, but the unjust detention by the defendant of the plaintiff's money or goods.

***Modes of proof.***

We are not concerned here to trace the change from the ancient method of proof—oath backed by "good suit," *i.e.*, the oaths of an adequate number of friends and neighbours—through the earlier form of jury trial, in which the jury were supposed to know the truth of their own knowledge, to the modern establishment of facts by testimony brought before a jury who are bound to give their verdict according to the evidence. But there was one mode of proof which, after the Norman Conquest, made a material addition to the substantive law. This was the proof by writing, which means writing authenticated by seal. Proof by writing was admitted under Roman influence, but, once admitted, it acquired the character of being conclusive which belonged to all proof in early Germanic procedure. Oath, ordeal, and battle were all final in their results. When the process was started there was no room for discussion. So the sealed writing was final too, and a man could not deny his own deed. We still say that he cannot, but with modern refinements. Thus the deed, being allowed as a solemn and probative document, furnished a means by which a man could bind himself, or rather effectually declare himself bound, to anything not positively forbidden by law. Whoever could afford parchment and the services of a clerk might have the benefit of a "formal contract" in the Roman sense of the term. At this day the form of deed called a bond or "obligation" is, as it stands settled after various experiments, extremely artificial; but it is essentially a solemn admission of liability, though its conclusive stringency has been relaxed by modern legislation and practice in the interest of substantial justice. By this means the performance of all sorts of undertakings, pecuniary and otherwise, could be and was legally secured. Bonds were well known in the 13th century, and from the 14th century onwards were freely used for commercial and other purposes; as for certain limited purposes they still are. The "covenant" of modern draftsmen is a direct promise made by deed; it occurs mainly as incident to conveyances of land. The mediæval "covenant," *conventio*, was, when we first hear of it, practically equivalent to a lease, and never became a common instrument of miscellaneous contracting, though the old books recognize the possibility of turning it to various uses of which there are examples; nor had it any sensible influence on the later development of the law. On the whole, in the old common law one could do a great deal by deed, but very little without deed. The minor bargains of daily life, so far as they involved mutual credit, were left to the jurisdiction of inferior courts, of the Law Merchant, and—last, not least—of the Church.

Popular custom, in all European countries, recognized simpler ways of pledging faith than parchment and seal. A handshake was enough to bind a bargain. Whatever secular law might say, the Church said it was an open sin to break plighted faith; a matter, therefore, for spiritual correction, in other words, for compulsion exercised on the defaulter by the bishop's or the archdeacon's court, armed with the power of excommunication. In this way the ecclesiastical courts acquired much business which was, in fact, as secular as that of a modern county court, with the incident profits. Mediæval courts lived by the suitors' fees. What were the king's judges to do? However high they put their claims in the course of the rivalry between Church and Crown, they could not effectually prohibit the bishop or his official from dealing with matters for which the king's court provided no remedy. Continental jurists had seen their way, starting from the Roman system as it was left by Justinian, to reduce its formalities to a vanishing quantity, and expand their jurisdiction to the full breadth of current usage. English judges could not do this in the 15th century, if they could ever have done so. Nor would simplification of the requisites of a deed, such as

has now been introduced in many jurisdictions, have been of much use at a time when only a minority even of well-to-do laymen could write with any facility.

There was no principle and no form of action in English law which recognized any general duty of keeping promises. But could not breach of faith by which a party had suffered be treated as some kind of legal wrong? There was a known action of trespass and a known action of deceit, this last of a special kind, mostly for what would now be called abuse of the process of the court; but in the later Middle Ages it was an admitted remedy for giving a false warranty on a sale of goods. Also there was room for actions "on the case," on facts analogous to those covered by the old writs, though not precisely within their terms. If the king's judges were to capture this important branch of business from the clerical hands which threatened to engross it, the only way was to devise some new form of action on the case. There were signs, moreover, that the Court of Chancery would not neglect so promising a field if the Common Law judges left it open.

***Assumpsit.***

The mere fact of unfulfilled promise was not enough, in the eyes of mediæval English lawyers, to give a handle to the law. But injury caused by reliance on another man's undertaking was different. The special undertaking or "assumption" creates a duty which is broken by fraudulent or incompetent miscarriage in the performance. I profess to be a skilled farrier, and lame your horse. It is no trespass, because you trusted the horse to me; but it is something like a trespass, and very like a deceit. I profess to be a competent builder; you employ me to build a house, and I scamp the work so that the house is not fit to live in. An action on the case was allowed without much difficulty for such defaults. The next step, and a long one, was to provide for total failure to perform. The builder, instead of doing bad work, does nothing at all within the time agreed upon for completing the house. Can it be said that he has done a wrong? At first the judges felt bound to hold that this was going too far; but suitors anxious to have the benefit of the king's justice persevered, and in the course of the 15th century the new form of action, called *assumpsit* from the statement of the defendant's undertaking on which it was founded, was allowed as a remedy for non-performance as well as for faulty performance. Being an action for damages, and not for a certain amount, it escaped the strict rules of proof which applied to the old action of debt; being in form for a kind of trespass, and thus a privileged appeal to the king to do right for a breach of his peace, it escaped likewise the risk of the defendant clearing himself by oath according to the ancient popular procedure. Hence, as time went on, suitors were emboldened to use "assumpsit" as an alternative for debt, though it had been introduced only for cases where there was no other remedy. By the end of the 16th century they got their way; and it became a settled doctrine that the existence of a debt was enough for the court to presume an undertaking to pay it. The new form of action was made to cover the whole ground of informal contracts, and, by extremely ingenious devices of pleading, developed from the presumption or fiction that a man had promised to pay what he ought, it was extended in time to a great variety of cases where there was in fact no contract at all.

***Consideration.***

The new system gave no new force to gratuitous promises. For it was assumed, as the foundation of the jurisdiction, that the plaintiff had been induced by the defendant's undertaking, and with the defendant's consent, to alter his position for the worse in some way. He had paid or bound himself to pay money, he had parted with goods, he had spent time in labour, or he had foregone some profit or legal right. If he had not committed himself to anything on the strength of the defendant's promise, he had suffered no damage and had no cause of action. Disappointment of expectations is unpleasant, but it is not of itself *damnum* in a legal sense. To sum up the effect of this in modern language, the plaintiff must have given value of some kind, more or less, for the defendant's undertaking. This something given by the promisee and accepted by the promisor in return for his undertaking is what we now call the *consideration* for the promise. In cases where debt would also lie, it coincides with the old requirement of value received (*quid pro quo*) as a condition of the action of debt being available. But the conception is far wider, for the consideration for a promise need not be anything capable of delivery or possession. It may be money or goods; but it may also be an act or series of acts; further (and this is of the first importance for our modern law), it may itself be a promise to pay money or deliver goods, or to do work, or otherwise to act or not to act in some specified way. Again, it need not be anything which is obviously for the promisor's benefit. His acceptance shows that he set some value on it; but in truth the promisee's burden, and not the promisor's benefit, is material. The last refinement of holding that, when mutual promises are exchanged between parties, each promise is a consideration for the other and makes it binding, was conclusively accepted only in the 17th century. The result was that promises of mere bounty could no more be enforced than before, but any kind of lawful bargain could; and there is no reason to doubt that this was in substance what most men wanted. Ancient popular usage and feeling show little more encouragement than ancient law itself to merely gratuitous alienation or obligations. Also (subject, till quite modern times, to the general rule of common-law procedure that parties could not be their own witnesses, and subject to various modern statutory requirements in various classes of cases) no particular kind of proof was necessary. The necessity of consideration for the validity of simple contracts was unfortunately confused by commentators, almost from the beginning of its history, with the perfectly different rules of the Roman law about *nudum pactum*, which very few English lawyers took the pains to understand. Hasty comparison of misunderstood Roman or canon law is answerable for a large proportion of the worst faults in our old-fashioned text-books. Doubtless many canonists, probably some common lawyers, and possibly some of the judges of the Renaissance time, supposed that *ex nudo pacto non oritur actio* was in some way a proposition of universal reason; but it is a long way from this to concluding that the Roman law had any substantial influence on the English.

The doctrine of consideration is in fact peculiar to those jurisdictions where the common law of England is in force, or is the foundation of the received law. Substantially similar results are obtained in other modern systems by professing to enforce all deliberate promises, but imposing stricter conditions of proof where the promise is gratuitous.

***Deeds.***

As obligations embodied in the solemn form of a deed were thereby made enforceable before the doctrine of consideration was known, so they still remain. When a man has by deed declared himself bound, there is no need to look for any bargain, or even to ask whether the other party has assented. This rugged fragment of ancient law remains embedded in our elaborate modern structure. Nevertheless gratuitous promises, even by deed, get only their strict and bare rights. There may be an action upon them, but the powerful remedy of specific performance—often the only one worth having—is denied them. For this is derived from the extraordinary jurisdiction of the Chancellor, and the equity administered

Probably the settlement of a blood-feud, with provisions for the payment of the fine by instalments, was the nearest approach to a continuing contract, as we now understand the term, which the experience of Germanic antiquity could furnish. It is also probable that the performance of such undertakings, as it concerned the general peace, was at an early time regarded as material to the commonweal; and that these covenants of peace, rather than the rudimentary selling and bartering of their day, first caused our Germanic ancestors to realize the importance of putting some promises at any rate under public sanction. We have not now to attempt any reconstruction of archaic judgment and justice, or the lack of either, at any period of the darkness and twilight which precede the history of the Middle Ages. But the history of the law, and even the present form of much law still common to almost all the English-speaking world, can be understood only when we bear in mind that our forefathers did not start from any general conception of the State's duty to enforce private agreements, but, on the contrary, the State's powers and functions in this regard were extended gradually, unsystematically, and by shifts and devices of ingenious suitors and counsel, aided by judges, rather than by any direct provisions of princes and rulers. Money debts, it is true, were recoverable from an early time. But this was not because the debtor had promised to repay the loan; it was because the money was deemed still to belong to the creditor, as if the identical coins were merely in the debtor's custody. The creditor sued to recover money, for centuries after the Norman Conquest, in exactly the same form which he would have used to demand possession of land; the action of debt closely resembled the "real actions," and, like them, might be finally determined by a judicial combat; and down to Blackstone's time the creditor was said to have a property in the debt—property which the debtor had "granted" him. Giving credit, in this way of thinking, is not reliance on the right to call hereafter for an act, the payment of so much current money or its equivalent, to be performed by the debtor, but merely suspension of the immediate right to possess one's own particular money, as the owner of a house let for a term suspends his right to occupy it. This was no road to the modern doctrine of contract, and the passage had to be made another way.

*Action for debt.*

In fact the old action of debt covered part of the ground of contract only by accident. It was really an action to recover any property that was not land; for the remedy of a dispossessed owner of chattels, afterwards known as Detinue, was only a slightly varying form of it. If the property claimed was a certain sum of money, it might be due because the defendant had received money on loan, or because he had received goods of which the agreed price remained unpaid; or, in later times at any rate, because he had become liable in some way by judgment, statute, or other authority of law, to pay a fine or fixed penalty to the plaintiff. Here the person recovering might be as considerable as the lord of a manor, or as mean as a "common informer"; the principle was the same. In every case outside this last class, that is to say, whenever there was a debt in the popular sense of the word, it had to be shown that the defendant had actually received the money or goods; this value received came to be called *quid pro quo*—a term unknown, to all appearance, out of England. Nevertheless the foundation of the plaintiff's right was not bargain or promise, but the unjust detention by the defendant of the plaintiff's money or goods.

*Modes of proof.*

We are not concerned here to trace the change from the ancient method of proof—oath backed by "good suit," *i.e.*, the oaths of an adequate number of friends and neighbours—through the earlier form of jury trial, in which the jury were supposed to know the truth of their own knowledge, to the modern establishment of facts by testimony brought before a jury who are bound to give their verdict according to the evidence. But there was one mode of proof which, after the Norman Conquest, made a material addition to the substantive law. This was the proof by writing, which means writing authenticated by seal. Proof by writing was admitted under Roman influence, but, once admitted, it acquired the character of being conclusive which belonged to all proof in early Germanic procedure. Oath, ordeal, and battle were all final in their results. When the process was started there was no room for discussion. So the sealed writing was final too, and a man could not deny his own deed. We still say that he cannot, but with modern refinements. Thus the deed, being allowed as a solemn and probative document, furnished a means by which a man could bind himself, or rather effectually declare himself bound, to anything not positively forbidden by law. Whoever could afford parchment and the services of a clerk might have the benefit of a "formal contract" in the Roman sense of the term. At this day the form of deed called a bond or "obligation" is, as it stands settled after various experiments, extremely artificial; but it is essentially a solemn admission of liability, though its conclusive stringency has been relaxed by modern legislation and practice in the interest of substantial justice. By this means the performance of all sorts of undertakings, pecuniary and otherwise, could be and was legally secured. Bonds were well known in the 13th century, and from the 14th century onwards were freely used for commercial and other purposes; as for certain limited purposes they still are. The "covenant" of modern draftsmen is a direct promise made by deed; it occurs mainly as incident to conveyances of land. The mediæval "covenant," *conventio*, was, when we first hear of it, practically equivalent to a lease, and never became a common instrument of miscellaneous contracting, though the old books recognize the possibility of turning it to various uses of which there are examples; nor had it any sensible influence on the later development of the law. On the whole, in the old common law one could do a great deal by deed, but very little without deed. The minor bargains of daily life, so far as they involved mutual credit, were left to the jurisdiction of inferior courts, of the Law Merchant, and—last, not least—of the Church.

Popular custom, in all European countries, recognized simpler ways of pledging faith than parchment and seal. A handshake was enough to bind a bargain. Whatever secular law might say, the Church said it was an open sin to break plighted faith; a matter, therefore, for spiritual correction, in other words, for compulsion exercised on the defaulter by the bishop's or the archdeacon's court, armed with the power of excommunication. In this way the ecclesiastical courts acquired much business which was, in fact, as secular as that of a modern county court, with the incident profits. Mediæval courts lived by the suitors' fees. What were the king's judges to do? However high they put their claims in the course of the rivalry between Church and Crown, they could not effectually prohibit the bishop or his official from dealing with matters for which the king's court provided no remedy. Continental jurists had seen their way, starting from the Roman system as it was left by Justinian, to reduce its formalities to a vanishing quantity, and expand their jurisdiction to the full breadth of current usage. English judges could not do this in the 15th century, if they could ever have done so. Nor would simplification of the requisites of a deed, such as

has now been introduced in many jurisdictions, have been of much use at a time when only a minority even of well-to-do laymen could write with any facility.

There was no principle and no form of action in English law which recognized any general duty of keeping promises. But could not breach of faith by which a party had suffered be treated as some kind of legal wrong? There was a known action of trespass and a known action of deceit, this last of a special kind, mostly for what would now be called abuse of the process of the court; but in the later Middle Ages it was an admitted remedy for giving a false warranty on a sale of goods. Also there was room for actions "on the case," on facts analogous to those covered by the old writs, though not precisely within their terms. If the king's judges were to capture this important branch of business from the clerical hands which threatened to engross it, the only way was to devise some new form of action on the case. There were signs, moreover, that the Court of Chancery would not neglect so promising a field if the Common Law judges left it open.

The mere fact of unfulfilled promise was not enough, in the eyes of mediæval English lawyers, to give a handle to the law. But injury caused by reliance on another man's undertaking was different. The special undertaking or "assumption" creates a duty which is broken by fraudulent or incompetent miscarriage in the performance. I profess to be a skilled farrier, and lame your horse. It is no trespass, because you trusted the horse to me; but it is something like a trespass, and very like a deceit. I profess to be a competent builder; you employ me to build a house, and I scamp the work so that the house is not fit to live in. An action on the case was allowed without much difficulty for such defaults. The next step, and a long one, was to provide for total failure to perform. The builder, instead of doing bad work, does nothing at all within the time agreed upon for completing the house. Can it be said that he has done a wrong? At first the judges felt bound to hold that this was going too far; but suitors anxious to have the benefit of the king's justice persevered, and in the course of the 15th century the new form of action, called *assumpsit* from the statement of the defendant's undertaking on which it was founded, was allowed as a remedy for non-performance as well as for faulty performance. Being an action for damages, and not for a certain amount, it escaped the strict rules of proof which applied to the old action of debt; being in form for a kind of trespass, and thus a privileged appeal to the king to do right for a breach of his peace, it escaped likewise the risk of the defendant clearing himself by oath according to the ancient popular procedure. Hence, as time went on, suitors were emboldened to use "assumpsit" as an alternative for debt, though it had been introduced only for cases where there was no other remedy. By the end of the 16th century they got their way; and it became a settled doctrine that the existence of a debt was enough for the court to presume an undertaking to pay it. The new form of action was made to cover the whole ground of informal contracts, and, by extremely ingenious devices of pleading, developed from the presumption or fiction that a man had promised to pay what he ought, it was extended in time to a great variety of cases where there was in fact no contract at all.

**Assumpsit.**

The new system gave no new force to gratuitous promises. For it was assumed, as the foundation of the jurisdiction, that the plaintiff had been induced by the defendant's undertaking, and with the defendant's consent, to alter his position for the worse in some way. He had paid or bound himself to pay money, he had parted with goods, he had spent time in labour, or he had foregone some profit or legal right. If he had not committed himself to anything on the strength of the defendant's promise, he had suffered no damage and had no cause of action. Disappointment of expectations is unpleasant, but it is not of itself *damnum* in a legal sense. To sum up the effect of this in modern language, the plaintiff must have given value of some kind, more or less, for the defendant's undertaking. This something given by the promisee and accepted by the promisor in return for his undertaking is what we now call the *consideration* for the promise. In cases where debt would also lie, it coincides with the old requirement of value received (*quid pro quo*) as a condition of the action of debt being available. But the conception is far wider, for the consideration for a promise need not be anything capable of delivery or possession. It may be money or goods; but it may also be an act or series of acts; further (and this is of the first importance for our modern law), it may itself be a promise to pay money or deliver goods, or to do work, or otherwise to act or not to act in some specified way. Again, it need not be anything which is obviously for the promisor's benefit. His acceptance shows that he set some value on it; but in truth the promisee's burden, and not the promisor's benefit, is material. The last refinement of holding that, when mutual promises are exchanged between parties, each promise is a consideration for the other and makes it binding, was conclusively accepted only in the 17th century. The result was that promises of mere bounty could no more be enforced than before, but any kind of lawful bargain could; and there is no reason to doubt that this was in substance what most men wanted. Ancient popular usage and feeling show little more encouragement than ancient law itself to merely gratuitous alienation or obligations. Also (subject, till quite modern times, to the general rule of common-law procedure that parties could not be their own witnesses, and subject to various modern statutory requirements in various classes of cases) no particular kind of proof was necessary. The necessity of consideration for the validity of simple contracts was unfortunately confused by commentators, almost from the beginning of its history, with the perfectly different rules of the Roman law about *nudum pactum*, which very few English lawyers took the pains to understand. Hasty comparison of misunderstood Roman or canon law is answerable for a large proportion of the worst faults in our old-fashioned text-books. Doubtless many canonists, probably some common lawyers, and possibly some of the judges of the Renaissance time, supposed that *ex nudo pacto non oritur actio* was in some way a proposition of universal reason; but it is a long way from this to concluding that the Roman law had any substantial influence on the English.

**Consideration.**

The doctrine of consideration is in fact peculiar to those jurisdictions where the common law of England is in force, or is the foundation of the received law. Substantially similar results are obtained in other modern systems by professing to enforce all deliberate promises, but imposing stricter conditions of proof where the promise is gratuitous.

As obligations embodied in the solemn form of a deed were thereby made enforceable before the doctrine of consideration was known, so they still remain. When a man has by deed declared himself bound, there is no need to look for any bargain, or even to ask whether the other party has assented. This rugged fragment of ancient law remains embedded in our elaborate modern structure. Nevertheless gratuitous promises, even by deed, get only their strict and bare rights. There may be an action upon them, but the powerful remedy of specific performance—often the only one worth having—is denied them. For this is derived from the extraordinary jurisdiction of the Chancellor, and the equity administered

**Deeds.**

by the Chancellor was not for plaintiffs who could not show substantial merit as well as legal claims. The singular position of promises made by deed is best left out of account in considering the general doctrine of the formation of contracts; and as to interpretation there is no difference. In what follows, therefore, it will be needless, as a rule, to distinguish between "parol" or "simple" contracts, that is, contracts not made by deed, and obligations undertaken by deed.

From the conception of a promise being valid only when given in return for something accepted in consideration of the promise, it follows that the giving of the promise and of the consideration must be simultaneous. Words of promise uttered before there is a consideration for them can be no more than an offer; and, on the other hand, the obligation declared in words, or inferred from acts and conduct, on the acceptance of a consideration, is fixed at that time, and cannot be varied by subsequent declaration, though such declarations may be material as admissions. It was a long while, however, before this consequence was clearly perceived. In the 18th century it was attempted, and for a time with considerable success, to extend the range of enforceable promises without regard to what the principles of the law would bear, in order to satisfy a sense of natural justice. This movement was checked only within living memory, and traces of it remain in certain apparently anomalous rules which are indeed of little practical importance, but which private writers, at any rate, cannot safely treat as obsolete. However, the question of "past consideration" is too minute and technical to be pursued here. The general result is that a binding contract is regularly constituted by the acceptance of an offer, and at the moment when it is accepted; and, however complicated the transaction may be, there must always, in the theory of English law, be such a moment in every case where a contract is formed. It also follows that an offer before acceptance creates no duty of any kind ("A revocable promise is unknown to our law"—Anson); which is by no means necessarily the case in systems where the English rule of consideration is unknown. The question what amounts to final acceptance of an offer is, on the other hand, a question ultimately depending on common sense, and must be treated on similar lines in all civilized countries where the business of life is carried on in a generally similar way. The rules that an offer is understood to be made only for a reasonable time, according to the nature of the case, and lapses if not accepted in due time; that an expressed revocation of an offer can take effect only if communicated to the other party before he has accepted; that acceptance of an offer must be according to its terms, and a conditional or qualified acceptance is only a new proposal, and the like, may be regarded as standing on general convenience as much as on any technical ground.

**Correspondence.**

Great difficulties have arisen, and in other systems as well as in the English, as to the completion of contracts between persons at a distance. There must be some rule, and yet any rule that can be framed must seem arbitrary in some cases. On the whole our modern doctrine is to some such effect as the following:—

The proposer of a contract can prescribe or authorize any mode, or at least any reasonable mode, of acceptance, and if he specifies none he is deemed to authorize the use of any reasonable mode in common use, and especially the post. Acceptance in words is not always required; an offer may be well accepted by an act clearly referable to the proposed agreement, and constituting the whole or part of the performance asked for—say the despatch of goods in answer to an order by post, or the doing of work bespoken; and it seems that in such cases further communication—unless expressly requested—is not necessary as matter of law, however prudent and desirable it may be. Where a promise and not an act is sought (as where a tradesman writes a letter offering goods for sale on credit), it must be communicated; in the absence of special direction letter post or telegraph may be used; and, further, the acceptor having done his part when his answer is committed to the post, English courts now hold (after much discussion and doubt) that any delay or miscarriage in course of post is at the proposer's risk, so that a man may be bound by an acceptance he never received. It is generally thought—though there is no English decision—that, in conformity with this last rule, a revocation by telegraph of an acceptance already posted would be inoperative. Much more elaborate rules than the English rules are laid down in some Continental codes. It seems doubtful whether their complication achieves any gain of substantial justice worth the price. At first sight it looks easy to solve some of the difficulties by admitting an interval during which one party is bound and the other not. But, apart from the risk of starting fresh problems as hard as the old ones, English principles, as above said, require a contract to be concluded between the parties at one point of time, and any exception to this would have to be justified by very strong grounds of expediency. We have already assumed, but it should be specifically stated, that neither offers nor acceptances are confined to communications made in spoken or written words. Acts or signs may and constantly do signify proposal and assent. One does not in terms request a ferryman to put one across the river. Stepping into the boat is an offer to pay the usual fare for being ferried over, and the ferryman accepts it by putting off. This is a very simple case, but the principle is the same in all cases. Acts fitted to convey to a reasonable man the proposal of an agreement, or the acceptance of a proposal he has made, are as good in law as equivalent express words. The term "implied contract" is current in this connexion, but it is unfortunately ambiguous. It sometimes means a contract concluded by acts, not words, of one or both parties, but still a real agreement; sometimes an obligation imposed by law where there is not any agreement in fact.

**Interpretation.**

The obligation of contract is an obligation created and determined by the will of the parties. Herein is the characteristic difference of contract from all other branches of law. The business of the law, therefore, is to give effect so far as possible to the intention of the parties, and all the rules for interpreting contracts go back to this fundamental principle and are controlled by it. Every one knows that its application is not always obvious. Parties often express themselves obscurely; still oftener they leave large parts of their intention unexpressed, or (which for the law is the same thing) have not formed any intention at all as to what is to be done in certain events. But even where the law has to fill up gaps by judicial conjecture, the guiding principle still is, or ought to be, the consideration of what either party has given the other reasonable cause to expect of him. The court aims not at imposing terms on the parties, but at fixing the terms left blank as the parties would or reasonably might have fixed them if all the possibilities had been clearly before their minds. For this purpose resort must be had to various tests: the court may look to the analogy of what the parties have expressly provided for other specified events, to the constant or general usage of persons engaged in like business, and, at need, ultimately to the court's own sense of what is just and expedient. All auxiliary rules of this kind

are subject to the actual will of the parties, and are applied only for want of sufficient declaration of it by the parties themselves. A rule which can take effect against the judicially known will of the parties is not a rule of construction or interpretation, but a positive rule of law. However artificial some rules of construction may seem, this test will always hold. In modern times the courts have avoided laying down new rules of construction, preferring to keep a free hand and deal with each case on its merits as a whole.

*Evidence.*

There are certain rules of evidence which to some extent guide or restrain interpretation. In particular, oral testimony is not allowed to vary the terms of an agreement reduced to writing. This is really in aid of the parties' deliberate intention, for the object of reducing terms to writing is to make them certain. There are apparent exceptions to the rule, of which the most conspicuous is the admission of evidence to show that words were used in a special meaning current in the place or trade in question. But they are reducible, it will be found, to applications (perhaps over-subtle in some cases) of the still more general principles that, before giving legal force to a document, we must know that it is really what it purports to be, and that when we do give effect to it according to its terms we must be sure of what its terms really say. The rules of evidence here spoken of are modern, and have nothing to do with the archaic rule already mentioned as to the effect of a deed.

*Performance.*

Every contracting party is bound to perform his promise according to its terms, and in case of any doubt in the sense in which the other party would reasonably understand the promise. Where the performance on one or both sides extends over an appreciable time, continuously or by instalments, questions may arise as to the right of either party to refuse or suspend further performance on the ground of some default on the other side. Attempts to lay down hard and fast rules on such questions are now discouraged, the aim of the courts being to give effect to the true substance and intent of the contract in every case. Nor will the court hold one part of the terms deliberately agreed to more or less material than another in modern business dealings. "In the contracts of merchants time is of the essence," as the Supreme Court of the United States has said in our own day. Certain ancient rules restraining the apparent literal effect of common provisions in mortgages and other instruments were in truth controlling rules of policy. New rules of this kind can be made only by legislation. Whether the parties did or did not in fact intend the obligation of a contract to be subject to unexpressed conditions is, however, a possible and not uncommon question of interpretation. One class of cases giving rise to such questions is that in which performance becomes impossible by some external cause not due to the promisor's own fault. As to promises obviously absurd or impossible from the first, they are unenforceable only on the ground that the parties cannot have seriously meant to create a liability. For precisely the same reason, supported by the general usage and understanding of mankind, common social engagements, though they often fulfil all other requisites of a contract, have never been treated as binding in law.

*Illegality.*

In all matters of contract, as we have said, the ascertained will of the parties prevails. But this means a will both lawful and free. Hence there are limits to the force of the general rule, fixed partly by the law of the land, which is above individual will and interests, partly by the need of securing good faith and justice between the parties themselves against fraud or misadventure. Agreements cannot be enforced when their performance would involve an offence against the law. There may be legal offence, it must be remembered, not only in acts commonly recognized as criminal, disloyal, or immoral, but in the breach or non-observance of positive regulations made by the Legislature, or persons having statutory authority, for a great variety of purposes. It would be useless to give details on the subject here. Again, there are cases where an agreement may be made and performed without offending the law, but on grounds of "public policy" it is not thought right that the performance should be a matter of legal obligation, even if the ordinary conditions of an enforceable contract are satisfied. A man may bet, in private at any rate, if he likes, and pay or receive as the event may be; but for many years the winner has had no right of action against the loser. Unfortunate timidity on the part of the judges, who attempted to draw distinctions instead of saying boldly that they would not entertain actions on wagers of any kind, threw this topic into the domain of legislation; and the laudable desire of Parliament to discourage gambling, so far as might be, without attempting impossible prohibitions, has brought the law to a state of ludicrous complexity in both civil and criminal jurisdiction. But what is really important under this doctrine of public policy is the confinement of "contracts in restraint of trade" within special limits. In the Middle Ages and down to modern times there was a strong feeling—not merely an artificial legal doctrine—against monopolies and everything tending to monopoly. Agreements to keep up prices or not to compete were regarded as criminal. Gradually it was found that some kind of limited security against competition must be allowed if such transactions as the sale of a going concern with its goodwill, or the retirement of partners from a continuing firm, or the employment of confidential servants in matters involving trade secrets, were to be carried on to the satisfaction of the parties. Attempts to lay down fixed rules in these matters were made from time to time, but they were finally discredited by the decision of the House of Lords in the Maxim-Nordenfelt Company's case in 1894. Contracts "in restraint of trade" will now be held valid, provided that they are made for valuable consideration (this even if they are made by deed), and do not go beyond what can be thought reasonable for the protection of the interests concerned, and are not injurious to the public. (The Indian Contract Act, passed in 1872, has unfortunately embodied views now obsolete, and remains unamended.) All that remains of the old rules in England is the necessity of valuable consideration, whatever be the form of the contract, and a strong presumption—but not an absolute rule of law—that an unqualified agreement not to carry on a particular business is not reasonable.

*Fraud.*

Where there is no reason in the nature of the contract for not enforcing it, the consent of a contracting party may still not be binding on him because not given with due knowledge, or, if he is in a relation of dependence to the other party, with independent judgment. Inducing a man by deceit to enter into a contract may always be treated by the deceived party as a ground for avoiding his obligation, if he does so within a reasonable time after discovering the truth, and, in particular, before any innocent third person has acquired rights for value on the faith of the contract (see FRAUD). Coercion would be treated on principle in the same way as fraud, but such cases hardly occur in modern times. There is a kind of moral domination, however, which our courts watch with the utmost jealousy, and repress under the name of "undue influence" when it is used to obtain pecuniary advantage. Persons in a position of legal or practical authority — guardians, confidential advisers, spiritual directors, and the like—must not abuse their

authority for selfish ends. They are not forbidden to take benefits from those who depend on them or put their trust in them; but if they do, and the givers repent of their bounty, the whole burden of proof is on the takers to show that the gift was in the first instance made freely and with understanding. Large voluntary gifts or beneficial contracts, outside the limits within which natural affection and common practice justify them, are indeed not encouraged in any system of civilized law. Professional money-lenders were formerly checked by the usury laws: now that no rate of interest is in itself unlawful, courts and juries have shown a certain astuteness in applying the rules of law as to fraud and undue influence—the latter with certain special features—to transactions with needy "expectant heirs" and other improvident persons which seem on the whole unconscionable. In the case of both fraud and undue influence, the person entitled to avoid a contract may, if so advised, ratify it afterwards; and ratification, if made with full knowledge and free judgment, is irrevocable. A contract made with a person deprived by unsound mind or intoxication of the capacity to form a rational judgment is on the same footing as a contract obtained by fraud, if the want of capacity is apparent to the other party.

There are many cases in which a statement made by one party to the other about a material fact will enable the other to avoid the contract if he has relied on it, and it was in fact untrue, though it may have been made at the time with honest belief in its truth. This is so wherever, according to the common course of business, it is one party's business to know the facts, and the other practically must, or reasonably may, take the facts from him. In some classes of cases even inadvertent omission to disclose any material fact is treated as a misrepresentation. Contracts of insurance are the most important; here the insurer very seldom has the means of making any effective inquiry of his own. Misdescription of real property on a sale, without fraud, may according to its importance be a matter for compensation or for setting aside the contract. Promoters of companies are under special duties as to good faith and disclosure which have been worked out at great length in the modern decisions. But company law has become so complex within the present generation that, so far from throwing much light on larger principles, it is hardly intelligible without some previous grasp of them. Sometimes it is said that misrepresentation (apart from fraud) of any material fact will serve to avoid any and every kind of contract. It is submitted that this is certainly not the law as to the sale of goods or as to the contract to marry, and therefore the alleged universal rule does not exist. But it must be remembered that parties can, if they please, and not necessarily by the express terms of the contract itself, make the validity of their contract conditional on the existence of any matter of fact whatever, including the correctness of any particular statement. If they have done this, and the fact is not so, the contract has no force; not because there has been a misrepresentation, but because the parties agreed to be bound if the fact was so and not otherwise. It is a question of interpretation whether in a given case there was any such condition.

Mistake is said to be a ground for avoiding contracts, and there are cases which it is practically convenient to group under this head. On principle they seem to be mostly reducible to failure of the acceptance to correspond with the offer, or absence of any real consideration for the promise. In such cases, whether there be fraud or not, no contract is ever formed, and therefore there is nothing which can be ratified—a distinction which may have important effects. Relief against mistake is given where parties who have really agreed, or rather their advisers, fail to express their intention correctly. Here, if the original true intention is fully proved—as to which the court is rightly cautious—the faulty document can be judicially rectified.

*Disability.*

By the common law an infant (*i.e.*, a person less than twenty-one years old) was bound by contracts made for "necessaries," *i.e.*, such commodities as a jury holds, and the court thinks they may reasonably hold, suitable and required for the person's condition; also by contracts otherwise clearly for his benefit; all other contracts he might confirm or avoid after coming of age. An extremely ill-drawn Act of 1874 absolutely deprived infants of the power of contracting loans, contracting for the supply of goods other than necessaries, and stating an account so as to bind themselves; it also disabled them from binding themselves by ratification. The liability for necessaries is now declared by legislative authority in the Sale of Goods Act, 1893. Practically, people who give credit to an infant do so at their peril, except in cases of obvious urgency.

Married women were incapable by the common law of contracting in their own names. At this day they can hold separate property and bind themselves to the extent of that property—not personally—by contract. The law before the Married Women's Property Acts (1882 and 1893, and earlier Acts now superseded and repealed) was a very peculiar creature of the Court of Chancery; the number of cases in which it is necessary to go back to it is of course decreasing year by year. But a married woman can still be restrained from anticipating the income of her separate property, and the restriction is still commonly inserted in marriage settlements.

There is a great deal of philosophical interest about the nature and capacities of corporations, but for modern practical purposes it may be said that the legal powers of British corporations are directly or indirectly determined by Acts of Parliament. For companies under the Companies Acts the controlling instrument or written constitution is the memorandum of association. Company draftsmen, taught by experience, nowadays frame this in the most comprehensive terms. Questions of either personal or corporate disability are less frequent than they were. In any case, they stand apart from the general principles which characterize our law of contract.

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(F. Po.)

**Conveyancing** is the art or science of effecting the transfer of property, or modifying interests in relation to property, by means of written documents.

*History.*

In early legal systems the main element in the transfer of property was the change, generally accompanied by some public ceremony, in the actual physical possession: the function of documents, where used, being merely the preservation of evidence. Thus, in Great Britain in the feudal period, the common mode of conveying an immediate freehold was by *feoffment with livery of seisin*—a proceeding in which the transferee was publicly invested with the feudal possession or *seisin*, usually through the medium of some symbolic act performed in

the presence of witnesses upon the land itself. A deed or charter of feoffment was commonly executed at the same time by way of record, but formed no essential part of the conveyance. In the language of the old rule of the common law, the immediate freehold in corporeal hereditaments lay in livery, whereas reversions and remainders and all incorporeal hereditaments lay in grant, *i.e.*, passed by the delivery of the deed of conveyance or grant without any further ceremony. The process by which this distinction was broken down and the present uniform system of private conveyancing by simple deed was established, constitutes a long chapter in English legal history.

The land of a feudal owner was subject to the risk of forfeiture for treason, and to military and other burdens. The common law did not allow him to dispose of it by will. By the law of mortmain religious houses were prohibited from acquiring it. The desire to escape from these burdens and limitations gave rise to the practice of making feoffments to the *use* of, or upon trust for, persons other than those to whom the seisin or legal possession was delivered. The common law recognized only the legal tenant; but the *cestui que use* or beneficial owner gradually secured for his wishes and directions concerning the profits of the land the strong protection of the chancellors as exercising the equitable jurisdiction of the king. The resulting loss to the Crown and the great lords of the feudal dues and privileges, coupled with the public disadvantages arising from ownership of land which, in an increasing degree, was merely nominal, brought about the passing in the year 1535 of the famous Statute of Uses, the object of which was to destroy altogether the system of uses and equitable estates It enacted, in substance, that whoever should have a use or trust in any hereditaments should be deemed to have the legal seisin, estate, and possession for the same interest that he had in the use; in other words, that he should become in effect the feudal tenant without actual delivery of possession to him by the actual feoffee to uses or trustee. In its result the statute was a fiasco. It was solemnly decided that the Act transferred the legal possession to the use once only, and that in the case of a conveyance to A to the use of B to the use of or upon trust for C, it gave the legal estate to B, and left C with an interest in the position of the use before the statute. Thus was completed the foundation of the modern system of trusts fastened upon legal estates and protected by the equitable doctrines and practice of the judicature.

But the statute not only failed to abolish uses: it also opened the way to the evasion of the public ceremony of "livery of seisin," and the avoidance of all notoriety in conveyances. Other ways, besides an actual feoffment to uses, of creating a use had been in vogue before the statute. If A bargained with B, in writing or not, for the sale of land, and B paid the price, but A remained in legal possession, the Court of Chancery enforced the use or equitable interest in favour of B. The effect of a "bargain and sale" (as such a transaction was called) after the statute was to give B the legal interest without any "livery of seisin." This fresh danger was met in the very year of the statute itself by an enactment that a bargain and sale of an estate of inheritance or freehold should be made by deed publicly enrolled. But the Statute of Enrolments was in terms limited to estates of freehold. It was allowed that a bargain and sale for a term, say, of one year, must transfer the seisin to the bargainee without enrolment. And since what remained in the bargainor was merely a reversion which "lay in grant," it was an easy matter to release this by deed the day after. By this ingenious device was the publicity of feoffment or enrolment avoided, and the lease and release, as the process was called, remained the usual mode of conveying a freehold in possession down to the 19th century.

It was not until 1845 that the modern system of transfer by a single deed was finally established. By the Real Property Act of that year it was enacted that all corporeal hereditaments should, as regards the immediate freehold, be deemed to lie in grant as well as in livery. Since this Act the ancient modes of conveyance, though not abolished by it, have in practice become obsolete. Traces of the old learning connected with them remain, however, embedded in the modern conveyance. Many a purchase-deed recites that the vendor is *seised* in fee-simple of the property. It is the practice, moreover, to convey not only "to" but also "to the use of" a purchaser. For before the Statute of Uses, a conveyance made without any consideration or declaration of uses was deemed to be made to the use of the party conveying. In view of the operation of the statute upon the legal estate in such circumstances, it is usual in all conveyances, whether for value or not, to declare a use in favour of the party to whom the grant is made.

In its popular usage the word "conveyance" signifies the document employed to carry out a purchase of land. But the term "conveyancing" is of much wider import, and comprises the preparation and completion of all kinds of legal instruments. A well-known branch of the conveyancer's business is the investigation of title—an important function in the case of purchases or mortgages of real estate. With personal estate (other than leasehold) he has perhaps not so much concern. Chattels are usually transferred by delivery, and stocks or shares by means of printed instruments which can be bought at a law-stationer's. The common settlements and wills, however, deal wholly or mainly with personal property; and an interest in settled personalty is frequently the subject of a mortgage. Of late years, also, there has been an enormous increase in the volume of conveyancing business in connexion with limited joint-stock companies.

In the preparation of legal documents the practitioner is much assisted by the use of *precedents*. These are outlines or models of instruments of all kinds, exhibiting in accepted legal phraseology their usual form and contents with additions and variations adapted to particular circumstances. Collections of them have been in use from early times, certainly since printing became common. The modern precedent is, upon the whole, concise and businesslike. The prolixity which formerly characterized most legal documents has largely disappeared, mainly through the operation of recent statutes which enable many clauses previously inserted at great length to be, in some cases, *e.g.*, covenants for title, incorporated by the use of a few prescribed words, and in others safely omitted altogether. The Solicitors' Remuneration Act, 1881, has also assisted the process of curtailment, for there is now little or no connexion between the length of a deed and the cost of its preparation. So long as the draftsman adheres to recognized legal phraseology and to the well-settled methods of carrying out legal operations, there is no reason why modern instruments should not be made as terse and businesslike as possible.

***Contracts for sale.***

It is not usual for land to be sold without a formal agreement in writing being entered into. This precaution is due, partly to the Statute of Frauds (§ 4), which renders a contract for the sale of land unenforceable by action "unless the agreement upon which such action shall be brought, or some memorandum or note thereof, shall be in writing and signed by the party to be charged therewith or some other person thereunto by him lawfully authorized," and partly to the fact that there are few titles which can with prudence be exposed to all the requisitions that a purchaser under an "open contract" is entitled by law to make. Such a purchaser may, for example, require a forty years' title (Vendor and Purchaser Act, 1874). Under an open contract a vendor is presumed to be selling the fee-simple in possession, free from any incumbrance, or liability, or restriction as to user or otherwise; and if he cannot deduce a title of the statutory length, or procure an incumbrance or restriction to be removed, the purchaser may repudiate the contract. The preparation of an agreement for sale involves accordingly an examination of the vendor's title, and the exercise of skill and judgment in deciding how the vendor may be protected against trouble and expense without prejudice to the sale. Upon a sale by auction the agreement is made up of (1) the particulars, which describe the property; (2) the conditions of sale, which state the terms upon which it is offered; and

(3) the memorandum or formal contract at the foot of the conditions, which incorporates by reference the particulars and conditions, names or sufficiently refers to the vendor, and is signed by the purchaser after the sale. The object of the agreement, whether the sale is by private contract or by auction, is to define accurately what is sold, to provide for the length of title and the evidence in support of or in connexion with the title which is to be required except so far as it is intended that the general law shall regulate the rights of the parties, and to fix the times at which the principal steps in the transaction are to be taken. It is also usual to provide for the payment of interest at a prescribed rate upon the purchase money if the completion shall be delayed beyond the day fixed for any cause other than the vendor's wilful default, and also that the vendor shall be at liberty to rescind the contract without paying costs or compensation if the purchaser insists upon any requisition or objection which the vendor is unable or, upon the ground of expense or other reasonable ground, is unwilling to comply with or remove. Upon a sale by auction it is the rule to require a deposit to be paid by way of security to the vendor against default on the part of the purchaser.

*Abstract of title.*

The signature of the agreement is followed by the delivery to the purchaser or his solicitor of the abstract of title, which is an epitome of the various instruments and events under and in consequence of which the vendor derives his title. A purchaser is entitled to an abstract at the vendor's expense unless otherwise stipulated. It begins with the instrument fixed by the contract for the commencement of the title, or, if there has been no agreement upon the subject, with an instrument of such character and date as is prescribed by the law in the absence of stipulation between the parties. From its commencement as so determined the abstract, if properly prepared, shows the history of the title down to the sale; every instrument, marriage, birth, death, or other fact or event constituting a link in the chain of title, being sufficiently set forth in its proper order. The next step is the verification of the abstract on the purchaser's behalf by a comparison of it with the originals of the deeds, the probates of the wills, and office copies of the instruments of record through which the title is traced. The vendor is bound to produce the original documents, except such as are of record or have been lost or destroyed, but, unless otherwise stipulated, the expense of producing those which are not in his possession falls upon the purchaser (C. A., 1881). After being thus verified, the abstract is perused by the purchaser's advisers with the object of seeing whether a title to the property sold is deduced according to the contract, and what evidence, information, or objection, in respect of matters appearing or arising upon the abstract, ought to be called for or taken. For this purpose it is necessary to consider the legal effect of the abstracted instruments, whether they have been properly completed, whether incumbrances, adverse interests, defects, liabilities in respect of duties, or any other burdens or restrictions disclosed by the abstract, have been already got rid of or satisfied, or remain to be dealt with before the completion of the sale. The result of the consideration of these matters is embodied in "requisitions upon title," which are delivered to the vendor's solicitors within a time usually fixed for the purpose by the contract. In making or insisting upon requisitions regard is had, among other things, to any special conditions in the contract dealing with points as to which evidence or objection might otherwise have been required or taken, and to a variety of provisions contained in the V. and P. Act, 1874, and the Conveyancing Act, 1881, which apply, except so far as otherwise agreed, and of which the following are the most important: (1) Recitals, statements, and descriptions of facts, matters, and parties contained in instruments twenty years old at the date of the contract are, unless proved inaccurate, to be taken as sufficient evidence of the truth of such facts, matters, and descriptions; (2) a purchaser cannot require the production of, or make any requisition or objection in respect of, any document dated before the commencement of the title, (3) the cost of obtaining evidence and information not in the vendor's possession must be borne by the purchaser. The possibility of the rescission clause now commonly found in contracts for the sale of real estate being exercised in order to avoid compliance with an onerous requisition, is also an important factor in the situation. The requisitions are in due course replied to, and further requisitions may arise out of the answers. A summary method of obtaining a judicial determination of questions connected with the contract, but not affecting its validity, is provided by the V. and P. Act, 1874. Before completion it is usual for the purchaser to cause searches to be made in various official registers for matters required to be entered therein, such as judgments, land charges, and pending actions, which may affect the vendor's title to sell, or amount to an incumbrance upon the property.

*Requisitions.*

*Conveyances.*

When the title has been approved, or so soon as it appears reasonably certain that it will be accepted, the draft conveyance is prepared and submitted to the vendor. This is commonly done by and at the expense of the purchaser, who is entitled to determine the form of the conveyance, provided that the vendor is not thereby prejudiced, or put to additional expense. The common mode of conveying a freehold is now, as already mentioned, by ordinary deed, called in this case *an indenture*, from the old practice, where a deed was made between two or more parties, of writing copies upon the same parchment and then dividing it by an indented or toothed line. Indenting is, however, not necessary, and in modern practice is disused. A deed derives its efficacy from its being sealed and delivered. It is still a matter of doubt whether signing is essential. It is not necessary that its execution should be attested except in special circumstances, as, *e.g.*, where made under a power requiring the instrument exercising it to be attested. But in practice conveyances are not only sealed, but also signed, and attested by one or two witnesses. The details of a conveyance in any particular case depend upon the subject-matter and terms of the sale, and the state of the title as appearing by the abstract. The framework, however, of an ordinary purchase-deed consists of (1) the date and parties, (2) the recitals, (3) the testatum or witnessing-part, containing the statement of the consideration for the sale, the words incorporating covenants for title, and the operative words, (4) the parcels or description of the property, (5) the habendum, showing the estate or interest to be taken by the purchaser, and (6) any provisos or covenants that may be required. A few words will illustrate the object and effect of these component parts.

(1) The parties are the persons from whom the property, or some estate or interest in or in relation to it, is to pass to the purchaser, or whose concurrence is rendered necessary by the state of the title in order to give the purchaser the full benefit of his contract and to complete it according to law. It is often necessary that other persons besides the actual vendor should join in the conveyance, *e.g.*, a mortgagee who is to be paid off and convey his estate, a trustee of an outstanding legal estate, a person entitled to some charge or restriction who is to release it, or trustees who are to receive the purchase-money where a limited owner is selling under a power (*e.g.*, a tenant for life

under the power given by the Settled Land Act, 1882). Parties are described by their names, addresses, and occupations or titles, each person with a separate interest, or filling a distinct character, being of a separate part. (2) The recitals explain the circumstances of the title, the interests of the parties in relation to the property, and the agreement or object intended to be carried into effect by the conveyance. Where the sale is by an absolute owner there is no need for recitals, and they are frequently dispensed with; but where there are several parties occupying different positions, recitals in chronological order of the instruments and facts giving rise to their connexion with the property are generally necessary in order to make the deed intelligible. (3) It is usual to mention the consideration. Where it consists of money the statement of its payment is followed by an acknowledgment, in a parenthesis, of its receipt, which, in deeds executed since the C. A., 1881, dispenses with any endorsed or further receipt. A vendor, who is the absolute beneficial owner, now conveys expressly "as beneficial owner," which words, by virtue of the C. A., 1881, imply covenants by him with the purchaser that he has a right to convey, for quiet enjoyment, freedom from incumbrances, and for further assurance—limited, however, to the acts and defaults of the covenantor and those through whom he derives his title otherwise than by purchase for value. A trustee or an incumbrancer joining in the deed conveys "as trustee" or "as mortgagee," by which words covenants are implied that the covenantor individually has not done or suffered anything to incumber the property, or prevent him from conveying as expressed. As to the operative words, any expression showing an intention to pass the estate is effectual. Since the C. A., 1881, "convey" has become as common as "grant," which was formerly used. (4) The property may be described either in the body of the deed or in a schedule, or compendiously in the one and in detail in the other. In any case it is usual to annex a plan. Different kinds of property have their appropriate technical words of description. *Hereditaments* is the most comprehensive term, and is generally used either alone or in conjunction with other words more specifically descriptive of the property conveyed. (5) The habendum begins with the words "to hold," and the estate, on a sale in fee-simple, is limited, as already mentioned, not only *to*, but also *to the use of*, the purchaser. Before the C. A., 1881, it was necessary to add, after the name of the purchaser, the words "and his heirs," or "his heirs and assigns," though the word "assigns" never had any conveyancing force. But since that Act it is sufficient to add "in fee-simple" without using the word "heirs." Unless, however, one or other of these additions is made, the purchaser will even now get only an estate for his life. If the property is to be held subject to a lease or incumbrance, or is released by the deed from an incumbrance previously existing, this is expressed after the words of limitation (6) Where any special covenants or provisions have been stipulated for, or are required in the circumstances of the title, they are, as a rule, inserted at the end of the conveyance. In simple cases none are needed. Where, however, a vendor retains documents of title, which he is entitled to do where he sells a part only of the estate to which they relate, it is the practice for him by the conveyance to acknowledge the right of the purchaser to production and delivery of copies of such of them as are not instruments of record like wills or orders of Court, and to undertake for their safe custody. This acknowledgment and undertaking supply the place of the lengthy covenants to the like effect which were usual before the C. A., 1881. A trustee or mortgagee joining gives an acknowledgment as to documents retained by him, but not an undertaking. The foregoing outline of a conveyance will be illustrated by the following specimen of a simple purchase-deed of part of an estate belonging to an absolute owner in fee:—

THIS INDENTURE made the day of between A. B. of, &c., of the one part and C. D. of, &c., of the other part WHEREAS the said A. B. is seised (among other hereditaments) of the messuage hereinafter described and hereby conveyed for an estate in fee simple in possession free from incumbrances and has agreed to sell the same to the said C. D. for £100 NOW THIS INDENTURE WITNESSETH that in pursuance of the said agreement and in consideration of the sum of £100 paid to the said A. B. by the said C. D. (the receipt whereof the said A. B. doth hereby acknowledge) the said A. B. as beneficial owner doth hereby convey unto the said C. D. ALL THAT messuage or tenement situate &c., and known as, &c. TO HOLD the premises unto and to the use of the said C. D. his heirs and assigns [*or* in fee simple] And the said A. B. doth hereby acknowledge the right of the said C. D. to production and delivery of copies of the following documents of title [*mentioning them*] and doth undertake for the safe custody thereof IN WITNESS, &c.

It will be observed that throughout the deed there are no stops, the commencement of the several parts being indicated by capital letters. The draft conveyance having been approved on behalf of the vendor, it is engrossed upon stout paper or parchment, and there remains only the completion of the sale, which usually takes place at the office of the vendor's solicitor. A purchaser is not entitled to require the vendor to attend personally and execute the conveyance in his presence or that of his solicitor. The practice is for the deed to be previously executed by the vendor and delivered to his solicitor, and for the solicitor to receive the purchase-money on his client's behalf, since a purchaser is, under the C. A., 1881, safe in paying the purchase-money to a solicitor producing a deed so executed, when it contains the usual acknowledgment by the vendor of the receipt of the money. Upon the completion, the documents of title are handed over except in the case above referred to, and any claims between the parties in respect of interest upon the purchase-money, apportioned outgoings, or otherwise, are settled. The conveyance is, of course, delivered to the purchaser, upon whom rests the obligation of affixing the proper stamp—which he may do without penalty within thirty days after execution (Stamp Act, 1891). It may be added that, subject to any special bargain, which is rarely made, the costs of the execution by the vendor and other parties whose concurrence is necessary, and of any act required to be done by the vendor to carry out his contract, are borne by the vendor.

*Leases.*

Ordinary leases at rack-rents are not generally preceded by a formal agreement, such as is common on a sale of land, or by an investigation into the lessor's title. As a rule, the principal terms are arranged between the parties, and embodied with various ancillary provisions in a draft lease, which is prepared by the lessor's advisers and submitted to the lessee, the ultimate form and contents of the instrument being adjusted by negotiation. If an intending lessee desires to examine the title he must make an express bargain to that effect, for under a contract to grant a lease the intended lessee is not entitled, in the absence of such express stipulation, to call for the title to the freehold (V. and P. Act, 1874). By the Statute of Frauds all leases, except leases for a term not exceeding three years, and at not less than two-thirds of the rack-rent, were required to be in writing. And now by the Real Property Act, 1845, leases required by law to be in writing are void *at law* unless made by deed. An instrument, void as a lease under the Act, may, however, be valid as an agreement to take a lease; and since the Judicature Act, 1873, under which equitable doctrines prevail in the High Court, a person holding under an agree-

ment for a lease, of which specific performance would be granted, is treated in all branches of that court as if such a lease were already executed. Unless otherwise agreed, a lease is always prepared by a lessor's solicitor at the expense of the lessee; but the cost of the counterpart (*i.e.*, the duplicate executed by the lessee) is usually borne by the lessor.

*Assignment of leaseholds.*

Upon the sale and conveyance of a leasehold property substantially the same procedure is observed as above indicated in the case of a freehold. A few additional points, however, may be specially mentioned. Under an open contract the vendor cannot be called upon to show the title to the freehold reversion (V. and P. Act, 1874; C. A., 1881). Accordingly, the abstract of title begins with the lease, however old; but the subsequent title need not be carried back for more than forty years before the sale. The purchaser, apart from stipulation, must assume, unless the contrary appears, that the lease was duly granted, and upon production of the receipt for the last payment due for rent before completion, that all the covenants and provisions of the lease have been duly performed and observed up to the date of actual completion. The appropriate word of conveyance is "assign," and a conveyance of leaseholds is generally called an assignment. The vendor's covenants for title implied by his assigning "as beneficial owner" include, in addition to the covenants implied by those words in a conveyance of freehold, a covenant limited in manner above mentioned, that the lease is valid, and that the rent and the provisions of the lease have been paid and observed up to the time of conveyance (C. A., 1881). Where the vendor, as is the common case, remains liable after the assignment for the rent and the performance of the covenants, the purchaser must covenant to pay the rent, and perform and observe the covenants and provisions of the lease, and keep the vendor indemnified in those respects.

*Mortgages.*

A mortgage is prepared by the solicitor of the mortgagee, and the mortgagor bears the whole expenses of the transaction. It is seldom that there is any preliminary agreement, because (1) a contract to lend money is not specifically enforceable; and (2) inasmuch as the primary object of a mortgagee is to have his money well secured, he is not, generally, willing to submit to restrictions as to title or evidence of title which might give rise to difficulty or expense in the event of a sale of the mortgaged property. An intending mortgagor is accordingly required to show a title easily marketable, and to verify it at his own cost. A mortgage follows the same general form as a conveyance on sale, the principal points of difference being that the conveyance of the property is preceded by a covenant for the payment of the mortgage money and interest, and followed by a proviso for reconveyance upon such payment, and by any special provisions necessary or proper in the circumstances, such as a covenant for insurance and repairs where the security comprises buildings. The covenants for title implied by a mortgagor conveying "as beneficial owner" are the same as in the case of a vendor, but they are absolute and not qualified in the manner above pointed out.

The beneficial operation of the C. A., 1881, in shortening conveyances is well illustrated by a modern mortgage. For, by virtue of the Act, a mortgagee by deed executed after its commencement has, subject to any contrary provisions contained in the deed, the following powers to the like extent as if they had been conferred in terms: (1) a power of sale exercisable after the mortgage money has become due (*a*) if notice requiring payment has been served and not complied with for three months; (*b*) if any interest is in arrear for two months; or (*c*) there has been a breach of some obligation under the deed or the Act other than the covenant for payment of the mortgage money or interest; (2) a power to insure subject to certain restrictions; (3) a power, when entitled to sell, to appoint a receiver; and (4) a power while in possession to cut and sell timber. The Act contains ancillary provisions enabling a mortgagee upon a sale to convey the property for such estate or interest as is the subject of the mortgage, and to give a valid receipt for the purchase-money, and the purchaser is amply protected against any irregularities of which he had no notice. There are also large powers of leasing conferred by the Act upon mortgagor and mortgagee while respectively in possession, and a power for the mortgagor, whilst entitled to redeem, to inspect and take copies of title deeds in the mortgagee's possession. The elaborate provisions for all these purposes which were formerly inserted in mortgage deeds are now omitted; but sometimes the operation of the Act is modified in certain respects. The procedure upon a sale by a mortgagee is the same as in the case of any other vendor. He conveys, however, "as mortgagee," these words implying only a covenant by him against incumbrances arising from his own acts.

*Settlements.*

The frame of a strict settlement of real estate, which is usually made either on marriage or by way of resettlement on a tenant in tail under an existing settlement attaining twenty-one, has been much simplified; but such settlements still remain the most technical and most complicated of legal instruments. By virtue of the Settled Land Acts, 1882 to 1890, tenants for life and many other limited owners have extensive powers of sale, of leasing, and of doing numerous other acts required in a due course of management. These powers cannot be excluded or fettered by settlors. They are, as a rule, considered in practice to be sufficient, and the corresponding elaborate provisions formerly inserted in settlements are now omitted, the operation of the Acts being merely supplemented, where desirable, by some extension of the statutory powers, in relation, *e.g.*, to the investment and application of capital money. To complete the statutory machinery it is desirable that persons should be nominated by the settlement trustees for the purposes of the Acts. Since the C. A., 1881, provisions for the protection of jointresses or persons entitled under settlements to rent charges or annual sums issuing out of the land are no longer required, as all such persons have now powers of distress and entry, and of limiting terms to secure their respective interests. Terms for raising portions must still, however, be expressly created. The C. A., 1881, also confers large powers of management during the minorities of infants beneficially entitled upon persons either appointed for the purpose by the instrument or being such trustees as are mentioned in § 42. An estate in tail may now be limited by the use of the words "in tail" without the words "heirs of the body" formerly necessary. And a settlor generally conveys "as settlor," by which only a covenant for further assurance is implied under the C. A., 1881. Personal settlements are most often made upon marriage. The settled property is vested in trustees, either by the settlement itself, or in the case of cash, mortgage debts, stocks or shares, by previous delivery or transfer, upon trusts declared by the instrument.

The normal trusts after the marriage are (1) for investment; (2) for payment of the income of the husband's property to him for life, and of the wife's property to her for life for her separate use without power of anticipation whilst under coverture; (3) for payment to the survivor for his or her life of the income of both properties; (4) after the death of the survivor, both as to capital and income, for the issue of the marriage as the husband and wife shall jointly by deed appoint, and in default of joint appointment as the survivor shall by deed or will appoint, and in default of such appointment for the children of the marriage who attain twenty-one or being daughters marry, in equal shares, with the addition of a clause (called the hotchpot clause) precluding a child who or whose issue takes a part of the fund by appointment from sharing in the unappointed part without bringing the appointed share into account. Then follows a power for the trustees with the consent of the parents whilst respectively living to raise a part (usually a half) of the share of a child and apply it for his or her advancement or benefit. Power to apply income, after the death of the life tenants, for the maintenance and education of infants entitled in expectancy, is conferred upon trustees by the C. A., 1881. The ultimate trusts in the event of there being no children who attain vested interests are (1) of the husband's property for him

absolutely; and (2) of the wife's property for such persons as she shall when discovert by deed, or whether covert or discovert by will, appoint, and in default of appointment, for her absolutely if she survive the husband, but if not, then for her next of kin under the Statute of Distributions, excluding the husband. For all ordinary purposes the trustees have now under various statutes sufficient powers and indemnities. They may, however, in some cases need special protection against liability. A power of appointing new trustees is supplied by the Trustee Act, 1893. It is usually made exercisable by the husband and wife during their joint lives, and by the survivor during his or her life.

**Wills.** The form and contents of wills are extremely diverse. A will of, perhaps, the commonest type (*a*) appoints executors and trustees; (*b*) makes a specific disposition of a freehold or leasehold residence; (*c*) gives a few legacies or annuities; and (*d*) devises and bequeaths to the executors and trustees the residue of the real and personal estate upon trust to sell and convert, to invest the proceeds (after payment of debts and funeral and testamentary expenses) in a specified manner, to pay the income of the investments to the testator's widow for life or until another marriage, and subject to her interest, to hold the capital and income in trust for his children who attain twenty-one, or being daughters marry, in equal shares, with a power of advancement. Daughters' shares are frequently settled by testators upon them and their issue on the same lines and with the same statutory incidents as above mentioned in the observations upon settlements; and sometimes a will contains in like manner a strict settlement of real estate. It is a point often overlooked by testators desirous of benefiting remote descendants that future interests in property must, under what is known as the rule against perpetuities, be restricted within a life or lives in being and twenty-one years afterwards. In disposing of real estate "devise" is the appropriate word of conveyance, and of personal estate "bequeath." But neither word is at all necessary. "I leave all I have to A. B. and appoint him my executor" would make an effectual will for a testator who wished to give all his property, whether real or personal, after payment of his debts, to a single person. By virtue of the Land Transfer Act, 1897, Part I., real estate of an owner dying after 1897 now vests for administrative purposes in his executors or administrators, notwithstanding any testamentary disposition.

It remains to mention that by the Land Transfer Act, 1897, a system of compulsory registration of title, limited for the present to the county of London, has been established. (See LAND REGISTRATION.)

*United States.*—Conveyances of real estate in the United States are simple in form, and are often prepared by those who have had no professional training for the purpose. Printed blanks, sold at the law-stationers, are commonly employed. The lawyers in each state have devised forms for such blanks, sometimes peculiar in some points to the particular state, and sometimes copied verbatim from those in use elsewhere. Deeds intended to convey an absolute estate are generally either of the form known as *warranty deed* or of that known as *release deed*. The release deed is often used as a primary conveyance without warranty to one who had no prior interest in the land. Uniformity in deeds is rendered particularly desirable from the general prevalence of the system of recording all conveyances at length in a public office. Record books are printed for this purpose, containing printed pages corresponding to the printed blanks in use in the particular state, and the recording officer simply has to fill up each page as the deed of similar form was filled up. One set of books may thus be kept for recording warranty deeds, another for recording release deeds, another for recording mortgage deeds, another for leases, &c.

AUTHORITIES.—DAVIDSON. *Precedents and Forms in Conveyancing.* London, 1877 and 1885.—KEY and ELPHINSTONE. *Compendium of Precedents in Conveyancing.* London, 1899.—ELPHINSTONE. *Introduction to Conveyancing.* London, 1900. —POLLOCK. *The Land Laws.* London, 1896.

(S. WA.; S. E. B.)

**Conway** (or ABERCONWAY), a summer resort, municipal town, and parish in the county of Carnarvon, Wales, 14 miles by rail north-east from Bangor and 225 north-west from London. It is built on the side and at the foot of a hill (800 ft.) at the mouth of the river Conway, with Great Orme's Head and Llandudno 4 miles to the north. The river is crossed by two bridges—a tubular railway bridge, similar to that at Menai and only 40 feet shorter, built by Stephenson in 1846–48, and a handsome suspension bridge, designed by Telford and built of white stone, in keeping with the castle, in 1822–26. One of the old houses of the town, the Elizabethan Plas Mawr, is the headquarters of the Royal Cambrian Academy of Art. There are still a few fragments of the Cistercian abbey founded in 1185. The principal public buildings are the guildhall and the market hall; and there are a new bronze fountain, a convalescent home for children, and golf links. Area of the parish, 2437 acres; of the municipal borough, 3312 acres. Population of borough (1891), 3442; (1901), 4660. The river Conway, about 30 miles long, drains the beautiful Vale of Conway, in which stand Bettws-y-Coed, Llanrwst, and Trefriw, the last-named a favourite artists' haunt.

**Cooch** (or Kuch) **Behar,** a native state of India, in Bengal, a submontane tract, not far from Darjiling, entirely surrounded by British territory. Area, 1307 sq. m. Population (1881), 602,624; (1901), 567,037. The gross revenue in 1897–98 was Rs.22,39,668. The present Maharaja, Nripendra Narayan, G.C.I.E., was born in 1862 and educated under British guardianship at Patna and Calcutta. He is Hon. Lieutenant-Colonel of the 6th Bengal Cavalry. In 1897–98 he served in the Tirah campaign on the staff of General Yeatman-Biggs, and received the distinction of a C.B. In 1878 he married a daughter of Keshub Chundra Sen, the Brahmo leader. His eldest son has been educated in England. Among other improvements, a railway has been constructed, with the assistance of a loan from the British Government, for a length of 22 miles, which is now being extended for a farther 12 miles. The earthquake of 12th June 1897 caused damage to public buildings, roads, &c., in the state to the estimated amount of Rs.15,00,000.

The town of COOCH BEHAR is situated on the river Torsha, and has a railway station; population, 9535.

**Cook, Eliza** (1818–1889), English author, was born in 1818, in Southwark, being the daughter of a local tradesman. She was self-taught, and began when a girl to write poetry for such periodicals as the *Weekly Dispatch* and *New Monthly*. In 1840 she published *Melaia and other Poems*, and from 1849 to 1854 conducted a paper for the family called *Eliza Cook's Journal*. She also published *Jottings for my Journal* (1860), and *New Echoes* (1864); and in 1864 she was given a Civil List pension of £100 a year. As the author of a single poem, "The Old Armchair," Eliza Cook's name was for a generation after 1838 a household word both in England and in America, her kindly domestic sentiment making her a great favourite with the working-class and middle-class public. She died at Wimbledon, 25th September 1889.

**Cook, Thomas** (1808–1892), travelling agent, was born at Melbourne in Derbyshire on 22nd November 1808. Beginning work at the age of ten, he was successively a gardener's help and a wood-turner at Melbourne, and a printer at Loughborough. At the age of twenty he became a Bible-reader and village missionary for the county of Rutland; but in 1832, on his marriage, combined his wood-turning business with that occupation. In 1840 he became actively associated with the temperance movement, and printed at his own expense various publications in its interest, notably the *Children's Temperance Magazine*, the first of its kind to appear in England.

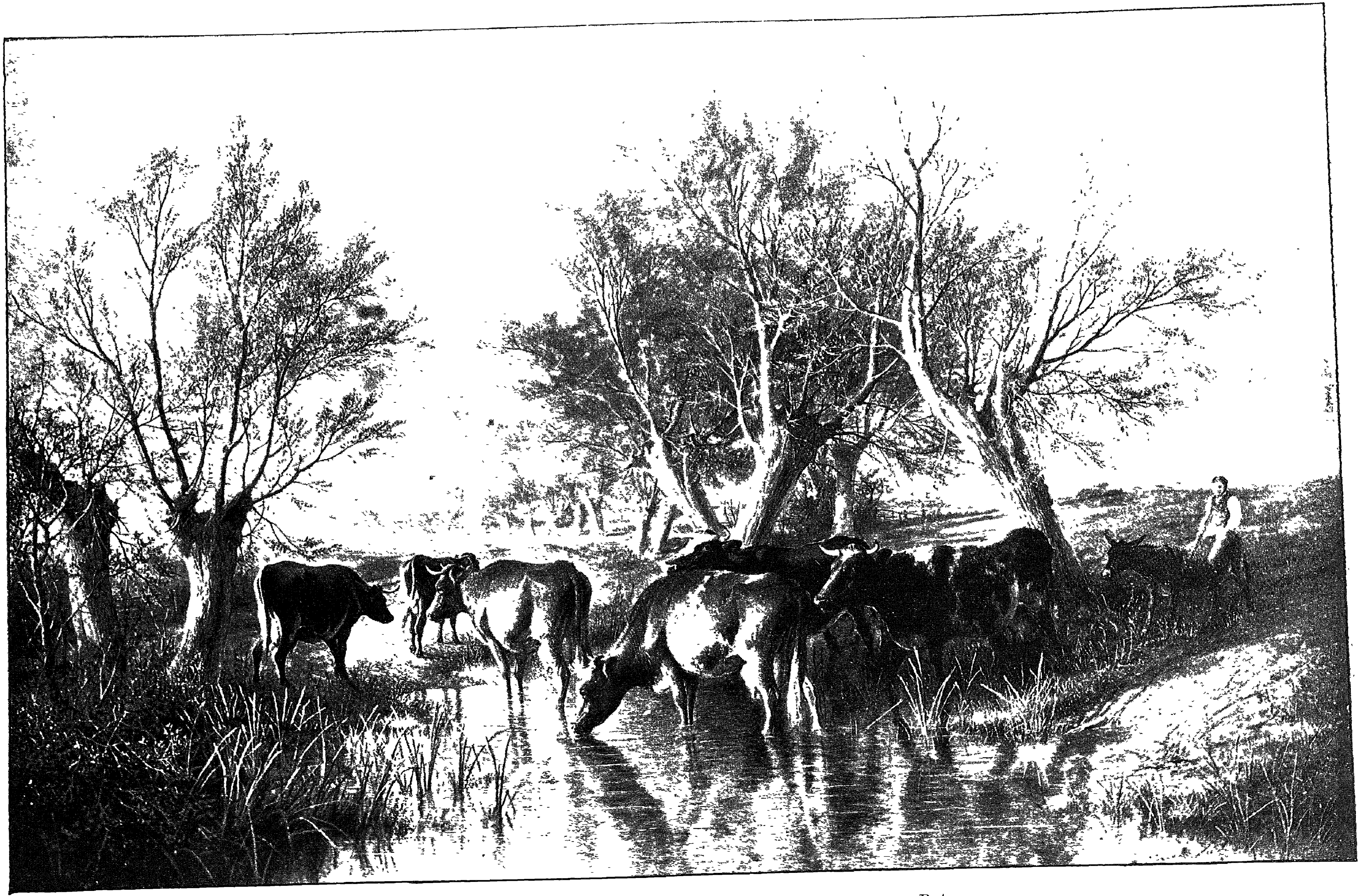
In June 1841 a large meeting was to be held at Loughborough in connexion with this movement, and Cook was struck with the idea of getting the railway company to run a special train from Leicester to the meeting. The company consented, and on 5th July there were carried 570 passengers from Leicester to Loughborough and back at a shilling a head. This is believed to be the first publicly-advertised excursion train ever run in England—private "specials," reserved for members of institutes and similar bodies, were already in use. The event caused great excitement, and Cook received so many applications to organize similar parties that he henceforward deserted wood-turning, while continuing his printing and publishing. The summers of the next three years were occupied with excursions like the first; but in 1845 Cook advertised a pleasure-trip on a more extensive scale, from Leicester to Liverpool and back, with opportunities for visiting the Isle of Man, Dublin, and Welsh coast. A *Handbook of the Trip to Liverpool* was supplied for the use of travellers. A trip to Scotland followed, and the excursionists were received in Glasgow with music and salute of guns. The next great impetus to popular travel was given by the Great Exhibition of 1851, which Cook helped 165,000 visitors to attend. On the occasion of the Paris exhibition of 1855 there was a Cook's excursion from Leicester to Calais and back for £1, 10s. The following year saw the first grand circular tour in Europe. This part of Cook's activity largely increased after 1863, when the Scottish railway managers broke off their engagements with him, and left him free for more distant enterprise. Switzerland was opened up in 1863, and Italy in 1864. Up to this time "Cook's tourists" had been personally conducted, but now he began to be an agent for the sale of English and foreign tickets, the holders of which travelled independently. Switzerland was the first foreign country accessible under these conditions, and in 1865 nearly the whole of Europe was included in the scheme. Its extension to the United States followed in 1866. For the benefit of visitors to the Paris exhibition, Cook made a fresh departure and leased a hotel there. In the same year began his system of "hotel-coupons," providing accommodation at a fixed charge. The year 1869 was marked by an extension of Cook's tours to Palestine, followed by further developments of travel in the East, his son, John Mason Cook, being appointed in 1870 agent of the Khedivial Government for passenger traffic on the Nile. The Franco-Prussian war of 1870–71 was expected to damage the tourist system, but, as a matter of fact, encouraged it, through the demand for combination, international tickets enabling travellers to reach the south of Europe without crossing the belligerent countries. At the termination of the war a party of American freemasons visited Paris under Mr J. M. Cook's guidance, and became the precursors of the present vast American tourist traffic. At the beginning of 1872 Mr J. M. Cook entered into formal partnership with his father, and the firm first took its well-known appellation of Thomas Cook and Son. In 1882, on the outbreak of Arabi Pasha's rebellion, Cook and Son were commissioned to convey Sir Garnet Wolseley and his suite to Egypt, and to transport the wounded and sick up the Nile by water, for which they received the thanks of the War Office. The firm was again employed in 1884 to convey General Gordon to the Sudan, and the whole of the men (18,000) and stores necessary for the expedition afterwards sent to relieve him. In 1889 Cook and Son acquired the exclusive right of carrying the mails, specie, soldiers, and officials of the Egyptian Government along the Nile. In 1891 the firm celebrated its jubilee, and on 19th July of the following year Thomas Cook died. He had been afflicted with blindness in his declining years. (J. M'F.)

**Cook** or **Hervey Islands,** a Polynesian archipelago lying about the Tropic of Capricorn, some 700 miles south by east of Samoa, mainly between 150°–160° E. long. It comprises ten partly volcanic, partly coralline, islands, the more important of which are *Rarotonga*, hilly, fertile, and well watered, with several cones 300 to 400 feet high, above which towers the majestic Rarotonga volcano (4000 feet), the culminating point of the archipelago; *Mangaia* (*Mangia*); *Aitaluki*, with luxuriant cocoanut palm groves; *Atui* (*Vatui*); *Mitiero; Mauki; Fenuaiti;* and the two *Hervey* islets, which give an alternative name to the group. The total area is 142 square miles, and the population in 1900 was 8400. Owing to its healthy, equable climate, the archipelago is well suited for European settlement; but the dangerous fringing coral reefs render it difficult of access, and it suffers also from the absence of good harbours. The natives, who are of Polynesian stock and speech, are nearly all Protestants, and since 1890 have enjoyed a general Legislature and an Executive Council, of which the *Arikis* ("Kings" and "Queens") are members. But all enactments are subject to the approval of the British Resident at Rarotonga, and a British Protectorate, proclaimed in 1888, was followed by the annexation of the whole archipelago by the Governor of New Zealand in November 1900.

**Cooktown,** a seaport in Queensland, Australia, in the county of Banks, at the mouth of the Endeavour river, about 1050 miles north-west of Brisbane. It is visited by the ocean steamers of several lines, and is the centre of a very extensive *bêche de mer* and pearl fishery. Tin and gold are worked in the district. The population in 1898 was estimated at 2560.

**Coolgardie,** a town in West Australia, about 310 miles by rail east by north of Perth and Freemantle, and 528 miles by rail north-east of Albany. Its goldfield, now considered a permanent one, was discovered in 1891. In course of time it will probably be connected with Esperance, the natural port of the goldfield, by railway. Its population was estimated in 1898 at 13,000; that of the goldfield at about 30,000.

**Cooper, Peter** (1791–1883), American manufacturer, inventor, and philanthropist, was born in New York on 12th February 1791. As a boy he worked with his father at hat-making, brewing, and brick-making, and had little opportunity for attending school. At the age of seventeen he was apprenticed to a carriage-builder. When he became of age he engaged in the manufacture of machines for shearing cloth, and during the war of 1812 his business was very profitable. Later he took up with success the manufacture of glue. About 1828 he erected the Canton Iron Works at Baltimore, Md., and in this enterprise laid the foundations of his fortune. In 1830 he designed and constructed the first locomotive built in America. He subsequently sold his works at Baltimore, and erected at Philippsburgh, Pa., the largest blast furnaces erected in America up to that time, and enlarged his enterprise by purchasing iron mines in the vicinity and building a railway to transport their ore to his furnaces. He was actively interested in the laying of the first Atlantic cable. His memory is perpetuated in the Cooper Union for the Advancement of Science and Art, which he founded in New York in 1854. This splendid institution is designed especially to furnish educational opportunities to the working classes. Its principal features are a free library and reading-room, lecture courses, and night and day classes. In the election of 1876 he was the candidate of the National Independent party for the presidency. He died in New York, 4th April 1883.



"Return to the Farm: Milking Time." By Sidney Cooper, R.A.

**Cooper, Thomas Sidney** (1803–1902), English painter, was born at Canterbury on 26th September 1803. In very early childhood he showed in many ways the strength of his artistic inclinations, but as the circumstances of his family did not admit of his receiving any systematic training, he began before he was twelve years old to work in the shop of a coach painter. A little later he obtained employment as a scene painter; and he alternated between these two occupations for about eight years. But the desire to become an artist continued to influence him, and all his spare moments were given up to drawing and painting from nature. At the age of twenty he went to London, drew for a while in the British Museum, and was admitted as a student of the Royal Academy. He then returned to Canterbury, where he was able to earn a living as a drawing-master and by the sale of sketches and drawings. In 1827 he settled in Brussels; but four years later he returned to London to live, and by showing his first picture at the Royal Academy (1833) began an unprecedentedly prolonged career as an exhibitor. Cooper's name is mainly associated with pictures of cattle or sheep, and the most notable of the many hundred he has produced are: "A Summer's Noon" (1836), "A Drover's Halt on the Fells" (1838), "A Group in the Meadows" (1845), "The Half-past One o'Clock Charge at Waterloo" (1847), "The Shepherd's Sabbath" (1866), "The Monarch of the Meadows" (1873), "Separated but not Divorced" (1874), "Isaac's Substitute" (1880), "Pushing off for Tilbury Fort" (1884), and "On a Farm in East Kent" (1889). He was elected an Associate of the Royal Academy in 1845, and a Royal Academician in 1867. He presented to his native place, in 1882, the Sidney Cooper Art Gallery, built on the site of the house in which he was born. He wrote his reminiscences, under the title of *My Life*, in 1890; and died on 7th February 1902.

**Co-operative Societies.**—The progress of co-operation, during the last twenty years of the 19th century, was very remarkable, both in the United Kingdom and abroad. Not only have the societies, in spite of numerous failures, greatly increased in number, membership, capital, and trade, but they have come into close relations, both commercial and for propaganda, with other co-operative societies in their own country and abroad; and finally an important International Co-operative Alliance has been formed for promoting mutual helpfulness and international trading relations.

The following figures show the growth of co-operation—that is to say, of working-class co-operation—in the United Kingdom:—

| | Societies. | Members. | Capital. | Business. |
|---|---|---|---|---|
| 1876 . . | 1113 | 493,189 | £5,742,297 [1] | £18,647,817 [1] |
| 1899 . . | 1858 | 1,675,998 | 28,267,398 | 75,422,895 |

Practically all these societies are registered with limited liability under the Industrial and Provident Societies Acts, their government is democratic, based on one vote for man or woman; and their members (or shareholders) and committeemen are almost exclusively the more provident of the working classes or belong to the class just above.

By far the greater part of these figures represent Workmen's Distributive Societies, or stores, flourishing chiefly in the North and Midlands of England and in Scotland, and numbering 1446, with 1,613,461 members, £22,294,624 capital, and sales of £45,047,446 in the year. The largest is that of Leeds, with 49,000 members and £1,500,000 sales. The shares in these societies are withdrawable in cash and not transferable. Their method is the "Rochdale system," now spread over the world, by which the twenty-eight poor weavers of Rochdale made co-operation, until then little but a dream and a series of failures, into a great practical success. A record is kept, by means of metal checks or otherwise, of each member's purchases; and at the end of each quarter, after payment of a fixed interest (never more than 5 per cent., and in very many societies less) on shares, and sometimes a proportion of profit to the employees, the surplus is divided to the members in proportion to their purchases. Thus they in effect obtain their necessaries at cost price. Not far from £7,000,000 is thus returned in the year, averaging nearly 2s. 8d. in the £ of purchases. In many successful societies an even higher dividend on purchases is paid, but the average prices of goods sold are often fixed above those current in the neighbourhood, so that the members, in addition to saving the retailer's profit, use their Society as a sort of savings bank, where they put away a halfpenny or so for every shilling they spend. In addition to retailing, a store often manufactures bread, clothes, boots, or flour, or farms land, usually for its own members only, but occasionally for sale to other societies also. Their productions in this way reach about £4,000,000 a year. They also invest large and increasing sums in building cottages to sell or let to their members; and they lend largely to their members to enable them to buy cottages.

***Distribution.***

Outwardly these stores may look like mere shops, but they are really much more. First, they are managed with a view not to a proprietor's profit but to cheap and good commodities. Secondly, they have done an immense work for thrift and the material prosperity of the working classes, and as teachers of business and self-government. But, further, they have a distinct social and economic aim, namely, to correct the present inequalities of wealth, and substitute for the competitive system an industry controlled by all in the common interest and distributing on principles of equity and reason, mutually agreed on, the wealth produced. With this view they acknowledge the duties of fair pay and good conditions for their own employees, and of not buying goods made under bad conditions. The best societies further set aside a small proportion of their profits for educational purposes, including concerts, social gatherings, classes, lectures, reading-rooms and libraries. They often make grants to causes with which they sympathize; and their members are often prominent in local government affairs, co-operative candidates being occasionally run for school-boards and town councils. Though the societies are non-political, they are usually centres of "progressive" ideas. There are of course many defects, and of their million and two-thirds members a large, and many fear an increasing, proportion, attracted by the prosperity of the societies, think chiefly of what they themselves gain; but the government of the movement has, hitherto at least, been largely in the hands of men of ideas who believe that stores are but a step to co-operative production and on to the "co-operative commonwealth."

***Aims.***

It is indeed only when we come to federations of co-operative societies, and above all to production, with its large number of employees, that the industrial and educational side of the movement is most seen. The Co-operative Union, Limited, for instance, is a propagandist federation of all the chief co-operative societies in Great Britain, and some in Ireland, which does a great amount of educational work. Its income is over £8000 a year; it looks after the legal and parliamentary interests of the societies, carries on much educational work by means of literature, lectures, classes, scholarships, summer meetings at the universities, and so on; organizes numerous local conferences for discussion, and once a year a great national Co-operative Congress and Exhibition of productions, in some chief centre of population. The Co-operative Wholesale Society, Limited, is a trading federation of nearly 1100 stores, which include over 1,300,000 individuals. Founded in 1863 on a small scale, in 1901 its capital was £3,314,887 and its employees about 11,000. Its sales in 1901 were estimated to reach £17,000,000. Besides its merchant trade, it manufactures to the value of £2,500,000, owning factories, warehouses, and land in many districts. It owns steamships and is a large importer, and is also the bank of the Co-operative Societies, and the chief outlet for the always redundant capital of the stores. The Scottish stores also have their Wholesale Society, not less important relatively. For many purposes these two societies are in partnership. Their net profits are returned to the stores as a dividend on purchases, and thence to the whole body of members. There are also smaller local federations of stores, mostly for corn-milling and baking.

***Production.***

Strongly contrasting with this production by associations of consumers, or "consumers' production," is the co-partnership or "Labour Co-partnership" branch of co-operation. The simplest form of such co-operation is an association of producers formed to carry on their own industry. Originally such associations were intended to consist solely of the workers employed, but membership is now open to the distributive societies, which are their chief customers, and usually to all sympathizers. Shares are transferable, not withdrawable. Profits first pay the agreed "wages of capital," and of what remains the main part goes to the employees as a dividend on their wages and to the customers as a dividend on their purchases. In well-established societies the dividends on wages average about 1s. on the £ of wages. This is not usually paid in cash, but credited to the employees as share capital, whereby all may become members. Besides other producers' associations,

***Co-partnership.***

[1] Figure not quite complete.

more or less co-operative, there were, at the end of 1900, 90 such co-partnership associations at work in England. Some of them are very small, while others have businesses of £40,000 a year or more; the majority show fair, sometimes large, profits. Each is governed by a committee, or directors, who are elected by the members and appoint a manager.

We constantly hear that co-operative production is a failure. There have no doubt been many failures, especially of big experiments attempted among men totally unprepared. But many of the failures counted were not truly co-operative. At the present day consumers' production is successful beyond all question, while the net growth of producers' associations in recent years has been marked both in number and importance. These two forms of production best illustrate the two rival theories which divide British co-operation, and between whose partisans the conflict has at times been sharp. The consumers' theory maintains that all profit on price is abstracted from the consumer and must be returned to him; while to him should also belong all capital and control, subject to such regulations as the State and the Trade Unions enforce. This theory is fully exemplified in the English Wholesale Society, and in one of the corn mills, which employ workmen, whether co-operators or not, for wages only and admit no individual, but only co-operative societies, to membership. It is also exemplified by the great majority of the stores, though in their case the employee may become a member in his capacity as a consumer. The co-partnership theory, on the other hand, maintains that the workers actually employed in any industry, whether distributive or productive, should be partners with those who find the capital, and those who buy the produce, and should share with them profit, responsibilities, and control. The consumers' party contend that societies of producers make a profit out of the consumers, and thus are never truly co-operative, while as they multiply they must compete against each other. The co-partnership party answer that labour at least helps to make the profit, and that competition, as yet almost insignificant between their societies, can be avoided by federating them (a process long ago begun) for buying and selling in common, and for other common purposes, while leaving each the control and responsibility of its own affairs. They further advocate the eventual federation of the productive wing of co-operation with the distributive wing for settling prices and all matters in which their interests might conflict. In this way they say the co-operative system may extend indefinitely without sacrificing either individual responsibility and freedom, or a general unity and control, so far as these are necessary to secure the common interest. On the other hand they hold that the opposing system tends more and more to centralization and bureaucracy, and divorces the individual workman from all personal interest in his work and from any control over its conditions. They contend, moreover, that, in spite of the great advantages consumers' production has in its command of a market and of abundant capital, only a small part of industry can ever be carried on by associations of the persons who actually consume the produce.

***Rival theories.***

On the working out of these two principles depends the future of co-operation. The example of Scotland probably throws light on the problem. There co-operative production, amounting in 1900 to £1,815,042, is nearly all carried on by federations of consumers' societies, including the Scottish Wholesale, applying more or less successfully the co-partnership principle—*i.e.*, their employees are admitted to share in profits, and may become members, whereby they are further admitted to share capital and control. The type of organization hence resulting is very much the same as where a society of producers admits consumers' societies to membership and sets aside a proportion of the profits to be returned to them as dividend upon their purchases. To this type, we have seen, English productive societies started by producers have come, and it would appear that those started by consumers must tend to it. Besides the societies already mentioned, the Irish co-operative dairies rank as co-partnership. The earliest and latest statistics of British and Irish co-operative productive societies, of whatever origin, accepting that principle are:—

| | 1883. | 1900. |
|---|---|---|
| Societies at work | 15 | 265 |
| Trade | £160,751 | £3,553,593 |
| Capital | £106,436 | £1,547,729 |
| Profits | £9,031 | £158,315 |
| Losses | £114 | £7,418 |
| Dividend on Wages | Unknown | £20,545 |

An association of co-operative societies and individuals, called the Labour Association, exists to maintain this principle of co-partnership in co-operative production and also promote its gradual adoption in businesses of a capitalistic character. Some progress in this latter direction is being made, there being a tendency to improve upon mere profit-sharing by capitalizing the workman's "bonus," whereby he becomes a shareholder, and the business is gradually modified in a co-operative direction. There are remarkable instances of such modification abroad, notably that of the great iron-foundry and "Familistère" at Guise in France; the most noteworthy in England is that of the South Metropolitan Gas Company. After only a few years of the system 3000 workers own shares worth over £103,000 besides £33,000 on deposit; they also elect two of themselves directors of the Company. Unfortunately this example is marred by a feud with the Trade Unions, whereas there is usually friendship and even alliance between Trade Unionism and co-partnership, and other, co-operative societies.

In Ireland stores have not hitherto flourished, though a few exist. Irish co-operation is agricultural, and dates from the foundation of one co-operative dairy in 1889. Thence has grown a movement already of great importance and rapidly advancing. In 1890 there was still only one such society, in 1891 there were 17, but on 31st December 1900 there were 412, of which 171 were dairies, 106 agricultural societies, and 76 banks. By August 1901 the societies numbered about 470, of which of course not all were yet at work, and the members about 54,000. To form a dairy the small working farmers of a district register a society and take up shares of £1 each, in proportion to the number of their cows. Each brings his milk to be separated, is paid for the butter-making material it contains, and receives back skim milk. Any profit is divisible, nine-tenths to the suppliers of milk in proportion to the value of their supplies, and one-tenth to the dairy employees as dividend on wages. These dairies in 1900 produced butter worth more than £700,000. Their rapid spread is due to their great influence in improving the quality of butter, and hence raising the farmers' gains. The "agricultural" societies are chiefly engaged in buying farm requisites pure and cheap, and retailing them among their members; in this way they have saved the farmers very large sums. Their trade is about £100,000. The co-operative banks, many of them just beginning, are of the Raiffeisen type described later (though a few have limited liability) and aim at providing the peasants with necessary capital and expelling the usurer. They are increasing rapidly. Among miscellaneous objects of co-operation are selling eggs, poultry, barley, and pigs, joint ownership of machinery, joint grazing, potato-spraying, producing flax, and so on, and these promise a great growth in number and variety. The dairy societies, moreover, have federated into an agency for reaching the English market; and the agricultural societies into an Irish Wholesale for purchasing to the best advantage. Besides the direct profits and economies of these societies, they have greatly benefited Ireland by teaching men of all classes, parties, and religions to act together for peaceful progress; they have led to a wide diffusion of better agricultural knowledge, and to the establishment by Government of the Agricultural Department.

***Irish agriculture.***

Turning abroad we find, in almost all civilized countries,

important and growing movements roughly similar to those above described, but, on the whole, less identified with the working classes, and less coloured by their social and economic ideals. The most prominent fact since 1877 is the great growth of agricultural co-operation from small dimensions, till it amounts to a great force almost everywhere, and in some countries to a revolution; notably in Denmark, where almost every village is an example of varied co-operation, dealing with butter, eggs, bacon, stock, bee-keeping, or fruit-growing, or with the supply of household or farm requisites, to the great enrichment of the country. Co-operative dairies first appeared in Denmark in 1882; in 1900 they numbered 1052, dealt with four-fifths of all the milk of the country, and produced butter worth £7,000,000. Co-operative bacon factories began in 1887, and in 1900 dealt with six-tenths of all the pigs; and so on. Agricultural co-operation is now the strongest branch of the movement in France, and its backbone are the agricultural syndicates or associations. These, though they began only in 1883, numbered 1500 in 1895, and now probably number 2500, with 700,000 to 800,000 members. They are not technically co-operative societies, but rather trade unions, and they have certain political and professional aims; but they do an immense amount of co-operative work, especially in associated buying, and they spread the spirit of association everywhere, and promote many strictly co-operative societies. Everywhere the main features of this agricultural movement, alike in France, Germany, Italy, Belgium, Holland, or in Canada, New Zealand, and the United States, are similar to those we have seen in Ireland and Denmark; it is supplementary to individual cultivation; hardly ever does it appear as associations for cultivating in common, and, speaking generally, it has no very ideal aims, but seeks chiefly to give the farmer a better profit: especially it brings within reach of the peasant many of the advantages of large farming. In England there are a number of farms worked by stores, and several large associations for the supply of farm requisites, but the typical agricultural co-operation, based on the small village societies and federations of such societies, has been almost unknown. An attempt is, however, being made to promote such a movement on the lines which have been successful in Ireland.

*Foreign countries.*

As part of agricultural co-operation we may reckon the development of an entirely new type of credit co-operation. The Schultze-Delitzsch credit societies are primarily town institutions, and while they have multiplied and grown great, and sometimes grown capitalistic, many thousands of country folk have learnt to bless the little Raiffeisen loan banks. Such a bank is an association of neighbours uniting to borrow a sum of money, in order to lend it out as cheaply as possible in small sums to such of themselves as need loans. It also receives savings deposits, which often produce a large part or even all the capital the society needs to lend. Usually a few of the members are persons of rather more means than the others, and join to help their neighbours by increasing the society's credit. These have no special privilege, but by common consent they usually take a leading part. In the true Raiffeisen bank the liability of each member is unlimited, but limited liability has been introduced in some of its modifications. The society confines its operations strictly to a small area, say a parish, where every one knows every one. Each borrower must specify the purpose for which he wants a loan, say to buy a cow or drain a field, or pay off a moneylender, and this is rigorously inquired into. Any member, however poor, can obtain a loan for a profitable approved purpose, and no one, however rich, can obtain one on any other terms. Practically all the members see that the money is applied as agreed, and while the loans are often made for long periods—a year or two, or several, so as to repay themselves out of the profit—power is reserved to call them in at short notice if misapplied. No bills, mortgages, or other securities are taken, except a note of hand with sometimes one or two sureties. There are two committees, one to lend and do the work of the society, and the other to supervise the first. While the directors of the Schultze-Delitzsch societies get commission on the business done, there is no remuneration for services in the Raiffeisen societies except that the accountant gets a small salary. There are no shares, or only shares of a very small value, and practically nothing is paid on them as interest or dividend.

*Raiffeisen loan banks.*

These Raiffeisen banks boast that neither member nor creditor has ever lost a penny by them, and while this is denied, it seems at least near the truth. Their credit is so good that they can obtain money at very low rates, and as their expenses are trifling they can re-lend to their members at very little more. In Germany they usually lend at about 5 per cent. Only men of good character can obtain membership, and thus, besides spreading prosperity, these societies have everywhere been great promoters of sobriety and good conduct. They exist solely for the sake of the members as borrowers, and make no profit, except a little for reserve, whereas the Schultze-Delitzsch Bank works for profit, and puts first the interest of the members as small capitalists and lenders. The Raiffeisen banks have a purely mutual character, free from any element of capitalism; it is even alleged that the members can never divide out the reserve; if they fall short of the co-operative ideal it is in the matter of self-help, seeing that the presence of some richer members is necessary, or at least very desirable. In self-help the Schulze-Delitzsch system is specially strong. Raiffeisen founded the first such bank in 1849, just before Schultze-Delitzsch founded his first; the second in 1854. The third began in 1862, and so on. Not till 1880 did they begin really to spread.

Though co-operative credit societies are split up into innumerable groups, insisting on various minor modifications, and making various compromises between the two systems, these two types really include them all. They have spread from Germany into almost all European countries, even at last to Ireland and England, besides America and Asia. In Germany there were in March 1901, out of a total of 19,557 co-operative societies, 12,140 credit associations, and these lent out in 1900 more than £120,000,000. In Italy, Austria, and Hungary they are also strong. In 1896 it was estimated that £150,000,000 a year must be very well within the total amount lent by money co-operation on the Continent of Europe: £190,000,000 may be estimated for 1900. Of this total only a small percentage represents loans by banks of the Raiffeisen type, which, though very numerous, often lend only a few hundred pounds each in the year.

While English and some other forms of co-operation have always repudiated State help, and probably rightly so far as their own work is concerned, it is very noticeable that in the modern development of agriculture the action of the State and of local authorities has played a great part in performing or assisting functions which neither voluntary association nor individual enterprise could well perform alone; in providing technical education, expert advisers, exhibitions and prizes; in distributing information in all forms; in finding out markets, controlling railway rates, subsidizing steamboats, and even grading, branding, warehousing, and freezing produce, and maintaining trade agents abroad. These things have of course not been done for co-operative societies alone, but for agriculture in general; but co-operation has benefited, and much has been done expressly to encourage the formation of associations of cultivators, and provincial and national federations of such associations; and government departments of agriculture are found acting through such bodies, and with their advice and assistance. Indeed, harm has sometimes been done by subsidizing and forcing co-operative societies, whether for political motives or merely from mistaken policy. Experience shows that governments can do a very great deal, at least for agricultural co-operation, but only on condition that they encourage and do not undermine self-help and

*State action.*

private initiative. Thus while we sometimes find voluntary association advocated as a step towards, and sometimes on the other hand as a substitute for and bulwark against state-socialism, we find in practice these two forces working each in its own sphere and in a manner complementary one to the other, while underlying and essential to both is the force of individual action and self-help.

Amongst minor but still important developments may be mentioned the steady growth of co-operative production in France; the co-operative labour gangs, or rather societies, which undertake building and navvying work in Italy; the socialist co-operation, which supports political organizations, a press, and members of parliament, in Belgium; and the letting out of railway construction to co-operative groups of workmen in New Zealand and Victoria. It has been roughly estimated that altogether the members of one or other branch of co-operation number 6,000,000, representing with their families a population of 25,000,000 people.

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(A. WI*.)

**Coorg** (*Kodagu*=steep mountains), a province of India, administered by a Commissioner, subordinate to the Governor-General through the Resident of Mysore, who is officially also Chief Commissioner of Coorg. It lies in the south of the peninsula, on the plateau of the Western Ghats, sloping inland towards Mysore. It is now an attractive field of coffee cultivation, though the greater part is still under forest. The administrative headquarters are at Mercara (population, 7034).

Its area is 1583 square miles. In 1881 the population was 178,302; in 1891 it was 173,055, showing a decrease of 3 per cent., and an average density of 109 persons per square mile. This decrease is attributed partly to the decline of the coffee industry, and partly to the high mortality among immigrant coolies. The indigenous population increased by no less than 16 per cent., while the immigrant population decreased by 29 per cent. In 1897, which was an exceptionally unhealthy year, the registered death-rate was as high as 50·38 per thousand. Classified according to religion and race, the indigenous Coorgs numbered 32,611; Hindus, 124,234; Mahommedans, 12,665; native Christians, 2931; Europeans, 249; Eurasians, 212; Jains, 114; Parsis, 39. In 1901 the population was 180,461, showing an increase of 4 per cent.

The gross revenue in 1897–98 was Rs.8,38,000, and the total expenditure Rs.5,73,100. The cultivated area is 206,541 acres, of which 95,247 are under rice and 86,155 under coffee. The total area assessed for coffee is 106,611 acres, of which 31,732 acres are held by European planters. Some abandoned coffee land has been planted with tea, as an experiment. The cultivation of cinchona has proved unprofitable. The total exports are estimated at Rs.22,49,000, including 2462 tons of coffee, valued at Rs.19,69,600. The imports are estimated at Rs.29,02,000. There is no railway. In 1896–97 the number of schools was 120, attended by 5115 pupils. The proportion of boys at school was 30 per cent. of those of school-going age, compared with 2·3 per cent. for all India; the proportion of girls was 7 per cent., compared with 2·3 per cent. for all India. There are no colleges, but 24 scholarships are given to maintain Coorg students at colleges in Madras and Mysore. There are two secondary schools, at Mercara and Virajendrapet, with 647 pupils, two printing-presses, one of which issues the *Coorg Gazette,* and seven dispensaries.

**Copan.**—Since the time of Stephens this ruined city of the Mayas in North Honduras has again been several times visited by Mr A. P. Maudsley during the eighth and ninth decades of the 19th century. His chief finds have been some elaborately sculptured monoliths, standing still erect, or inclined like the Tower of Pisa, and a fine ornamental doorway of a temple. He has also made the important discovery that all the truncated pyramidal mounds were at one time crowned with temples, and are thus shown to be of the same character as those at Uxmal, Chichen-Itza, and other places in Yucatan, *i.e., teocalli,* "God's Houses," like the pyramids of Cholula, Teotihuacan, and Papantla in Mexico. Drawings, castings, and rubbings were taken of several of the monuments, and are published in the *Biologia Centrali-Americana.* Professor Eduard Seler of Berlin also explored the place in 1897, that is, less than three years after Maudsley's last visit, and found that in that short interval many of the remains had again become so thickly moss-grown that it was difficult to distinguish their outlines, while the forest clearings made by former explorers to reach the sites of the ancient buildings were once more overgrown with dense bush.

**Copenhagen** (Danish, *Kjöbenhavn,* "the merchants' haven"), the capital of Denmark, situated in 55° 41′ 13″ N. lat. and 12° 34′ 44″ E. long. Since 1875 the population has doubled itself, and in 1901, inclusive of the suburbs, amounted to 491,340. Not only has the city grown in extent also during this period, but considerable public improvements have been effected, the only alteration in the opposite direction being the destruction of the palace of Christiansborg by fire in 1884. Fortunately most of the art treasures which the palace contained were saved, but the edifice still remains a roofless ruin. The new public buildings are mostly found on the strip of land on which

the ramparts of the city formerly stood, and are in part intended to replace older less convenient structures, such as the new Royal Library, the new Polytechnic School, the new Mineralogical Museum, and the new Town Hall, an extensive and imposing edifice ornamented with a tower, of which the spire, when finished, will be the tallest in the North of Europe—about 330 feet. The Glyptothek was built by the State and the municipality, to accommodate a considerable collection of modern objects of art, the gift of a wealthy citizen, M. Jacobsen, who has spent very large sums upon objects of national interest. The new Museum of Industrial Art is an outcome of the movement for applying art to the commoner objects of industry. The old Royal Picture Gallery and the Collection of Engravings, which formerly occupied a portion of the upper storey of the palace of Christiansborg, are now located in the new State Museum of Art, which is situated in a corner of the Östre Anlæg, a fine public garden formed out of a portion of the old ramparts. A similar garden, but smaller, is the so-called Örstedspark. Besides these new Museum buildings, another is in contemplation, destined to receive the Museums of Northern Antiquities, the Ethnographic Museum, and some others, which are now very inconveniently housed in the so-called Prindseus Palais; but this new National Museum is to be built near the latter palace, and in part to replace it. Two private collections must also be mentioned, which, though the property of private persons, are accessible to the public. One of them is the New Glyptothek, a collection of antique sculptures belonging to M. Jacobsen, and preserved at his private residence. It contains a number of important specimens, and is one of the largest, if not the largest private collection of its kind out of Italy. The other is styled Dansk Folke-museum, and illustrates the domestic life of the Danish nation, particularly the peasantry, since 1600, by means of specimens of furniture, utensils, costumes, &c. The Frederik or Marble Church, the erection of which was begun in 1749 but discontinued in 1770, remained a ruin until 1874, when it was purchased by a wealthy banker, M. Tietgen, at whose expense the work was recommenced. The edifice was not carried up to the height originally intended, but the magnificent dome, which reminds one of the finest examples in Italy, is conspicuous far and wide. The diameter is only a few feet less than that of St Peter's in Rome. As the church now stands it is one of the principal works of the architect, F. Meldahl.

Not only is Copenhagen the political capital, but it is also the centre of the higher culture of the nation. It is the seat of the university, which has 80 professors and lecturers, with an average number of about 1900 students, and is fully equipped with the requisite scientific apparatus, such as a library, observatory, botanical garden, museums for natural history, and other collections, laboratories, &c. The Royal Library is one of the largest institutions of its kind. The learned societies comprise the Royal Society of Sciences, the Society of Northern Antiquaries, and numerous others. Technical instruction is provided by the Polytechnic School, which is a State institution; the School of the Technical Society, which, though a private foundation, enjoys public subvention; and also by the High School of Agriculture, Veterinary Art, and Forestry, with 30 professors and lecturers. The schools which prepare for the university, &c., are nearly all private, but are all under the control of the State. Elementary instruction is mostly provided by the communal schools, of which there are thirty within the area of the municipality. Twenty of these are free; ten, in which a somewhat fuller education is given, exact fees. The expense incurred by the municipality for schools, over and above the amount of the school fees, was in 1897, £110,000. The number of children in the area mentioned was 49,337, of whom 37,248 received instruction in the communal schools.

Copenhagen is by far the most important commercial town in Denmark, and has fully shared the steady and considerable increase in the trade of the country during the last thirty years. According to an estimate furnished by the director of the Statistical Bureau of Denmark, the annual value of the exports by sea may be taken at 168 million crowns, or £9,500,000; that of the imports at 295 million crowns, or £16,400,000. The trading capabilities have been much increased by the construction of the new Free Port, at the northern extremity of the town, well supplied with warehouses and other conveniences. It is connected with the main railway station by means of a new circular railway, while a short branch connects it with the ordinary custom-house quay. Advantage has been taken of the facilities afforded by the free port to establish a more perfect steam communication with Sweden particularly in order to accommodate through traffic. Within a short distance of the free port is the station of the new Eastern Railway, which runs along the shore of the Sound, connecting Copenhagen with Elsinore by a direct line. At the end of 1899, 284 sailing vessels above four tons, with an aggregate tonnage of 18,145 tons, belonged to Copenhagen, while the steamers numbered 292, with a collective tonnage of 219,055 tons. In 1899, 9200 clearances inwards were effected by sailing vessels, 9177 by steamers. Of the former, 4391 were Danish vessels, 4181 Swedish, only 14 English. Of the steamers, 7057 were Danish, 338 were English. Besides these, a limited number of passing vessels touched the port. The inward-bound cargoes amounted to 1,580,002 tons, of which 955,557 were carried in Danish bottoms. The cargoes which arrived from foreign ports amounted to 1,366,637 tons, of which 750,257 tons were in Danish bottoms. The total of the outward-bound cargoes was 720,671 tons, of which 573,233 were carried in Danish bottoms; of this total, 391,052 were destined for foreign ports, of which 248,945 were in Danish bottoms. The total of the cargoes exchanged between Copenhagen and other Danish ports was 542,984 tons, of which but a very small proportion was carried by foreign vessels. The total of exports and imports by sea was 2,300,670 tons, of which 1,895,559 tons were carried by steamers. Copenhagen is not an industrial town. The manufactures carried on are mostly only such as exist in every large town, and the export of manufactured goods is inconsiderable. The only very large establishment is one for the construction of iron steamers, engines, &c., but some factories have been erected within the area of the free port for the purpose of working up imported raw materials duty free. (C. A. G.)

**Coppée, Francis Edouard Joachim** (known as **François**) (1842———), French poet and novelist, was born in Paris, 12th January 1842. His father held a small post in the Civil Service, and he owed much to the care of an admirable mother. After passing through the Lycée Saint-Louis, he became a clerk in the Ministry of War, and soon sprang into public favour as a poet of the young "Parnassian" school. His first verses date from 1864. They were republished with others in 1866 in a collected form (*Le Reliquaire*), followed (1867) by the successful *Intimités* and *Poèmes Modernes* (1867–69). In the latter year his first play, *Le Passant*, was received with marked approval at the Odéon Theatre, and later *Fais ce que dois* and *Les Bijoux de la Délivrance*, short metrical dramas inspired by the war, were warmly applauded. After filling a post in the Library of the Senate, M. Coppée was chosen in 1878 as archivist of the Comédie-Française, an office which he held till 1884. In

that year his election to the Academy caused him to retire altogether from his public appointments. Meanwhile he continued to publish volumes of poetry at frequent intervals, including *Les Humbles* (1872), *Le Cahier Rouge* (1874), *Olivier* (1875), *L'Exilée* (1876), *Contes en Vers*, &c. (1881), *Poèmes et Récits* (1886), *Arrière-Saison* (1887), and others. Of late years he has printed but little poetry, unless aroused by some occasion of public interest, such as the visit of the Tsar to Paris (1896). Besides the plays mentioned above, two others written in collaboration with M. d'Artois, and some light pieces of little importance, M. Coppée has produced *Madame de Maintenon* (1881), *Severo Torelli* (1883), *Les Jacobites* (1885), and other serious dramas in verse, including *Pour la Couronne* (1895). The performance of a short episode of the Commune, *Le Pater*, was prohibited by the Government (1885). M. Coppée's first story in prose, *Une Idylle pendant le Siège*, appeared in 1875. It was followed by various volumes of short tales, by *Toute une Jeunesse*,—an attempt to reproduce the feelings, if not the actual wants, of the writer's youth,—by *Les Vrais Riches* (1892), by *Le Coupable* (1896), &c. A series of reprinted short articles on miscellaneous subjects, styled *Mon Franc Parler*, appeared from 1893 to 1896; and in 1898 was published *La Bonne Souffrance*, the outcome of M. Coppée's reconversion to the Roman Catholic Church, which has gained very wide popularity. The immediate cause of his return to the faith was a severe illness which twice brought him to the verge of the grave. Hitherto he had taken little open interest in public affairs, but he now joined the most violent section of Nationalist politicians, while retaining contempt for the whole apparatus of democracy. He took a leading part against the prisoner in the Dreyfus case, and was one of the originators of the notorious Ligue de la Patrie Française. M. Coppée, who became an officer of the Legion of Honour in 1888, has a home at Mandres, near Boissy St Léger. He has published a collected edition of his poetry and another of his plays, and remains one of the most popular of French writers. Alike in verse and prose, he concerns himself with the plainest expressions of human emotion, with elemental patriotism, and the joy of young love, and the pitifulness of the poor, bringing to bear on each a singular gift of sympathy and insight. The lyric and idyllic poetry, by which he will chiefly be remembered, is animated by musical charm, and in some instances, such as *La Bénédiction* and *La Grève des Forgerons*, displays a vivid, though not a sustained, power of expression. There is force, too, in the gloomy tale *Le Coupable*. But he exhibits all the defects of his qualities. In prose especially, his sentiment often degenerates into sentimentality, and he continually approaches, and sometimes oversteps, the verge of the trivial. Nevertheless, by neglecting that canon of contemporary art which would reduce the deepest tragedies of life to mere subjects for dissection, he has won those common suffrages which he fully deserves, and which, where literature is concerned, he probably does not undervalue.

**Copper.**—The sources of copper, its applications and its metallurgy, have undergone great changes. Forty years ago Chile was the largest producer, reaching her maximum in 1869 with 54,867 tons; but in 1899 her production had fallen off to 25,000 tons. Great Britain, though she had made half the world's copper in 1830, held second place in 1860, making from native ores 15,968 tons; in 1898 her production was only 640 tons. The United States made only 572 tons in 1850, and 12,600 tons in 1870; but she to-day makes more than 60 per cent. of the world's total. Le Play estimated the world's production in 1850 at 52,400 tons. It is now about ten times as great. The statistics for 1899, prepared by H. R. Merton and Co., are as follows, in English tons of fine copper:—

| | |
|---|---|
| United States | 262,206 |
| Spain and Portugal | 53,720 |
| Japan | 27,560 |
| Chile | 25,000 |
| Germany | 23,460 |
| Australia | 20,750 |
| Mexico | 19,335 |
| Producers of under 10,000 tons each | 44,835 |
| Total | 476,866 |

As the stock on hand rarely exceeds three months' demand, and is often little more than a month's supply, it is evident that consumption has kept close pace with production. This extraordinary increase corresponds closely with that of pig iron, of which the world's production was about 3,600,000 tons in 1850, and 35,921,617 tons in 1898. The world, therefore, has needed these two metals in almost equal proportions for the development of modern mechanical industry. Great Britain is still the largest copper consumer. The statistics of consumption for 1898 assign to—

| | | |
|---|---|---|
| Great Britain | 139,704 tons, or 32·1 % | of the world's production |
| United States | 120,348 ,, ,, 27·7 % | ,, ,, ,, |
| Germany | 70,000 ,, ,, 16·1 % | ,, ,, ,, |
| France | 42,652 ,, ,, 9·7 % | ,, ,, ,, |

The large demand for copper to be used in sheathing ships ceased on the introduction of iron in shipbuilding because of the difficulty of coating iron with an impervious layer of copper; but the consumption in the manufacture of electric apparatus and for electric conductors has far more than compensated.

The scale on which modern mines are worked and modern smelters planned has reached proportions formerly unknown. For example, the Rio Tinto Company in Spain and the Anaconda in Butte, Montana, each handles between one and a half and two million tons of ore a year; and these companies, with the Calumet and Hecla, and the Boston and Montana Companies, make more than one-third of the world's total. This has brought about a corresponding increase in the scale of the machinery used:—(1) *mechanical calciners* have in great measure taken the place of hand furnaces; (2) both *reverberatory and cupola furnaces*, as well as their auxiliary apparatus, have been enlarged; and mechanical appliances have been adapted to both for the purpose of saving hand labour; (3) the *pneumatic method* in Bessemer converters of concentrating ore to metallic copper has been applied very extensively; (4) some progress has been made towards smelting ores by the heat of combustion of their own elements, through what is known as *pyritic smelting*; and some new smelting methods have been introduced, notably the direct process of Messrs Nicholls and James; (5) the *electrolytic refining* of copper has come into general use.

*Calcination and calcining furnaces.*—As most copper ores contain sulphur, which can be driven off at low temperatures as sulphurous acid gas, calcination is a preliminary to smelting. To aid in extracting the sulphur mechanical agitation is almost universally resorted to. Three types of mechanical calciners are used, all developments of English inventions. In the White-Howell revolving cylinder furnace with lifters—a modification of the Oxland—the ore is fed and discharged in a continuous stream. The Brückner cylinder resembles the Elliot and Russell black ash furnace; its cylinder tapers slightly towards each end and is generally 18 feet long by 8 feet 6 inches in its greatest diameter. Its charge of from 8 to 12 tons of ore or concentrates is slowly agitated at a rate of three revolutions a minute, and in from 24 to 36 hours it is reduced from say 40 or 35 per cent. to 7 per

cent. of sulphur. The ore is under better control than is possible with the continuous feed and discharge, and when sufficiently roasted can be passed red-hot to the reverberatory furnace. These advantages compensate for the wear and tear and the cost of moving the heavy dead-weight. The M'Dougall furnace is turret-shaped, and consists of a series of circular hearths, on which the ore is agitated by rakes attached to revolving arms and made to fall from hearth to hearth. It has been modified by Herreshoff, who uses a large hollow revolving central shaft cooled by a current of air. The shaft is provided with sockets, into which movable arms with their rakes are readily dropped. The Peter Spence type of calcining furnace has been followed in a large number of inventions. In some the rakes are attached to rigid frames, with a reciprocating motion, in others to cross-bars moved by revolving chains. Some of these furnaces are straight, others circular. Some have only one hearth, others three. This and the previous type of furnace, owing to their large capacity, are at present in greatest favour. The M'Dougall-Herreshoff, working on ores of over 30 per cent. of sulphur, requires no fuel; but in furnaces of the Spence-O'Hara type fuel must be used, as an excess of air enters through the slotted sides and the hinged doors which open and shut frequently to permit of the passage of the rakes. The consumption of fuel, however, does not exceed 1 of coal to 10 of ore. The quantity of ore which these large furnaces, with a hearth area as great as 2000 feet and over, will roast varies from 40 to 60 tons a day. Shaft calcining furnaces like the Gerstenhoffer, Hasenclaver, and others designed for burning pyrites fines have not found favour in modern copper works. Kilns and stalls roast so small a quantity that they would cover too much ground and involve too much handling.

*The fusion of ores in reverberatory and cupola furnaces.*—After the ore has been partially calcined, it is smelted to extract its earthy matter and to concentrate the copper with part of its iron and sulphur into a matte. In reverberatory furnaces it is smelted by fuel in a fireplace, separate from the ore, and in cupolas the fuel, generally coke, is in direct contact with the ore. When Swansea was the centre of the copper-smelting industry in Europe, many varieties of ores from different mines were smelted in the same furnaces, and the Welsh reverberatory furnaces were used. To-day more than eight-tenths of the copper ores of the world are reduced to impure copper bars or to fine copper at the mines; and where the character of the ore permits, the cupola furnace is found more economical in both fuel and labour than the reverberatory.

The Welsh method, with its seven or eight operations, finds adherents only in Wales and Chile. In America the usual method is to roast ores or concentrates so that the matte yielded by either the reverberatory or cupola furnace will run from 45 to 50 per cent. in copper, and then to transfer to the Bessemer converter, which blows it up to 99 per cent. In Butte, Montana, reverberatories have in the past been preferred to cupola furnaces, as the charge has consisted mainly of fine roasted concentrates; but even there the cupola is gaining ground. To smelt Butte ores there are about 75 reverberatories, but the number will be reduced by the replacement of small by large furnaces, heated by gas instead of solid fuel. At the Boston and Montana works tilting reverberatories, modelled after open hearth steel furnaces, were first erected; but they were found to possess objectionable features. Now both these and the egg-shaped reverberatories are being abandoned for furnaces as long as 43 feet 6 inches from bridge to bridge and of a width of 15 feet 9 inches, heated by gas, with regenerative checker work at each end, and fed with ore or concentrates, red-hot from the calciners, through a line of hoppers suspended above the roof. Furnaces of this size smelt 200 tons of charge a day. But even when the old type of reverberatory is preferred, as at the Argo works, Colorado, where rich gold- and silver-bearing copper matte is made, the growth of the furnace in size has been steady. Richard Pearce's reverberatories in 1878 had an area of hearth of 15 feet by 9 feet 8 inches, and smelted 12 tons of cold charge daily, with a consumption of 1 ton of coal to 2·4 tons of ore. His present furnaces are 35 feet by 16 feet, and smelt 50 tons daily of hot ore, with the consumption of 1 ton of coal to 3·7 tons of ore.

The home of cupola smelting was Germany, where it has never ceased to make steady progress. In Mansfeld brick cupola furnaces are without a rival in size, equipment, and performance. They are round stacks, designed on the model of iron blast furnaces, 29 feet high, fed mechanically, and provided with stoves to heat the blast by the furnace gases. The low percentage of sulphur in the roasted ore is little more than enough to produce a matte of 40 to 45 per cent., and therefore the escaping gases are better fitted than those of most copper cupola furnaces for burning in a stove. But as the slag carries on an average 46 per cent. of silica, it is only through the utmost skill that it can be made to run as low on an average as 0·3 per cent. in copper oxide. As the matte contains on an average 0·2 per cent. of silver, it is still treated by the Ziervogel wet method of extraction, the management dreading the loss which might occur in the Bessemer process of concentration, applied as preliminary to electrolytic separation. Blast furnaces of large size, built of brick, have of late years treated the richest and more silicious ores of Rio Tinto, and at present the Rio Tinto Company is introducing converters at the mine. This method of extraction contrasts favourably in time with the leaching process, which is so slow that over 10,000,000 tons of ore are always under treatment on the immense leaching floors of the company's works in Spain. In the United States the cupola has undergone a radical modification in being built of water-jacketed sections. The first water-jacketed cupola which came into general use was a circular inverted cone, with a slight taper, of 36 inches' diameter at the tuyeres, and composed of an outer and an inner metal shell, between which water circulated. As greater size has been demanded, oval and rectangular furnaces—as large as 180 inches by 56 inches at the tuyeres—have been built in sections of cast or sheet iron or steel. A single section can be removed and replaced without entirely emptying the stack, as a shell of congealed slag always coats the inner surface of the jacket. The largest furnaces are those of the Boston and Montana Company at Great Falls, Montana, which have put through 500 tons of charge daily, pouring their melted slag and matte into large wells of 10 feet in diameter. A combined brick- and water-cooled furnace was first used by the Oxford Copper Company, and has been adopted by the Iron Mountain Company at Kerwick, Cal., for matte concentration. In it the cooling is effected by water pipes, interposed horizontally between the layers of bricks. The Mt. Lyell smelting works in Tasmania, which are of special interest, will be referred to later.

*Concentrating matte to copper in the Bessemer converter.*—As soon as the pneumatic method of decarburizing pig iron was accepted as practicable, experiments were made with a view to Bessemerizing copper ores and mattes. One of the earliest and most exhaustive series of experiments was made on Rio Tinto ores at the John Brown works by Mr John Holloway, with the ambitious aim of both smelting the ore and concentrating the matte in the same furnace, by the heat evolved through the oxidation of their sulphur and iron. Experiments along the same lines were made by Francis Bawden at Rio Tinto and Claude Vautin in Australia. The difficulty of effecting

this double object in one operation was so great that in subsequent experiments the aim was merely to concentrate the matte to metallic copper in converters of the Bessemer type. The concentration was effected without any embarrassment till metallic copper commenced to separate and chill in the bottom tuyeres. To meet this obstacle M. Manhès proposed elevated side tuyeres, which could be kept clear by punching through gates in a wind box. His invention was adopted by the Vivians, at the Aiguelles works in France, and at Leghorn in Italy. But the greatest expansion of this method has been in the United States, where now more than 400,000,000 ℔ of copper are annually made in Bessemer converters. Vessels of several designs are used—some modelled exactly after steel converters, others barrel-shaped, but all with side tuyeres elevated about 10 inches above the level of the bottom lining. Practice, however, in treating copper matte differs essentially from the treatment of pig iron, inasmuch as from 20 to 30 per cent. of iron must be eliminated as slag and an equivalent quantity of silica must be supplied. The only practical mode of doing this, as yet devised, is by lining the converter with a silicious mixture. This is so rapidly consumed that the converters must be cooled and partially re-lined after 3 to 6 charges, dependent on the iron contents of the matte. When available, a silicious rock containing copper or the precious metals is of course preferred to barren lining. The material for lining, and the frequent replacement thereof, constitute the principal expense of the method. The other items of cost are *labour*, the quantity of which depends on the mechanical appliances provided for handling the converter shells and inserting the lining; and the *blast*, which in barrel-shaped converters is low and in vertical converters is high, and which varies therefore from 3 to 15 ℔ to the square inch. The quantity of air consumed in a converter which will blow up about 35 tons of matte per day is about 3000 cubic feet per minute. The operation of raising a charge of 50 per cent. matte to copper usually consists of two blows. The first blow occupies about 25 minutes, and oxidizes all but a small quantity of the iron and some of the sulphur, raising the product to white metal. The slag is then poured and skimmed, the blast turned on and converter re-tilted. During the second blow the sulphur is rapidly oxidized, and the charge reduced to metal of 99 per cent. in from 30 to 40 minutes. Little or no slag results from the second blow. That from the first blow contains between 1 per cent. and 2 per cent. of copper, and is usually poured from ladles operated by an electric crane into a reverberatory, or into the settling well of the cupola. The matte also, in all economically planned works, is conveyed, still molten, by electric cranes from the furnace to the converters. When lead or zinc is not present in notable quantity, the loss of the precious metals by volatilization is slight, but more than 5 per cent. of these metals in the matte is prohibitive. Under favourable conditions in the larger works of the United States the cost of converting a 50 per cent. matte to metallic copper is generally understood to be only about $\frac{5}{10}$ to $\frac{6}{10}$ of a cent per ℔ of refined copper.

*Pyritic smelting.*—The heat generated by the oxidation of iron and sulphur has always been used to maintain combustion in the kilns or stalls designed for roasting pyrites. Since Holloway's and other early experiments, no serious attempts have been made to utilize the heat escaping from a converting vessel in smelting ore and matte either in the same apparatus or in a separate furnace. But considerable progress has been made in smelting highly sulphuretted ores by the heat of their own oxidizable constituents. At Tilt Cove, Newfoundland, the Cape Copper Company smelted copper ore, with just the proper proportion of sulphur, iron, and silica, successfully without any fuel, when once the initial charge had been fused with coke. The furnaces used were of ordinary design and built of brick. Lump ore alone was fed, and the resulting matte showed a concentration of only 3 into 1. When, however, a hot blast is used on highly sulphuretted copper ores, a concentration of 8 of ore into 1 of matte is obtained, with a consumption of less than one-third the fuel which would be consumed in smelting the charge had the ore been previously calcined. A great impetus to pyritic smelting was given by the investigations of Mr W. L. Austin, of Denver, Colorado, and both at Leadville and Silverton raw ores are successfully smelted with as low a fuel consumption as 3 of coke to 100 of charge. But the largest establishment in which advantage is taken of the self-contained fuel is at the smelting works of the Mt. Lyell Company, Tasmania. There the blast is raised from 600° to 700° F. in stoves heated by extraneous fuel, and the raw ore smelted with only 3 per cent. of coke. The ore is a compact iron pyrites containing, of copper 2·5 per cent., of silver 3·83 oz., of gold 0·139 oz. It is smelted raw with hot blast in cupola furnaces, the largest being 210 in. by 40 in. The resulting matte runs 25 per cent. This is reconcentrated raw in hot-blast cupolas to 55 per cent., and blown directly into copper in converters. Thus these ores, as heavily charged with sulphur as those of the Rio Tinto, are speedily reduced by three operations and without roasting, with a saving of 97·6 per cent. of the copper, 93·2 per cent. of the silver, and 93·6 per cent. of the gold.

*The Nicholls and James process.*—Messrs Nicholls and James have applied, very ingeniously, well-known reactions to the refining of copper, raised to the grade of white metal. This process is practised by the Cape Copper and Elliot Metal Company. A portion of the white metal is calcined to such a degree of oxidation that when fused with the unroasted portion, the reaction between the oxygen in the roasted matte and the sulphur in the raw material liberates the metallic copper. The metal is so pure that it can be refined by a continuous operation in the same furnace.

*Electrolytic refining and separation of gold and silver.*—The principles have long been known on which is based the electrolytic separation of copper from the certain elements which generally accompany it, whether these, like silver and gold, are valuable, or, like arsenic, antimony, bismuth, silenium, and tellurum, are merely impurities. But it was not until the dynamo was improved as a machine for generating large quantities of electricity at a very low cost that the electrolysis of copper could be practised on a commercial scale. To-day, by reason of other uses to which electricity is applied, electrically deposited copper of high conductivity is in ever-increasing demand, and commands a higher price than copper refined by fusion. This increase in value permits of copper with not over £2 or $10 worth of the precious metals being profitably subjected to electrolytic treatment. Thus many million ounces of silver and a great deal of gold are recovered which formerly were lost. The mining district of Butte, Mont., alone produces annually about 10,000,000 ounces of silver and 40,000 ounces of gold, all of which is recovered by electrolytic separation. The methods of electrolytic refining used in Europe and America necessarily differ only in detail. (See ELECTRO-CHEMISTRY.) Most of them employ the *multiple system*, in which the soluble anodes of cast copper and cathodes of thin copper strippings are hung in lead-lined vats. A few works have adopted the *series system*, in which the anodes are sheets of rolled copper, one side of which is being dissolved while the refined copper is being deposited on the reverse from the adjacent sheet.

These are usually suspended in slate vats, owing to the higher voltage used. In the multiple system the anodes are generally cast plates of from 1 inch to $1\frac{1}{2}$ inches in thickness, while in the series system they must be rolled sheets, usually $\frac{1}{4}$ inch thick. The multiple system anodes are sometimes cast directly from the blister furnace or the converter, but they are smoother, more compact, and make less scrap if roughly refined. At the Anaconda works the Bessemer copper is poured into a revolving cylindrical refinery, where it is poled, and thence poured into large ladles mechanically handled, which hold the measured weight of an anode. At other works similar ladles capable of holding 150 ℔ are moved by overhead trolleys. At the Baltimore works Walker's travelling tables present the moulds in rotation to the pouring ladle. The old method of slow hand-ladling has been discarded in the United States works, and the refining furnace, whether for making anodes or casting the cathodes, has been enlarged to a capacity of from 80,000 ℔ to 120,000 ℔ to a charge. The electrolyte is invariably an acidulated solution of cupric sulphate. The current density seldom if ever exceeds 18 ampères to the square foot, and it can be economically raised to that point only when a high temperature and rapid circulation of the electrolyte is maintained. In some rare instances where water power is in excess of requirements, the electrolyte is heated by raising the resistance and by forcing the current through small conductors. With an 18-ampère current, anodes of 1 inch thickness are dissolved in 15 days, and therefore a plant of given size to-day, using a current of high density, turns out at least three times more copper than formerly, when a current density of 6 ampères per square foot was deemed the highest safe maximum limit. The accumulation of dangerous quantities of impurities in the electrolyte is corrected in most works by withdrawing at intervals a given proportion of the whole, recovering its valuable contents and replacing it by pure electrolyte. The metals which it is the aim of most works to recover from copper anodes are copper, gold, and silver. The former is deposited on the cathode, while the precious metals separate and collect as slime, with their valuable or valueless ingredients, in the bottom of the vat, or as a coating on the anodes. Copper is invariably used as the conductor, and almost every works adopts different methods of attaching the electrodes to the permanent conductors.

The only published statement of the cost of refining copper on a large scale is that given in the report of the Anaconda Company, which turns out from its works in Anaconda about 80,000,000 ℔ of copper annually. The total cost, including taxes but not interest on plant, was in 1897–98, $\frac{3}{4}$ cent per pound. This is in excess of the cost on the Atlantic seaboard and in Europe, where fuel and labour are both cheaper. Only electrolytic copper, together with that from Lake Superior, has sufficient purity and conductivity to be used for electrical purposes. It enters the market as cathodes, which are the rough plates, as withdrawn from the tanks, or cast into ingots, wire bars, and cakes. The conductivity of the cathodes is higher than that of the copper cast from them. Copper can be electrolytically deposited on irregular moulds, or as tubes on revolving mandrils. To ensure density, where this is done, agate burnishers travel over the surface of the tube during deposition, as in the Elmore process.

Modern methods in copper smelting have therefore effected enormous economy in time, space, and labour. To-day with pyritic smelting a sulphuretted copper ore, fed into a cupola in the morning, can be passed directly to the converter, blown up to metal, and shipped as 99 per cent. bars by evening—an operation which formerly, with heap roasting of the ore and repeated roasting of the mattes in stalls, would have occupied not less than four months. A large furnace and a Bessemer converter, the pair capable of making a million pounds of copper a month from a low-grade sulphuretted ore, will not occupy a space of more than 25 feet by 100 feet; and whereas, in making metallic copper out of a low-grade sulphuretted ore, one day's labour used to be expended on every ton of ore treated, to-day one day's labour will carry at least four tons of ore through the different mechanical and metallurgical processes necessary to reduce them to metal. (J. Ds.)

**Coppermine,** a river of Mackenzie district, Canada, about 475 miles long, taking its rise in a lake in approximately 110° 20′ W. long. and 65° 50′ N. lat., and flowing south and then north-westward to Coronation Gulf in the Arctic Ocean. It was discovered by Hearne in 1771, and was explored from Point Lake to the sea by Captain (afterwards Sir John) Franklin in 1821.

**Coptic Church.**—Racially the Copts are descendants of the ancient Egyptians, the name *Egypt* meaning "land of the Gypt," as the Copts are to this day called in Arabic. By the Coptic church, therefore, is meant the native church of Egypt or church of Alexandria. Its founder was St Mark, after whom was called the cathedral, which survived the Arab conquest. From St Mark the succession has been maintained to the present time, but not unbroken. Up to the 5th century the church of Alexandria played a part in the Christian world scarcely second to that of Rome: the names of Origen, Athanasius, and Cyril bear witness to her greatness. But in the time of Dioscorus, 25th patriarch, the church, always fond of speculation, was rent asunder by the controversy concerning the single or two-fold nature of our Lord, as stated by Eutyches. The Eutychian doctrine, approved by the council of Ephesus, was condemned by that of Chalcedon in 451. But to this decision, though given by 636 bishops, the Copts refused assent—a refusal which profoundly affected both the religious and the political history of their country. From that moment they were treated as heretics. The emperor appointed a new bishop of Alexandria, whose adherents the Copts styled Melkites or Imperialists, while the Copts were called Monophysites and Jacobites. The court party and the native party each maintained its own line of patriarchs, and each treated the other with bitter hostility. For nearly two centuries strife and persecution continued. The well-meant ecthesis of Heraclius was a failure and was followed by repression, till in 640 the Copts found their opportunity in the Saracen invasion. The fall of the Byzantine empire meant the fall of the Byzantine church, and after some resistance the Copts accepted a change of masters, which gave them religious freedom. The orthodox or Melkite party, consisting mostly of Byzantine Greeks, was swept away, and the double succession of patriarchs practically ceased. True, even in 1901 there was an orthodox patriarch of Alexandria living in Cairo, but he had only a few Greeks for followers, and scarcely a nominal succession has been maintained. But the Coptic succession has been continuous and real.

*History.*

"The most holy Pope and patriarch of the great city of Alexandria and of all the land of Egypt, of Jerusalem the holy city, of Nubia, Abyssinia, and Pentapolis, and all the preaching of St Mark," as he is still called, had originally jurisdiction over all the places named. Jurisdiction over Abyssinia remains, but from Nubia and Pentapolis Christianity has disappeared. The ancient rule is that no bishop is eligible for the patriarchate. The requirement of a period of desert life has so far prevailed that no one but a monk from one of the desert monasteries is now qualified. This rule, harmless perhaps

*Hierarchy.*

when the monasteries were the great schools of learning and devotion, now puts a premium on ignorance, and is disastrous to the church. The patriarch is chosen by an assembly of bishops and elders. The candidate is brought in chains from the desert, and, if only in monk's orders is passed through the higher grades except that of bishop. The patriarch's seat was transferred some time after the Arab conquest from Alexandria to the fortress town of Babylon (Old Cairo), and in modern times it was shifted to Cairo proper. The other orders and offices in the church are metropolitan, bishop, chief priest, priest, archdeacon, deacon, reader, and monk. The number of bishoprics in ancient times was very large—Athanasius says nearly 100. At present there remain ten in Egypt, one at Khartum, and three in Abyssinia.

The numerous remaining churches in Egypt but faintly represent the vast number standing in ancient times.

***Buildings.*** Rufinus says that he found 10,000 monks in the one region of Arsinoe. Later, in 616, the Persians are described as destroying 600 monasteries near Alexandria. Abû Sâlih (12th century) gives a list of churches surviving in his day, and their number is astonishing. The earliest were cut out of rocks and caverns. In the days of Constantine and Justinian basilicas of great splendour were built, such as the church of St Mark at Alexandria and the Red Monastery in Upper Egypt. This type of architecture permanently influenced Coptic builders, but there prevailed also a type, probably native in origin, though possessing Byzantine features, such as the domed roofing. There is no church now standing which bears any trace of the fine glass mosaics which once adorned the basilicas, nor is there any example of a well-defined cruciform ground-plan. But the use of the dome by Coptic architects is almost universal, and nearly every church has at least three domes overshadowing the three altars. The domes are sometimes lighted by small windows, but the walls are windowless, and the churches consequently gloomy. Among the most interesting churches are those of Old Cairo, those in the Wadi Natrûn, and the Red and White Monasteries.

Every church has three altars at the eastern end in three contiguous chapels. The central division is called

***Church fittings.*** the *haikal* or sanctuary, which is always divided from the choir by a fixed partition or screen with a small arched doorway closed by double doors. This resembles the Greek iconostasis. *Haikal* screen and choir screen are often sumptuously carved and inlaid. A marble basin for the mandatum in the nave, and an epiphany tank at the west are common features. The altar is usually built of brick or stone, hollow within, and having an opening to the interior. A wooden altar-slab covered with crosses, &c., lies in a rectangular depression on the surface, and it is used in case of need as a portable altar. Chalice and paten, ewer and basin, crewet and chrismatory, are found as in the western churches. The aster consists of two crossed half-hoops of silver and is used to place over the wafer. The flabellum is used, though now rarely made of precious metal. Some examples of silver-cased textus now remaining are very fine. Every church possesses thuribles—the use of incense being universal and frequent—and diadems for the marriage service. The use of church bells is forbidden by the Moslems, except in the desert, and church music consists merely of cymbals and triangles which accompany the chaunting.

The sacramental wine is usually made from raisins, but the juice must be fermented. Churches even in Cairo

***Rites and ceremonies.*** have a press for crushing the raisins. The eucharistic bread is baked in an oven built near the sanctuary. The wafer is a small loaf about 3 inches in diameter and 1 inch thick, stamped with the trisagion and with crosses. Communion must be received fasting. Confession is required, but of late has somewhat fallen into disuse. Laymen receive in both kinds. The wafer being broken into the chalice, crumbs or "pearls" are taken out in a spoon and so administered, as in the Greek rite. Reservation is uncanonical. Renaudot states that it was permitted in cases of great extremity, when the host remained upon the altar with lamps burning and a priest watching, but it is not now practised, and there is no evidence of any such vessel as a pyx in Coptic ritual. Small benedictional crosses belong to each altar, and processional crosses are common. The crucifix is unknown, for while paintings and frescoes abound, graven images are absolutely forbidden. The liturgy is still read in the extinct Coptic language, but the gospel and lessons are also read in the vernacular Arabic. Seven sacraments are recognized—baptism, confirmation, eucharist, penance, orders, matrimony, and unction of the sick. The chief fasts are those of Advent, of Nineveh, of Heraclius, Lent, and Pentecost. Pilgrimage to Jerusalem is a duty and sometimes a penance.

Vestments are a difficult subject, obscured by writers like Renaudot and Denzinger, who found their statements on written evidence without having visited

***Vestments.*** Egypt. The majority of the Coptic vestments have peculiarities in form and name, not corresponding closely with vestments of western ritual. But the pallium is the symbol of patriarchal office. Cope and chasuble formerly existed, and for both there is pictorial as well as documentary evidence; but the chasuble has disappeared, and the supervestment of the celebrant is now the cope or *burnus*. The dalmatic remains in use and is often enriched with embroidered figures and texts. The *shamlah* and *tailasân* are peculiar vestments, something like an amice. The *patrashîl* corresponds to the Greek *epitrachelion*, and the *kamâs*, or armlets, to *epimanikia*. The girdle is a liturgical vestment and is worn over the dalmatic. Mitre and pastoral staff are used by bishops, although the mitre is not of western shape and resembles rather a crown, as it is in fact called in Arabic.

The whole of the Coptic ritual deserves much fuller study than it has received. Since the 7th century the church has been so isolated as to be little influenced by changes affecting other communions. Consequently it remains in many respects the most ancient monument of primitive rites and ceremonies in Christendom. But centuries of subjection to Moslem rule have much weakened and degraded it. The priesthood are very ill-paid and mostly very ignorant. Among the younger Copts, however, there is now a strong reforming party who are anxious to remove the reproach of the clergy by education, remembering the time when the church of Alexandria was as famous for learning as for zeal. They desire also to resist the serious encroachments of Roman Catholic, American Presbyterian, and other foreign missions upon their ancient faith. Their great need is an enlightened patriarch of strong character, with funds to found a theological college.

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(A. J. B.)

**Copyhold.**—Since the publication of the article in the ninth edition of the *Ency. Brit.* the law relating to the

statutory enfranchisement of copyhold, first established by the Copyhold Act, 1841, has been consolidated by the Copyhold Act, 1894. Owing to the incidents attaching to land "holden by copy of court roll according to the custom of the manor" in the shape of fines and heriots, the inability to grant a lease for a term exceeding a year, and to the peculiar rules as to descent, waste, dower, curtesy, alienation, and other matters, varying often from manor to manor and widely differing from the uniform law applicable to land in general, enfranchisement, or the conversion of land held by copyhold tenure into freehold, is often desired. This could and may still be effected at common law, but only by agreement on the part of both the lord and the tenant. Moreover, it was subject to other disadvantages. The cost fell on the tenant, and the land when enfranchised was subject to the encumbrances attaching to the manor, and so an investigation into the lord's title was necessary. In 1841 an Act was passed to provide a statutory method of enfranchisement, removing some of the barriers existing at common law; but the machinery created was only available where both lord and tenant were in agreement. The Copyhold Act, 1852, went further, and for the first time introduced the principle of compulsory enfranchisement on the part of either party. By the Copyhold Act, 1894, which now governs statutory enfranchisement, the former Copyhold Acts, 1841–87, were repealed, and the law was consolidated and improved. Enfranchisement is now effected under this Act, though in certain cases it is also to be obtained under special Acts, such as the Land Clauses Consolidation Act, 1848; and the old common-law method with all its disadvantages is still open. The Copyhold Act, 1894, deals both with compulsory and with voluntary enfranchisement. In either case the sanction of the Board of Agriculture must be obtained; and powers are bestowed on it to decide questions arising on enfranchisement, with an appeal to the High Court. The actual enfranchisement, where it is compelled by one of the parties, is effected by an award made by the board; in the case of a voluntary enfranchisement it is completed by deed. Under the Act it is open to both lord and tenant to compel enfranchisement, though the expenses are to be borne by the party requiring it. The compensation to the lord, in the absence of an agreement, is ascertained under the direction of the board on a valuation made by a valuer or valuers appointed by the lord and tenant; and may be paid either in a gross sum or by way of an annual rent charge issuing out of the land enfranchised, and equivalent to interest at the rate of 4 per cent. on the amount fixed upon as compensation. This rent charge is redeemable on six months' notice at twenty-five times its annual amount. The tenant, even if he is the compelling party, may elect either method; but the lord has not the same option, and where the enfranchisement is at his instance, unless there is either an agreement to the contrary or a notice on the part of the tenant to exercise his option, the compensation is a rent charge. Power is conferred on the lord to purchase the tenant's interest where a change in the condition of the land by enfranchisement would prejudice his mansion house, park, or gardens; while on the other hand, in the interest of the public or the other tenants, the board is authorized to continue conditions of user for their benefit.

*Act of 1894.*

So far the provisions relating to compulsory enfranchisement have been dealt with; but even in the case of a voluntary agreement the lord and tenant are only entitled to accept enfranchisement with the consent of the Board of Agriculture. The consideration in addition to a gross sum or a rent charge may consist of a conveyance of land, or of a right to mines or minerals, or of a right to waste in lands belonging to the manor, or partly in one way and partly in another. The effect of enfranchisement, whether it be voluntary or compulsory, is that the land becomes of freehold tenure subject to the same laws relating to descent, dower, and curtesy as are applicable to freeholds, and so freed from Borough English, Gavelkind (save in Kent), and other customary modes of descent, and from any custom relating to dower, or free-bench, or tenancy by curtesy. Nevertheless, the lord is entitled to escheat in the event of failure of heirs, just as if the land had not been enfranchised. The land is held under the same title as that under which it was held at the date at which the enfranchisement takes effect; but it is not subject to any estate right, charge, or interest affecting the manor. Every mortgage of the copyhold estate in the land enfranchised becomes a mortgage of the freehold, subject though to the priority of the rent charge paid in compensation under the Act. All rights and interests of any person in the land and all leases remain binding in the same manner. On the other hand the tenant's rights of common still continue attached to the freehold; and, without express consent in writing of the lord or tenant respectively, the right of either in mines or minerals shall not be affected by the change. Some other changes are also made by the Act. No creation of new copyholds by granting land out of the waste is permissible, save with the consent of the Board of Agriculture; and it would seem as if the Act had rendered the customary court a very shadowy institution by enacting that a valid admittance of a new copyholder may be made without holding a court.

Under the earlier Acts, machinery to free the land from the burden of the old rents, fines, and heriots was set up, commuting them into a rent charge or a fine. Commutation, however, is never compulsory, and differs from enfranchisement in that, whereas by enfranchisement the land in question is converted into freehold, by commutation it still continued parcel of the manor, though subject to a rent charge or a fine, as might have been agreed. The ordinary laws of descent, dower, and curtesy were, however, substituted for the customs in relation to these matters incidental to the land in question before commutation, and the timber became the tenant's. (JNO. S.)

# COPYRIGHT.

SINCE 1877 the system of international copyright has been remodelled by the Bern Convention; the United States has conferred a species of international copyright on foreign authors; and considerable changes have been made in the English law of copyright.

So far as the English law of copyright in books is concerned the chief developments have been by decisions of the Courts explaining the exact limits to which protection extends. The most marked and certain progress has been in the application of the law of copyright to the periodical press (in 1877 it was not clear whether a newspaper was for all purposes within the Copyright Act), in order to protect within reasonable limits the labour and expenditure of newspapers that obtain for the public the earliest news and arrange it for publication. The old common-law theory that a perpetual copyright existed over literary

work, as laid down by Lord Mansfield, no doubt has been abandoned. But the Copyright Act, 1842, has been liberally construed as to what is a literary work and what is original matter. It is now settled law that a newspaper is a book within the meaning of the Act, and can claim all rights that a book has under the Copyright Act. Thus, at the present time, leading articles, special articles, and even news items are protected. Current prices of stocks and shares, translations, the compilation of a directory, summaries of legal proceedings, and other similar literary work, so far as the literary form, the labour, and money are concerned, are equally protected. In short, the test may now be broadly stated to be, whether labour of the brain and expenditure of money have been given for the production; whilst the old requirement of original matter is not strictly maintained, or, at any rate, is broadly interpreted. Thus, the *St James's Gazette* was restrained from making extracts from a descriptive article by Rudyard Kipling in the *Times*, and the *Pall Mall Gazette* protected its cable reports of Australian cricket-matches. The latest leading case, however, on the subject is *Walter* v. *Lane* (decided in the House of Lords, 6th August 1900). The question raised was, whether or not copyright applied under the Act of 1842 in respect of *verbatim* reports of speeches. Four of the law lords, viz., the Lord Chancellor, Lord Davey, Lord James of Hereford, and Lord Brampton, upheld the claim to copyright in such cases, whilst Lord Robertson was the sole dissentient. The point of law was examined by each judge with great care; but the gist of their decision is to be found in the opening sentences of the judgment of the Lord Chancellor (Lord Halsbury), who said:—"My lords, I should very much regret if I were compelled to come to the conclusion that the state of the law permitted one man to make profit out of and to appropriate to himself the labour, skill, and capital of another. And it is not denied that in this case the defendant seeks to appropriate to himself the labour, skill, and capital of another. In the view I take of this case, I think the law is strong enough to restrain what to my mind would be a grievous injustice."

Apart from newspapers, protection has been extended to publications having no literary character; Messrs Maple's furniture catalogue, and the Stock Exchange prices on the "tape" have been awarded the same protection as directories. On the other hand, it has been decided that there is no copyright in a title, though if a new title is so like one with an established reputation that it will mislead the public, it may be restrained, not on grounds of copyright, but as a use of a title akin to common-law fraud. The *Sphere* and *Spear*, titles of misleading similarity, assumed by two weekly periodicals that appeared almost simultaneously in London in 1900—the latter, however, being but short-lived—could not successfully attack each other, because neither had an established reputation when the title of the other was first adopted. The Courts have declined to protect works which are mere copies of railway time-tables, or the "tips" of a sporting prophet, or mechanical devices with no independent literary matter, such as patterns for cutting ladies' sleeves.

A committee of the House of Lords has considered proposals and heard evidence concerning various Bills for the amendment of the law of copyright, both literary and artistic. The general tendency of all the proposals is to increase the protection given to authors and artists, by lengthening the term of protection to thirty years after the death of the author, by increasing the amount of protection given (as by forbidding abridgments, dramatization of novels, and translations), and by increasing the efficacy of the remedies for infringement. Many difficult questions, however, remain for consideration, especially in artistic copyright.

*Plays and Music.*—The only decision of importance affecting the drama has been the "Little Lord Fauntleroy" case, in which the person who dramatized the novel of another without his consent, an operation up to that time believed to be unassailable in law, was attacked successfully, by preventing him from using printed or written copies of the play, either to deposit with the Lord Chamberlain or as prompt-books. In every case where much of the original dialogue of the novel is taken, this stops the production of the dramatization. In music, statutes of 1882 and 1888 have prevented the use of the provisions inflicting penalties for the performance of copyright songs for purposes of extortion, by allowing the Court to inflict a penalty of one farthing and make the plaintiff pay the costs, if justice requires it. Authors reserving the right of public performance are required to print a notice to that effect on all copies of the music. An important decision on musical copyright is the recent case in which it has been held that the reproduction of copyright tunes on perforated slips for an Æolian mechanical organ is not an infringement of the copyright in the tune.

*Artistic Copyright.*—The most striking decisions have been those in the "Living Picture" cases (in which it was decided that *tableaux vivants* are not infringements of the copyright of the pictures from which they are taken), and a series of cases relating to photographs, which were not much in the contemplation of the framers of the Artistic Copyright Act of 1862. It has been decided that the "author" of a photograph is the person who groups and effectively superintends the picture, and not his employer, nor the sun, which has some claims to the title. The private sitter has restrained the photographer from exhibiting or selling the photographs for which he has been paid, but in several cases the celebrity who has sat to a photographer at his request and without payment, has not been allowed to distribute his photograph to newspapers for reproduction without the consent of the photographer. (See Artistic Copyright below.)

*Colonial Copyright.*—The International Copyright Act, 1886, contains provisions designed to extend the benefit of the British Copyright Acts to works first produced in the colonies, while allowing each colony to legislate separately for works first produced within its own limit. The latter permission has been adopted by several of the colonies. The desire of Canadian printers to allow or require copyright works to be reprinted or printed in Canada has given rise to a very difficult controversy. The colonies at present are all included in the system of international copyright established by the Bern Convention hereafter explained.

*International Copyright.*—Until 1886 international copyright in Great Britain rested on a series of Orders in Council, made under the authority of the International Copyright Act, 1844, conferring on the authors of a particular foreign country the same rights in Great Britain as British authors, on condition of their registering their work in Great Britain within a year of first publication abroad. A condition of the granting of each order was that the Sovereign should be satisfied that reciprocal protection was given in the country in question to British authors.

*The Bern Convention.*—As the result of conferences at Bern in 1885 and 1887, this system was simplified and made more general by the treaty known as "The Bern Convention," signed at Bern on 5th September 1887. The contracting parties were the British Empire, Belgium, France, Germany, Italy, Spain, Switzerland, Tunis, and Hayti. Luxemburg, Monaco, Norway, and Japan have since joined. Austria and Hungary have a separate con-

vention with Great Britain, concluded on 24th April 1893. The notable absentees among European powers are Holland and Russia. The basis of the Bern Convention was that authors of any of the countries of the Union, or the publishers of works first published in one of them, should enjoy in each of the other countries of the Union the same rights as the law of that country granted to native authors. The only conditions were that the work should comply with the necessary formalities, such as registration, in the country where it was first published, in which case it was exempt from all such formalities elsewhere; and that the protection required from any country should not exceed that given in the country of origin. The rights conferred included the sole right of making a translation of the work for ten years from its first publication. The Convention was retrospective; that is to say, it applied to copyright works published before its coming into existence, each country being allowed to protect vested interests, or copies already made by others, as it should think best.

The rights of foreign authors in Great Britain rest on legislation giving effect to the Bern Convention, namely, the International Copyright Act of 1886 (49 and 50 Vict. c. 33), and an Order in Council made under that Act, dated 28th November 1887. These confer on the author or publisher of a work of literature or art first published in one of the countries which are parties to the Convention, after compliance with the formalities necessary there, the same rights as if the work had been first published in the United Kingdom, provided that those rights are not greater than those enjoyed in the foreign country.

The rights of British authors in foreign countries rest in each country on the domestic legislation by which the particular country has given effect to its promise contained in the Bern Convention, and are enforced by the courts of that country. The Bern Convention was revised in minor details not affecting its broad principles by a conference meeting in Paris, and Great Britain adopted the results of their labours by an Order in Council dated 7th March 1898.

AUTHORITIES.—BIRRELL, A. *Copyright in Books.* London, 1899. —COHEN, B. A. *Law of Copyright.* London, 1896.—EDMUNDS, L. *Copyright in Designs.* London, 1895.—KNOX and HIND. *Copyright in Designs.* London, 1899.—SCRUTTON, T. E. *Law of Copyright,* third edition. London, 1896. (T. E. S.)

## AMERICAN COPYRIGHT.

An Act of the United States, known as the Act of March 1891, which replaced the Act of July 1870, and which is still in force, constituted the most important modification in copyright law since the original Act of 1790. Under all Acts preceding it, copyright had been granted to "citizens or residents of the United States," the term "resident" having been, in decisions prior to 1891, construed to mean a person domiciled in the United States with the intention of making there his permanent abode. The works of foreigners could thus be reproduced without authorization, and they were so reproduced in so far as there was prospect of financial gain. The leading publishers, however, had from the earliest times made terms with British authors, or with their representatives, the British publishers, for producing authorized American editions. But at most they were only able to secure by this means an advantage of a few weeks' priority over the unauthorized editions, and the good-will of the conscientious buyer; so that if they paid the author any considerable sum, the price of the authorized editions had to be made so high that it was not easy to secure a remunerative sale. The unauthorized editions had the further advantage in competition, that for the purpose of being manufactured more promptly and more economically, they could be and often were issued in an abbreviated and garbled form, an injury which to not a few writers seemed more grievous than the lack of pecuniary profit. In Great Britain, during the first half of the 19th century the copyright law had been so interpreted as to secure recognition of the rights of American authors for such works as were produced there not later than in any other country, so that authors like Washington Irving and Fenimore Cooper secured for a time satisfactory returns; but after 1850 the conditions became the same as in the United States. Unauthorized editions were published, and were often incomplete and garbled.

As from decade to decade the books produced on either side of the Atlantic, which possessed interest for readers of the other side, increased in quantity and in importance, the evil of these unrestricted piracies increased. The injury to British authors was greater only in proportion as the English books were more numerous. The pressure from Great Britain during the last half of the 19th century for international copyright was continuous; and in America it was recognized by authors, by representative publishers, and by the more intelligent people everywhere, that the existing conditions were of material disadvantage. The loss to American authors was direct; and the loss to legitimate American publishers was also clear, in that better returns could be secured by adequate payments for rights that could be protected by law than by "courtesy" payments for authorizations that carried no legal rights. An injury was being done to American literature; for, when authorized editions of American works had to compete against unauthorized and more cheaply produced editions of English works, the business incentive for literary production was seriously lessened. In fiction particularly, authors had to contend against a flood of cheaply produced editions of "appropriated" English books. Equally to be condemned were the ethics of a relation under which one class of property could be appropriated while other classes secured legal protection. On these several grounds efforts had long been made to secure international copyright. Between 1843 and 1886 no less than eleven international copyright Bills were drafted, for the most part at the instance of the copyright associations or copyright leagues. They were one after the other killed in committee. In 1886 the twelfth international copyright Bill was brought before the Senate by Senator Jonathan Chace of Rhode Island, and was referred to the Committee on Patents. In 1887 the American Publishers' Copyright League (succeeding the earlier American Publishers' Associations) was organized, with William H. Appleton as president, and G. H. Putnam as secretary. The Executive Committee of this league formed, with a similar committee of the Authors' Copyright League, a Conference Committee, under the direction of which the campaign for copyright was continued until the passage of the Act of March 1891. Of the Authors' Copyright League James Russell Lowell was the first president, being succeeded by Edmund Clarence Stedman. The secretary during the active work of the League was Mr Robert U. Johnson. Under the initiative of the Conference Committee copyright leagues were organized in Boston, Chicago, St Louis, Cincinnati, Minneapolis, Denver, Colorado City, and other places. The Chace Bill was introduced in the House in March 1888. In May 1890 this Bill, with certain modifications, came before the House, and was there defeated. In March 1891 the same measure, with certain further modifications, secured a favourable vote in the House during the last hour of the last day of the session, was passed by the Senate, and was promptly signed by President Harrison. Thus, after a struggle extending over fifty-three years, the United States accepted the principle of international copyright.

*The Act of 1891.*—The provisions of the copyright law, as amended by the Act of 1891, may be briefly summarized as follows:—

A. *Works of Literature.*—1. Copyright is granted to authors, whether resident or non-resident, for a term of twenty-eight years. A further term of fourteen years is granted to the author if at the expiration of the first term he be still living, or to his widow or children if he be dead. Unless the author survives the first term, or leaves widow or children, the copyright is limited to twenty-eight years. The essential change indicated in this section of the law is the extension of copyright privileges to non-resident producers. 2. In order to secure copyright, all editions of the works of all authors, resident or non-resident, must be entirely manufactured within the United States, the term "manufactured" including the setting of type as well as printing and binding. Prior to 1891 the works of American authors could be put into print on either side of the Atlantic. This manufacturing condition was insisted on by the typographical unions. 3. The country of which a non-resident author is citizen must concede to American authors copyright privileges equivalent to those which it concedes to its own authors. 4. As under the British Act, the works of resident as well as of non-resident authors must be published in the home country not later than in any other country. 5. The regulations previously in force for making the entries of copyright are continued. 6. While the importation of *editions* of the books so copyrighted is prohibited, whether the authors of the same be American or foreign, invoices may be imported of not more than two copies each, said copies being certified to be "for use and not for sale." 7. Foreign periodicals, of which there are no editions printed from type set in the United States, cannot secure an American copyright. The importation of such periodicals is unrestricted except for such numbers as contain reprints of material that has already in some other form secured an American copyright. An English author who copyrights and publishes a volume in the United States, some chapters of which have previously been printed in an English magazine, is not able to prevent the reprinting in the United States of an unauthorized issue of those chapters. In case all the chapters have been printed in a foreign periodical before the publication of the American edition, its American copyright has probably been forfeited. 8. The foreign author has the same control as the native author over translations of such of his books as have been copyrighted in the United States. There is, however, no prohibition of the importation of an edition of a work printed in a language other than that in which it has secured its copyright. 9. Authors or their assigns have the exclusive right to dramatize and to translate any of their works for which copyright has been obtained under the laws of the United States.

B. *Works of Art.*—Foreign artists and designers are accorded the term or terms accorded to foreign authors and to domestic artists. To reproductions in the form of chromos, lithographs, or photographs the condition of American manufacture is attached, but not to the more artistic forms of reproduction, so that foreign authors can control engravings or photogravures of their designs, whether these are manufactured in Europe or in the United States. This provision is held by artists and art publishers of the Continent, who had in past years suffered severely from American appropriations of their productions, to be of special importance. In the case of a painting, drawing, statue, statuary, or a model or design for a work of the Fine Arts, in addition to the title, if there be one, a description and a photograph must be sent.

C. *Music.*—Foreign composers are given the same terms that are accorded to Americans. American manufacture is not necessary, but the condition of reciprocity is the same as in the case of books.

The Act came into effect 1st July 1891. The provisions having to do with international copyright become operative in the case of a foreign state only when the President proclaims that the state has fulfilled the condition of reciprocity. The Act has been put into force with foreign states as follows:—1st July 1891, Great Britain, Belgium, France, Switzerland; 8th March 1892, Germany (by separate treaty); 31st October 1892, Italy; 8th May 1893, Denmark; 15th July 1895, Spain; 20th July 1895, Portugal; 27th February 1896, Mexico; 13th April 1896, Sweden and Norway; 25th May 1896, Chile; 19th October 1899, Costa Rica; 20th November 1899, the kingdom of the Netherlands. In the case of each state the territory covered by the provisions of the law includes the possessions, dependencies, &c. The copyright agreement with Great Britain, therefore, covers the Crown colonies of the empire, such as India, and the independent dominions and states, such as Canada, Australia, &c. An American work which has been duly entered for copyright in Great Britain secures, as a British publication secures, the protection of copyright under the provisions of the Bern convention throughout the territory of the several states that are parties to that convention.

Amendments to the copyright law have been made as follows:—*3rd March 1893*—Producers of article entitled to copyright who had heretofore failed to make delivery, according to the regulation in force, of two copies of the article to be copyrighted, but who had complied with all the other provisions of the Act, and who shall before 1st March 1893 make such delivery, shall be entitled to complete the entry of copyright accordingly. *2nd March 1895*—The penalty to be paid in case of the infringement of the copyright of a photograph made from any object not a work of the Fine Arts shall be limited to a maximum of $5000; and in case of the infringement of a work of the Fine Arts, or of a photograph of the same, to a maximum of $10,000, one-half of said penalties to be paid to the proprietors of the copyright, and the other half to the Treasury of the United States. *1st January 1897*—The performance of dramatic and musical compositions without the consent of the authors involves a liability for damages of not less than $100 for the first performance, and $50 for every subsequent performance as to the Court shall appear just. If the unlawful performance be wilful and for profit, the party responsible shall be guilty of a misdemeanour, and upon conviction shall be imprisoned for a period not exceeding one year. *19th February 1897*—A Bill establishing as the Copyright Department of the Library of Congress a Bureau of Copyrights, the head of which bears the title Register of Copyrights. *3rd March 1897*—Through a modification of section 4963, the responsibility for enjoining the publication or the selling of any article made or imported in violation of the United States copyright laws is placed upon the Circuit Court of the United States in the city of the person complaining of violation.

The salaries of the staff of the Bureau of Copyrights, as established in 1897, amounted to $36,440. The Appropriation Bill passed by Congress in March 1900, increasing the appropriation for the library as a whole, gave the staff of the Copyright Bureau an additional allowance, making the total $51,080. According to the annual statement of the Register of Copyrights of 30th December 1899, the fees received during the twelve preceding months for copyright entries and for the recording of assignments aggregated $60,803.50. The copyright entries comprised 78,370 titles of United States productions, and 8122 titles of foreign productions. These figures include works of art and musical compositions. During the years immediately preceding 1900 the producers of copyright property paid into the United States Treasury from $15,000 to $20,000 annually in excess of the cost of carrying on the Copyright Bureau, and with the increased expenditure for the maintenance of the bureau there will still apparently be a surplus of fees amounting to $10,000. In addition to this, the producers of copyrighted books deliver to the library of Congress a copy required as a voucher for the copyright entry and a further copy for the use of the nation. The books so delivered aggregate from 6100 to 6500 works each year.

The existing American copyright law is defective in several respects, and the following considerations are submitted with a view to its amendment:—

1. The condition that books or works of art must be "manufactured" in America in order to secure American copyright should be eliminated. In case it may not prove practicable to secure the abolition of the manufacturing condition, consideration ought certainly to be given promptly to the just claims of authors whose books are originally produced in some language other than English. There is no logical connexion between the right of an

author or artist to the control of his production and the interests of American workmen; the attempt to legislate for them jointly has brought about no little confusion and inequity. If American working men cannot secure a living in competition with labourers on the other side of the Atlantic, their needs should be cared for under the provisions of the protective tariff. It is, however, the belief of a large number of those who are engaged in the manufacturing of books that, with his advanced methods of work, the skilled American labourer has no reason to dread the competition of European craftsmen. With this manufacturing condition out of the way, there would be nothing to prevent the United States from becoming a party to the Convention of Bern. This would place intellectual property on both sides of the Atlantic on the same footing.

2. The requirement of publication in the United States simultaneously with that in the country of origin, practically debars the authors of France, Germany, and other Continental countries from securing any substantial benefit from the publication of American editions of their works, although these states have extended to American authors, without restrictions, the full advantage of their statutes. The amended law should provide that a work in a foreign language, emanating from a country with which the United States has copyright relations, should be registered for copyright in regular course with the deposit for purposes of identification of two copies of the work in the text of the original, and with the further deposit of a copy of the title-page in English. The law should provide that, in case within a specified term (say twelve months) there should be published a version in English, which had been printed from type set within the United States, and which had in other respects complied with the conditions of the American law, the work should secure the full protection of American copyright, not only for the English version as copyrighted, but for the original text. Under the present conditions the copyrighting of an American edition does not protect the original text from unauthorized translations. If, within the term specified, no edition should be produced for which the conditions of the American Act had been complied with, the right to reproduce the work in English might then fall into the public domain. A provision to such effect, while by no means sufficient to do full justice to Continental authors, would secure for such of these authors, whose books were available for the American reading public, the substantial advantages of American copyright.

3. The term of copyright in force in the United States is shorter than that accorded under the law of any other literature-producing country, excepting Greece. In France and in Russia the term covers the life of the author, and fifty years thereafter. In Germany, since 1834, the term has been for the life of the author and for thirty years thereafter. Under such a term of property the author is in a position to work, not only for himself, but for his children. The United States, with its increasingly important literary interests, ought not to be contented with a shorter term than that in force in Germany. (G. H. P*.)

### Artistic Copyright.

*History.*—Copyright, whether artistic or literary, is the creation of statute. Attempts were made by the first claimants of copyright to place property in ideas on a footing with other forms of property, and to claim for it rights in perpetuity; but in the year 1774 a decision in the House of Lords made it clear that neither public opinion nor law would recognize copyright as property in this sense. Since that time it has been recognized that property in copyright exists only by statute, and that its terms and conditions depend entirely upon Acts of the Legislature, and are liable at all times to alteration at the will of Parliament. Literary authors had protection for their work much earlier than artists. The first literary copyright Act came into existence in the reign of Queen Anne, but it was not until the reign of George II. that the Legislature afforded any protection for the work of artists. The first Artists' Copyright Bill was passed in the interest of William Hogarth, one of the greatest of English painters, who was engraver as well as painter, and who devoted a considerable portion of his time to engraving his own works. No sooner, however, were these published than his market was seriously damaged by the issue of inferior copies of his engravings by other publishers. To protect Hogarth from such piracy an Act was passed on 24th June 1735, which provided that "every person who should invent and design, engrave, etch, or work in mezzotinto or chiaroscuro, any historical or other print or prints, should have the sole right and liberty of printing and representing the same for the term of fourteen years, to commence from the day of the first publishing thereof, which shall be truly engraved with the name of the proprietor on each plate, and printed on every such print or prints." The penalty for piracy was the forfeiture of the plate and all prints, with a fine of 5s. for every pirated print.

Thirty-one years later (1766), in the reign of George III., a second Engraving Act was passed "to amend and render more effectual" the first Act, and "for vesting and securing to Jane Hogarth, widow, the property in certain prints," which extended the protection beyond the designer, who was also engraver, to any person who, not being himself a designer, made, or caused to be made, an engraving from any picture or other work of art. Jane Hogarth, the widow of the painter, found herself nearing the termination of the fourteen years' term of copyright granted by the first Act, with the probability that immediately on its expiry the engravings of her husband then on sale, and on which her livelihood depended, would be immediately pirated. It was mainly to save her from the loss of her livelihood that this second Copyright Bill extended the term of the copyright to twenty-eight years.

The engravers and publishers of the day were not over-scrupulous, and they sought to evade the penalties of the copyright Acts by taking the designs, and adding to them or taking from them, or both, and producing fresh engravings, seeking to make it appear that they were producing new works. These practices assumed such proportions that it became necessary, eleven years after the passing of the second Act (1777), to call upon Parliament to put through another short measure still further to protect the engraver, by prohibiting the copying "in whole or in part" (a clause not contained in the previous Acts), by varying, adding to, or diminishing from, the main design of an engraving without the express consent of the proprietor or proprietors. These three Acts remain in force to the present day. In 1852, in an international copyright Act, it was declared that the Engraving Acts collectively were intended to include prints taken by lithography or any other mechanical process.

In May 1814 an Act was passed to give protection to sculptors. The term of copyright for sculptors was a peculiar one. It was to last for fourteen years, with the proviso that, should the author be still alive, he should enjoy a further period of fourteen years, the copyright returning to him for the second fourteen should he have disposed of it for the first period. It is a condition of copyright with the sculptor that the author must put his name with the date upon every work before putting it forth or publishing it. A curious and interesting point in the interpretation of this Act is that according to the opinion of eminent jurists it is necessary to an infringement of the copyright of a piece of sculpture that the copy of it must take the form of another piece of sculpture; that a photograph, drawing, or engraving of a piece of sculpture is not to be considered a reproduction of it, and is, therefore, not an infringement of the sculptor's copyright.

*The Act of 1862.*—Strange as it may seem, painting was the last branch of the arts to receive copyright protection. The cause of the painters was taken up by the Society of Arts, who endeavoured, in the first instance, to pass an amendment and consolidation Bill dealing with engraving, sculpture, and painting; but, failing in their first effort, they limited their second to an attempt to pass a Bill in favour of painting, drawing, and photography. It was in the year 1862 that this Act, having passed

through Parliament, came into force. The absence of any antecedent protection for the painter is clearly stated in its preamble, which reads as follows: "Whereas by law as now established, the authors of paintings, drawings, and photographs have no copyright in such their works, and it is expectant that the law should in that respect be amended. Be it, therefore, enacted," &c. This preamble makes it clear that there is no copyright in any paintings, drawings, or photographs executed and dealt with before the year 1862; to be exact, 29th July of that year. The duration of the term of copyright in this Act of 1862 differs from its predecessors, by being made dependent on the life of the author, to which life seven years were added. In the Literary Copyright Act there are two terms—the life of the author and seven years, or forty-two years, whichever may prove the longer. In taking a fixed term like forty-two years it is necessary to have something to start from, and with a literary work it was easy to start from the date of publication. But pictures are not published. They may pass from the studio to the wall of the purchaser without being made public in any way. The difficulty was evidently before the author of this Act, and the artist's term was made his life and seven years after his death without any alternative. This term applies equally to photographers. Perhaps no Bill which ever passed through Parliament ostensibly for the purpose of benefiting a certain set of people has failed so completely as has this Bill to accomplish its end. It started by proposing to give copyright to authors of paintings, drawings, and photographs, and it would seem that no difficulty ought to have arisen as to whom such copyright should rightly belong; but the following clause of the Act has introduced confusion into the question of ownership:—

Provided that when any painting, or drawing, or the negative of any photograph, shall for the first time after the passing of this Act be sold, or disposed of, or shall be made, or executed for, or on behalf of any other person for a good or valuable consideration, the person so selling or disposing of, or making or executing the same, shall not retain the copyright thereof unless it be expressly reserved to him by agreement in writing, signed at or before the time of such sale or disposition, by the vendee or assignee of such painting or drawing, or such negative of a photograph, or by the person on whose behalf the same shall be so made or executed; but the copyright shall belong to the vendee or assignee of such painting, or drawing, or such negative of a photograph, or to the person for or on whose behalf the same shall have been made or executed; nor shall the vendee or assignee thereof be entitled to such copyright unless at or before the time of such sale or disposition an agreement in writing, signed by the person so selling or disposing of the same, or by his agent duly authorized, shall have been made to that effect.

That is to say, after promising the author copyright in his work for life and seven years, the Act stipulates that in order to get it the author must, at the time of the first sale or disposition of his picture, obtain a document in writing from the purchaser of the picture, reserving the copyright to the author, and the Act goes on to say that if he does not take this step the copyright becomes the property of the purchaser of the picture, but with the proviso, in order to secure it to him, he must have a document signed by the artist assigning the copyright to him; but if neither of these things is done, and no document is signed, the copyright does not belong to either the artist who sells or the client who buys, and the Act is silent as to whom it does belong to. It has disappeared and belongs to no one. There is no copyright existing in the work for any one. It has passed into the public domain, and any one who can get access to the work may reproduce it. Now, as most purchases are made from the walls of exhibitions, in ninety-nine cases out of a hundred the copyright is absolutely lost. And where the sale is arranged directly between the artist and his client, the difficulty experienced by the artist in raising the question as to whom the copyright shall belong to is so great, owing to the dread lest the mere mention of the signing of a document should cause the selling of the picture to fall through, that in numerous such cases the copyright lapses and becomes public property. Photographers are not affected by this clause, because they do not as a rule sell the negatives they produce, and with them the copyright lies in the negative. They carry on their trade in prints without the question of the negative arising. The picture-dealer, also, who buys a picture and copyright is not subjected to the same disability as the painter. The picture-dealer can sell a picture without saying a word to his client as to the copyright, which he, nevertheless, retains intact; the provision is applicable only to the *first* sale of the work, which, therefore, throws the whole of the disability upon the painter.

The Act gives the copyright of every work executed on commission to the person by whom it is commissioned. It makes it compulsory upon every owner of a copyright that he should register it at Stationers' Hall before he can take any action at law to protect it. The copyright does not lapse if unregistered, but so long as it remains unregistered no action at law can be taken on account of any infringement. A copyright can be registered at any time, even after an infringement, but the owner of the copyright cannot recover for any infringement before registration.

The Act provides for both penalties and damages in the following cases:—

1. For infringing copyright in the ordinary way by issuing unlawful copies.
2. For fraudulently signing or affixing a fraudulent signature to a work of art.
3. For fraudulently dealing with a work so signed.
4. For fraudulently putting forth a copy of a work of art, whether there be copyright in it or not, as the original work of the artist.
5. For altering, adding to, or taking away from a work during the lifetime of the author if it is signed, and putting it forth as the unaltered work of the author.
6. For importing pirated works.

The incongruities of this Act were so apparent that its promoters desired to stop it, feeling that it would be better to have no Bill at all than one which conferred so little upon the people it was intended to benefit; but Lord Westbury, the Lord Chancellor, who had charge of the Bill in the House of Lords, advised them to let it go through with all its imperfections, that they might get the right of the painter to protection recognized. This advice was followed, and the Bill had no sooner become law than a fresh effort was started to have it amended. Year by year the agitation went on, with the exception only of a period when Irish affairs took up all the attention of Parliament, and domestic legislation was rendered impossible. But within the last few years copyright has been again "in the air," and several independent committees have been at work upon the subject; and in 1898 the Copyright Association of Great Britain promoted a Bill, which was introduced into the House of Lords by Lord Herschell. It was a measure designed to deal with all forms of copyright—literary, musical, dramatic, and artistic,—and was remitted by the House of Lords for consideration to a committee, which, having sat for three sessions, decided not to proceed with Lord Herschell's measure, but to treat literature and art in separate Bills. It had under its consideration an artistic Bill, drafted for and presented by the Royal Academy, and a literary Bill and an artistic Bill drafted by the Committee itself. The main proposals in the latter were to give copyright to the author of any artistic work or photograph for a period of life and thirty years, unless the work be commissioned, in which case the copyright was to be the property of the employer, except in the case of sculpture intended to be placed in a street or public place. The Bill provides summary remedies for dealing with pirated works. It omits altogether any reference to registration, and it provides for international copyright.

To sum up the position of artistic copyright, we have five British Acts, three dealing with engraving, one with sculpture, and one with painting, drawing, and photography, and between them there is very little relation.

We have three terms of duration of copyright—28 years for engraving, 14 for sculpture, with a second 14 if the artist be alive at the end of the first, life and 7 years for painting, drawing, or photography. There are two different relations of the artist to his copyright. The sculptor's right to sell his work and retain his copyright has never been questioned so long as he signs and dates it. The painter's copyright is made to depend upon the signing of a document by the purchaser of his work. The engraver and the sculptor are not required to register; but the author's name, and the date of putting forth or publishing, must appear on his work. The painter cannot protect his copyright without registration, but this registration as it is now required is merely a pitfall for the unwary. Designed to give the public information as to the ownership and duration of copyrights, the uncertainty of its operation results in the prevention of information on these very points.

Difficult and complicated as is this whole subject of artistic copyright, it is perhaps not to be wondered at that ignorance of the law on the subject is very widespread, even amongst those who are most interested in its action. One of the commonest beliefs amongst artists is, that all they have to do to secure copyright is to register a picture at Stationers' Hall; but the authorities at Stationers' Hall ask no questions, and simply enter any particulars submitted to them on their printed form. Some artists make a practice, when they send a picture away to exhibition, to fill up one of these forms, reserving the copyright by their entry to themselves, in the belief that, if accompanied by the 1s. fee required by the Stationers' Hall, its entry will reserve the copyright to them, oblivious of the fact that the only thing which can reserve the copyright to them is the possession of a document assigning the copyright to them by the purchaser of the picture. Another useless method of attempting to reserve artists' copyrights is that adopted by the promoters of public exhibitions, with whom it is an almost constant practice to print on some portion of the catalogue of the exhibition a statement that "copyrights of all pictures are reserved," the impression apparently prevailing that a notice of this kind effectively reserves the copyright for the artist while selling his picture from the walls. It, of course, does no such thing, and the copyright of any picture sold in these circumstances, without the necessary document from the purchaser, must be lost to the artist, and pass irrevocably into the public domain.

In a work of art the work itself and the copyright are two totally distinct properties, and may be held by different persons. The conditions differ materially from those of a work of literature, in which as a rule there is no value apart from publication. There is a value in a work of art for its private enjoyment quite apart from its commercial value in the form of reproductions; but when the two properties exist in different hands, the person holding the copyright has no power to force the owner of the work of art to give him access to it for purposes of reproduction; this can only be effected by private arrangement. It has been argued that, as the two properties are so distinct, the owner of the copyright ought to have the right of access to the picture for the purpose of exercising his right to reproduce it. But it is easy to see that it would destroy the value of art property if proprietors knew that at any moment they might be forced to surrender their work for the purpose of reproduction, though for a time only.

There is often a strong sympathy between the artist and the person who buys his picture, and it is not at all unusual, when application is made to the owner of the picture for access to it, for him to submit the question of reproduction to the artist. Although the latter may really have no right in it, it is felt, as a practical matter, that he is largely interested in the character of the reproduction it is proposed to make. Hence the courtesy which is usually extended to him.

Of late years, owing to the increased facilities of reproduction, the practice has become very common of splitting up copyrights and granting licenses in what may be described as very minute forms. It would, of course, be impossible for a publisher to pay an artist the sum at which he values his entire copyright, simply that he might reproduce his picture in the form of a black-and-white block in a magazine, and it has consequently become quite common for the artist to grant a license for any and every particular form of reproduction as it may be required, so that he may grant the right of reproduction in one particular form in one particular publication, and even for a particular period of time, reserving to himself thus the right to grant similar licenses to other publishers. This is apparently not to the injury of the artist; it is probably to his advantage, and it certainly promotes business.

The great obstacle in the way of securing a really good Artistic Bill has been the introduction into it of photography. It was by a sort of accident that the photographer was given the same privileges as the painter in the Bill of 1862. The promoters of the Bill thought that the photographer would be protected by the Engraving Acts which covered prints; but since the photographers feared that, as their prints were of a different character from the prints from a plate, the Engraving Acts might not protect them, it was at the last moment decided to put photography into the Art Bill. The result of this was that the painter lost his chance of copyright on all works executed on commission. Legislators feared that if photographers held copyright in all their works the public would have no protection from the annoyance of seeing the photographs of their wives and daughters exhibited, and sold in shop windows by the side of "professional beauties" and other people, and made articles of commerce. So in the case of commissioned works, the copyright was denied to both painters and photographers, and there seems considerable fear that in any new legislation the attempt to give the same terms to both painter and photographer may lead to great injury and injustice to the public.

The Royal Commission which reported on the subject in 1878 proposed two distinct terms of copyright for painting and photography. The term for the painter was dependent on his life; that for the photographer was a definitely fixed term of years from the date of publication of his photographs; and there can be little doubt that this is the right way to deal with the two branches of copyright. The artist who paints a picture signs it, and there is no difficulty in knowing who is the author of a painting and in whom the term of copyright is vested. But who knows anything as to the authorship of a photograph? In a very large number of cases a photograph is taken by an employee, who is here to-day and gone to-morrow, and even his employer knows nothing of his existence. Of course, it may suit an employer to be able to maintain secrecy as to the authorship of his negative, inasmuch as it enables him to go on claiming copyright fees indefinitely; but it is not to the public interest. In most countries on the Continent a photographer has the fixed term of five years' copyright in an original photograph dating from its publication, which date, together with the name and address of the photographer, has to be stamped on every copy issued. In the public interest some such method of dealing with photographs should be introduced into any new Act. If the choice is between the Continental method and registration, the photographer would probably

choose the former, as it would entail no registration fees.

See also WALTER ARTHUR COPINGER, F.S.A. *The Law of Copyright in Works of Literature and Art.* London, 1893.—RICHARD WINSLOW, M.A., LL.B. *The Law of Artistic Copyright.* London, 1889. (E. BA.)

**Coquelin, Benoît Constant** (1841-——), French actor, was born at Boulogne, January 24, 1841. He was originally intended to follow his father's trade of baker, but his love of acting led him to the Conservatoire, where he entered Regnier's class in 1859. He won a prize for comedy less than a year afterwards, and made his *début* in December 1860 at the Comédie Française, of which house he became a *sociétaire* four years later. His first successes, which were made in classical comedy, were brilliantly sustained during the twenty years that succeeded his election as *sociétaire.* During that time he "created" the leading parts in a number of new plays, including *Gringoire* (1867), *Tabarin* (1871), *Paul Forestier* (1871), *L'Etrangère* (1876), *Jean Dacier* (1877), *Le Monde où l'on s'ennuie* (1881), *Les Rantzau* (1884), and others. In consequence of a dispute with the authorities over the question of his right to make provincial tours in France, he resigned his position at the Comédie Française in 1886. Three years later, however, the breach was healed; and, after a successful series of tours in Europe and the United States, he rejoined the Comédie Française as *pensionnaire* in 1889. He remained there three years, during which time the most notable events were the *début* of his son Jean in 1890, and the production of *Thermidor* (a play suppressed, for political reasons, on the third occasion of its performance), and of a version of *The Taming of the Shrew* under the title of *La Mégère Apprivoisée,* both in 1891. In 1892 he broke definitely with the Comédie Française, and toured for some time through the capitals of Europe with a company of his own.

In 1895 he joined the company at the Renaissance Theatre in Paris, and played there until he became director of the Porte-Saint-Martin Theatre in 1897. There his latest successes have been in *Cyrano de Bergerac* (1897) and *Plus que Reine* (1899). In 1900 he once more undertook an American tour. He has published: *L'Art et le Comédien* (1880), *Molière et le Misanthrope* (1881), essays on *Eugène Manuel* (1881) and *Sully-Prudhomme* (1882), *L'Arnolphe de Molière* (1882), *Les Comédiens* (1882), *L'Art de dire le Monologue* (with his brother, 1884), *Tantuffe* (1884), *L'Art du Comédien* (1894).

**Coquimbo,** a town and important port in Chile, in the province and department of the same name, situated in 29° 57′ 4″ S. lat. and 71° 21′ 12″ W. long. The population in 1895 was 7322. In 1898 it had 5·44 per cent. of the total export trade of Chile, and 3·34 per cent. of the import trade. In the same year it was visited by 484 ships (foreign and coastwise trade), of a total tonnage of 775,981 tons.

**Corato,** a town in the province of Bari, Apulia, Italy, 25 miles west from Bari, with olive and wine production. In the neighbourhood stands the Emperor Frederick II.'s hunting-seat, Castel del Monte. The population (1901) was 41,573.

**Cordoba,** a province in the centre of the Argentine Republic. The official area at the census of 1895 was 62,160 square miles; the population in 1895 amounted to 351,223—urban, 94,760; rural, 256,463. The province is divided into twenty-five departments. In 1895 there were 18,545 farms, 1,070,532 acres planted in cereals, 1,884,926 head of cattle, and 489,926 horses.

**Cordoba,** a city of the Argentine Republic, capital of the province of Cordoba, on the Rio Primero in 31° 25′ S. lat. and 63° 42′ W. long., about 435 miles north-west of Buenos Aires; in communication by rail with all the principal towns of the Republic. It has greatly increased in importance since 1875: the population of the town in 1895 was 42,783; of the suburbs, 11,679. Besides its other educational and scientific institutions, it contains the National Meteorological Bureau of the Argentine, the National Academy of Sciences (1894), a national secondary school, two national schools for teachers, and a good public library. There is a bronze equestrian statue of General Paz, and another of the legislator Dr Sarsfield. Bridges have been constructed to connect the town with two new districts which have sprung up as a result of the introduction of an extensive scheme of irrigation. The water supply is excellent. For internal communication there is an efficient service of electric and other trams.

**Cordova,** a province in the south of Spain, with a population of 420,714 in 1887 and 443,582 in 1897. Its area is 5300 square miles, divided into 16 administrative districts and 74 parishes. The river Guadalquivir divides the province into two very dissimilar portions. On the right bank is the mountainous region of the Sierra Morena, less peopled and fertile than the left bank, with its great plains and slightly undulated country towards the south and south-east in the direction of some spurs of the Sierra Nevada. One of the most picturesque chains of this province is the Sierra de Cordova at some distance from, but along, the right bank of the Guadalquivir, that runs from east-north-east to west-south-west. It waters the richest districts of Cordova, and has many tributaries, one of the most important being El Guadalmellato. The Guadiato and Bembezar are next in importance, and in the northern part of the province are several streams that are tributaries of the Guadiana. The climate is much varied. Snow is to be found for months on the highest peaks of the mountains, mild temperature in the plains except in the few torrid summer months, when rain seldom falls. The latest returns showed that out of 78,204 children of both sexes between the ages of 4 and 14, 36,357 only were on the school registers, and 27,940 attended classes. There are 266 miles of railways, some good first-class state roads, few good provincial and many fair municipal roads. Cordova is one of the provinces of Spain that pays most for the industrial and commercial taxes, though its principal resources and products are agricultural, and its mining interests anything but sufficiently developed. The mines, however, are important. Three lead, 11 argentiferous lead, and 25 coal mines were worked in 1898. Ten silver lead mines at work in 1898 produced 9059 metric tons, valued at £82,123, as compared with 6529 tons, valued at £61,945, in 1897. Three silver lead mines also produced 7439 tons, valued at £18,279, in 1898. The total value at pit's mouth of the output of the mines in 1898 was £257,269, against £193,656 in 1897. The coal mines are almost entirely in the hands of two important companies, Andaluces and Southern of Spain. The Belmez coal-field had in 1898 an output of 383,969 metric tons, valued £156,866, against 316,024 tons, valued £113,772, in 1897. This province also produced in 1898, 29,565 tons of coke, 20,105 of anthracite, 47 metric tons of silver. The most important group of silver lead mines belongs to Anglo-Bilbao companies, and the English lead works smelted 8573½ English tons of lead ore from their Linares mines, producing therefrom 6258 English tons of pig lead. The live stock in the province consists of 11,149 horses, 14,584 mules, 12,923 asses,

25,857 cattle, 214,908 sheep, 61,703 goats, and 54,668 pigs. About 365,000 acres are covered with wheat crops, 228,200 with barley, 50,820 with rye, 62,810 with oats, 36,357 with chick peas, 12,635 with vines, 482,495 with olives.

**Cordova,** the capital of the above province, had a population of 55,615 in 1887, and 55,506 in 1897. The township includes a very extensive territory outside the city proper; in fact, 310,000 acres of area, studded with factories of alcohol, hats, woollen stuffs, and silversmiths' works. The famous leather manufactures have decayed, though some good imitations of the old style are to be met with. Within the area of the town there are lovely gardens, plantations, orange, olive, and lemon groves, and pastures where popular and famed breeds of bulls for the national sport are reared, Cordova being celebrated for its school of bull-fighters. There are many modern public buildings and useful institutions, secondary and primary schools, a school founded in 1590 by the Bishop Pacheco of Cordova for girls, who take the same degrees as the other sex, a school of veterinaries, an academy of sciences, fine arts, and letters, polytechnic school, and an athenæum.

**Corea.** See KOREA.

**Corfu.** See GREECE (*Ionian Islands*).

**Corinth.**—The modern town of New Corinth, capital of an arrondissement in the province of Argolis and Corinth, Greece, is situated on the isthmus of Corinth, near the Bay of Lepanto, Greece, about 3½ miles from the site of the ancient city, at the junction of two railway lines, 57 miles west of Athens and 87 east-south-east of Patras, with which there is also frequent communication by steamer. With the opening of the Corinthian Ship Canal in 1893 its prosperity has somewhat revived. The chief exports are raisins, corn, oil, and silk. Population, 4100.

Corinth, after passing through its various stages called Greek, Roman, Byzantine, and Turkish, survived until 1858 as one of the most considerable towns of Greece, when it was, with the exception of a few houses, levelled to the ground by an earthquake, and New Corinth, a city with broad streets but no old traditions, was founded. A mere handful of the old population remained on the old site, which was marked out for continuous occupation by flowing water and fertile fields. At present a picturesque but poverty-stricken village of somewhat over 1000 inhabitants, mostly of Albanian descent, holds its place among the ruins of former days, and bears the name of Old Corinth. Its most picturesque features are its one gigantic plane tree nourished by the water of Pirene, shading nearly all of the public square, its venerable temple ruin, and Acro-Corinth rising above the village to a height of nearly two thousand feet. The view even from the village, over the Corinthian Gulf, of Parnassus with its giant neighbours on the north, of Cyllene and its neighbours on the west, and of Gerancia on the east, is very fine; but from Acro-Corinth the view is still finer, and is perhaps unsurpassed by any in Greece.

Such were the attractions and the features of Corinth known to those who visited it before 1896. The excavations begun in that year by the American School of Classical Studies at Athens, under the direction of Mr Rufus B. Richardson, have in each succeeding year brought to light important monuments of the ancient city, both of Roman and of Greek times. The outlook at the outset was not hopeful. In the first place, the long and continuous occupation made it appear probable that the slow and remorseless wear of ages had done much more than the destruction of Mummius to obliterate the traces of the ancient monuments; secondly, although there was one landmark of the old Greek city, namely, the old temple ruin, there was no certainty what one of the temples mentioned by Pausanias this was. In fact, by a perverse error, which one topographer after another had handed along, the wrong name of Athena Chalinitis was quite commonly applied to it. The current topography of Corinth was simply a web of conjecture, which gained nothing from the fact that one great name after another was added to the list of its vouchers. The great object to be attained by excavations was the locating of the agora; first, because Pausanias says that most of the important monuments of the city were in and near the agora; and secondly, because he could only thus be used as a guide and authority. As he mentions the monuments in order along the streets radiating from the agora, when the starting-point was once gained, one could hope to identify any foundations found along their various lines. One unsuccessful attempt to locate the agora by excavation had already been made.

*Modern archæological discoveries.*

In the first year's work of the American School twenty-one trial trenches from 10 to 20 feet deep, of varying lengths and scattered over a wide area, were dug, in the hope of finding, if not the agora itself, something which would give a clue that might lead up to the agora. The work was successful. Near the close of the campaign, somewhat less than a quarter of a mile to the north-west of the temple ruin, on the edge of a terrace, the theatre was found. This discovery laid the corner-stone of the topography of Corinth; for the theatre was, according to Pausanias, on the street leading from the agora towards Sicyon, and so to the west of the agora. Another trench, dug across the valley to the east of the temple, revealed a broad pavement of white limestone, extending from the north up the valley towards Acro-Corinth. This was clearly one of the great thoroughfares of the city, and so probably the street mentioned by Pausanias as leading from Lechaeum up to the agora. It was already as good as certain that, by following up this pavement until it was intersected by a line coming from Sicyon past the theatre, one would find oneself in the agora. Even before the agora was found, the temple seemed to take its place as the temple of Apollo, mentioned by Pausanias as "the first monument on your right as you go out of the agora on the street leading towards Sicyon." The limestone pavement yielded in the following year all that it had promised. It was soon seen to end in a flight of thirty-seven marble steps, in their present form of a late date, which lead up to the propylaea of the agora, the buttresses of which are well preserved and agree with the form of a Roman triumphal arch, a form given to the propylaea on the coins of imperial times from Domitian to Commodus. To the east of the staircase and close up against the agora itself, only at a much lower level, was found, buried under 35 feet of earth, the famous fountain, Pirene, tallying exactly with the description of Pausanias, as "a series of chambers resembling grottoes, and bearing a façade of white marble." This two-storey façade of porous stone, with arches opening into the chambers, belonged to the Roman city; and before the time of Pausanias, had received a facing of marble, which has now fallen off but has left traces of itself in the holes by which it was attached and in cartloads of chips which lay in front of the façade. This was not, however, the first form of Pirene. It was built up in front of a more simple Greek façade, which consisted of seven cross walls supporting a conglomerate stratum, and forming six chambers, whose only ornamentation was *antae* at the front end of the cross walls, and on

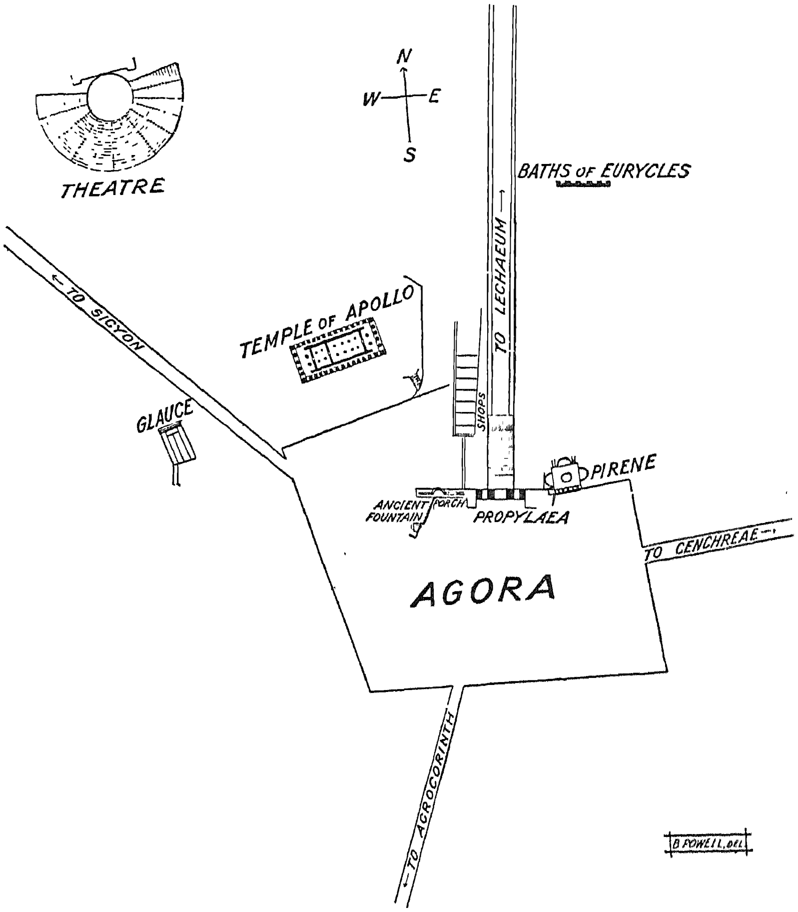
a parapet at the rear single slender Ionic columns between two *antae* supporting an entablature. The chambers were really reservoirs. The water flowed along their backs, poured into them, and then out into a large basin in the open air, enclosed by a large quadrangle with apses on three sides and the façade of the fountain on the other. The whole quadrangle was faced with marble. During the Byzantine period a pretentious but very rough addition was made to this façade by setting five marble columns about four feet in front of the older façade, with heavy architrave blocks running from them back into the façade, which was roughly cut into for the purpose, the object probably being to form a sort of balcony. The columns, the Corinthian capitals, and the bases are all of varying sizes, and, like the architrave blocks, were surely taken from earlier buildings.

barian captive like those found on Roman triumphal arches, is practically entire; and another, its counterpart, is preserved down to the thighs. These figures are not quite like Caryatids and Atlantes, which bear the entablature on their heads. They seem rather to prop up the Corinthian capitals, which rest upon pilasters that form a part of their backs. Two of these stood at each end of a re-entrant curve of the entablature. Two female heads of like proportions belonged to figures with the same architectural functions, bearing straight lines of entablature, and were placed probably to the right and left of the first pair. The building to which they belonged was probably a porch which abutted upon the propylaea on the west, and had a façade like the Septizonium at Rome on a small scale. The foundations of the porch were of a core of *opus incertum*.

To the west of the temple of Apollo was a cube of rock protruding some 10 feet from the ground. This, on being excavated, proved to be the fountain Glauce, an impressive structure entirely cut out of native rock, consisting of four chambers, with a porch of three pillars between two *antae*, approached by a flight of five steps. This falls in line, as it should, between the temple of Apollo and the theatre.

To the north of the propylaea and Pirene, the brick ruins in the middle of the village were explored, and appeared to be the baths of Eurycles, which should lie here on the street to Lechaeum. Some other monuments were identified with more or less probability. But enough has been located with absolute certainty to allow us to speak of a topography of Corinth, not as based on mere conjecture, but on facts; and for the first time a map of the central portion of the ancient city can be drawn.

This is perhaps the greatest result of the excavations, but much more has been accomplished. Vases and fragments of vases have been found, of all periods except the Mycenaean, a gap which will presumably be filled later. On the north side of the hillock on which stands the village schoolhouse there were found several rock-cut vertical shafts, which led into lateral passages used for burial. These contained unpainted vases in considerable quantity, of most varied forms, some of them with incised ornamentation, corresponding closely to the prehistoric pottery of Thera and Hissarlik. A deep digging near the foot of the staircase leading to the propylaea yielded fifteen vases with geometric decoration. In a well about 30 feet below the surface of the road leading westward out of the village square was found a large celebe of old Corinthian style in forty-six fragments, with pieces of several similar vases. A good many so-called Proto-Corinthian vases may be added to the list.




PLAN OF CORINTH SHOWING SITES OF EXCAVATIONS.

The statuary yielded by the excavations is mostly of Roman times. A head of Dionysus crowned with a wreath of ivy, and a round base with a relief of dancing Maenads, surpass in value the many headless statues which have been constantly turning up. But the most important sculptures of this period are a group of colossal statues supporting an entablature, a great part of which has been found. One of these figures, apparently a young bar-

In 1900 was found an ancient Greek fountain in the agora, 25 feet below the present surface of the soil. It is approached through an opening in an enclosure made of metopes and triglyphs, with the painted patterns on them almost as fresh as if they had been painted a year ago. Through the opening a flight of seven steps leads down to a quadrangular room, in the west wall of which are two bronze lion's heads, through the open mouths of which water was once discharged. The whole adjustment and its greater depth than the Roman surroundings prove its great antiquity. It is the only case of an intact Greek fountain, and so of the highest interest in itself, and perhaps still more interesting as an earnest of ancient things still to be discovered when the requisite level is reached.

Among the inscriptions, which are mostly of Roman

date, was one which deserves mention. It is cut in rather rough Greek letters upon a highly ornamented marble block, which in its second use served as the lintel of a Jewish synagogue. The block was broken at both ends, but in the middle appears ΑΓΩΓΗΕΒΡ, *i.e.*, συναγωγὴ Ἑβραίων. Under this lintel without doubt passed and repassed the great Apostle to the Gentiles.

A full account of the various discoveries is given in the volumes of the *American Journal of Archæology* for 1896–1901.

(R. B. R.)

**Corinth, Isthmus of.**—An isthmus of Greece, dividing the Gulf of Corinth from the Saronic Gulf. In 1893 a ship canal was opened through it, with its western entrance about $1\frac{1}{4}$ miles north-east of the little town of New Corinth. It was begun in 1881 by a French company, which ceased operations in 1889, a Greek company completing the undertaking. The canal is 100 feet broad, $3\frac{1}{2}$ miles long, and 26 feet deep. It shortens the journey from the Adriatic to the Piræus by 202 miles, but foreign steamships will not use it, as the narrowness of the canal and the strength of the current at times render the passage dangerous. About 1 mile from its western end it is crossed by the iron bridge of the Athens and Corinth Railway.

**Corinth,** capital of Alcorn county, Mississippi, U.S.A., situated in the north-eastern part of the state, on the Mobile and Ohio and the Southern Railways, at an altitude of 436 feet. During the Civil War, on October 3 and 4, 1862, it was the scene of a severe battle between the Confederates, under Van Dorn, and the Union forces, under Rosecrans, when the former were defeated with heavy loss. Population (1880), 2275; (1890), 2111; (1900), 3661.

**Corinto,** a town in Nicaragua, on the Pacific, the chief port of the Republic. Its harbour is one of the best protected on the coast of Central America, and is part of the ancient port of Realejo. Corinto is the terminus of the railway from Lake Managua, and is regularly visited by the various lines of steamers. It is estimated that it does 59 per cent. of the export and 62 per cent. of the import trade of Nicaragua. Population about 1500.

**Cork,** à maritime county of Ireland, province of Munster.

*Population.*—The area of the administrative county in 1900 was 1,838,921 acres, of which 415,766 were tillage, 971,221 pasture, 1608 fallow, 29,099 plantation, 24,996 turf-bog, 68,997 marsh, 213,688 barren mountain, and 83,546 water, roads, fences, &c. The new administrative county is identical in area with the old judicial county. The population in 1881 was 495,607, and in 1891, 438,432, of whom 219,988 were males and 218,444 females, divided as follows among the different religions:—Roman Catholics, 396,174; Protestant Episcopalians, 35,407; Presbyterians, 2130; Methodists, 3293; and other denominations, 1428. The decrease of population between 1881 and 1891 was 11·54 per cent. The average number of persons to an acre was ·24. Of the total population, 310,851 inhabited the rural districts, being an average of 129 persons to each square mile under crops and pasture. The population in 1901 was 401,813 (Roman Catholics, 366,085; Protestant Episcopalians, 31,411; Presbyterians, 1780; Methodists, 2946; others, 2591), being a decrease of 5·7 per cent. in the East Riding, and of 11·6 per cent. in the West Riding. The following table gives the degree of education in 1891 (excluding the city of Cork):—

| | Males. | Females. | Total. | Percentage. | | |
|---|---|---|---|---|---|---|
| | | | | R. C. | Pr. Epis. | Presb. |
| Read and write . | 121,978 | 113,651 | 235,629 | 69·9 | 91·9 | 95·7 |
| Read only . . | 11,940 | 12,013 | 23,953 | 7·7 | 3·4 | 2·2 |
| Illiterate . . | 32,576 | 35,632 | 68,208 | 22·4 | 4·7 | 2·1 |

In 1881 the percentage of illiterates among Roman Catholics was 32·5. Excluding the city of Cork, in 1891 there were 31 superior schools with 1439 pupils (Roman Catholics 1023, and Protestants 416), and 776 primary schools with 62,093 pupils (Roman Catholics 58,215, and Protestants 3878). The number of pupils on the rolls of the national schools on 30th September 1899 was 74,408, of whom 69,325 were Roman Catholics and 5083 Protestants.

The following table gives the number of births, deaths, and marriages in various years:—

| Year. | Births. | Deaths. | Marriages. |
|---|---|---|---|
| 1881 | 12,253 | 8736 | 1988 |
| 1891 | 9,713 | 8047 | 1759 |
| 1899 | 9,220 | 7030 | 1926 |

In 1899 the birth-rate per 1000 was 21·0, and the death-rate 16·0; the rate of illegitimacy was 1·8 per cent. of the total births. The total number of emigrants who left the county between 1st May 1851 and 31st December 1899 was 491,932, of whom 255,162 were males and 236,770 females. The following are the chief towns in the county, with their populations in 1891:—Cork, 75,345 (in 1901, 75,978); Queenstown, [illegible]; Fermoy, 6469; Kinsale, 4605; Youghal, 4317; Mallow, 4366; Bandon, 3488.

*Administration.*—The county is divided into seven parliamentary divisions, East, Middle, North, North-East, South South-East, and West, the number of registered electors in 1900 being respectively 6990, 7822, 7463, 7393, 6611, 8339, and 6683. The ratcable value in 1900 was £1,095,885. By the Local Government (Ireland) Act, 1898, the fiscal and administrative duties of the grand jury and (to a less extent) of other bodies were transferred to a county council, urban and rural district councils were established, and under that Act the county now comprises 7 urban and 18 rural sanitary districts. Under the same Act the city of Cork constitutes a separate county.

*Agriculture.*—The following tables give the acreage under crops, including meadow and clover, and the amount of live stock in 1881, 1891, 1895, and 1900:—

| | Wheat. | Oats. | Barley, Beans, Rye, &c. | Potatoes. | Turnips. | Other Green Crops. | Meadow and Clover. | Total. |
|---|---|---|---|---|---|---|---|---|
| 1881 | 24,597 | 101,933 | 22,280 | 68,709 | 33,784 | 14,914 | 164,307 | 431,445 |
| 1891 | 10,353 | 93,598 | 17,848 | 56,986 | 31,984 | 17,839 | 169,726 | 398,334 |
| 1895 | 4,770 | 99,805 | 19,587 | 53,798 | 34,510 | 20,309 | 184,167 | 416,946 |
| 1900 | 6,840 | 95,572 | 18,639 | 48,109 | 32,569 | 25,113 | 188,900 | 415,766 |

There were also a few acres under flax and rape during these years. For 1899 the total value of the cereal and other crops was estimated by the registrar-general at £2,753,756. The number of acres under pasture in 1881 was 973,567; in 1891, 988,369; and in 1900, 971,221.

| | Horses and Mules. | Asses. | Cattle. | Sheep. | Pigs. | Goats. | Poultry. |
|---|---|---|---|---|---|---|---|
| 1881 | 54,435 | 11,191 | 286,205 | 264,165 | 144,856 | 22,756 | 1,115,668 |
| 1891 | 57,937 | 13,052 | 417,581 | 416,423 | 147,439 | 21,551 | 1,125,955 |
| 1895 | 62,785 | 16,802 | 420,337 | 311,620 | 155,473 | 26,261 | 1,279,991 |
| 1900 | 57,157 | 18,713 | 444,668 | 320,361 | 132,653 | 28,119 | 1,451,516 |

The number of milch cows in 1891 was 174,760, and in 1900, 186,785. It is estimated that the total value of cattle, sheep, and pigs in 1899 was £6,538,272. In 1900 the number of holdings not exceeding 1 acre was 7089; between 1 and 5, 2493; between 5 and 15, 4750; between 15 and 30, 6436; between 30 and 50, 6532; between 50 and 100, 7992; between 100 and 200, 3342; between 200 and 500, 757; and above 500, 67—total, 39,458. The number of loans issued (the number of loans being the same as the number of tenants) under the Land Purchase Acts, 1885, 1891, and 1896, up to 31st March 1900, was 2603, amounting to £1,516,880. The number of loans for agricultural improvements sanctioned under sect. 31 of the Land Act, 1881, between 1882 and 1900, was 2559, and the amount issued £189,748, the largest amount in any county of Ireland. The total amount issued on loan for all classes of works under the Land Improvement Acts, from the commencement of operations to 31st March 1900, was £451,533.

*Fisheries.*—There are four deep-sea and coast fishing districts in the county—Youghal, Kinsale, Queenstown, and Castletown Bere—in which, in 1899, 748 vessels were registered, employing 3304 men and boys, and four salmon fishing districts—Cork, Bandon, Skibbereen, and Bantry—in which 777 persons were employed in the same year.

(W. H. PO.)

**Cork,** a maritime city, county and parliamentary borough (returning two members), on the river Lee, 138 miles south-west of Dublin. It is the centre of an extensive railway system, which includes the Great Southern and Western, the Cork, Bandon, and South Coast, the Cork and Macroom Direct, and the Cork, Blackrock, and Passage Railways. The new Protestant

cathedral was completed in 1879. The central tower is 240 feet high. The Parnell bridge over the south channel of the river was opened in 1882. The Crawford Science and Art Schools were opened in 1885, and stand on the site of the old Custom House. A new Protestant church, St Luke's, was erected in 1888. The principal manufactures are distilling, brewing, tanning, chemical manures, tweeds, and friezes, and there is an extensive trade in grain, provisions, and especially butter, the Cork butter market being the chief centre of the trade in Ireland. The port is the most important on the south coast of Ireland, the quays extending for over 4 miles, of which more than 2½ are available for shipping. In all 2368 vessels of 662,086 tons entered in 1899, and 1529 of 402,196 tons cleared. The registered shipping totalled 115 vessels of 21,193 tons. The total foreign and colonial imports for the same year, which included 1,138,870 cwts. of wheat and 2,207,700 of maize, amounted to £1,240,304. There are valuable salmon fisheries on the Lee, in which 370 persons were employed in 1899. In 1898 Cork was constituted one of the six county boroughs which have separate county councils. Population (1881), 80,124; (1891), 75,345, of whom 35,427 were males and 39,918 females, divided as follows among the different religions:—Roman Catholics, 64,561; Protestant Episcopalians, 8620; Presbyterians, 749; Methodists, 867; and others, 548. The population in 1901 was 75,978. In 1891 there were 22 superior schools, with 1771 pupils (1346 Roman Catholics and 425 Protestants), and 58 primary schools, with 11,115 pupils (9597 Roman Catholics and 1518 Protestants). The percentage of illiterates among Roman Catholics was 18·0; among Protestant Episcopalians, 3·2; among Presbyterians, 2·8; and among Methodists, 2·7. The population of the parliamentary borough in 1891 was 97,281 and in 1901, 99,693, and the registered number of electors in 1900, 13,153. The ratable value of the city in 1900 was £173,656. (W. H. PO)

**Cornelius, Carl August Peter** (1824–1874), German musician and poet, son of an actor at Wiesbaden, grandson of the well-known engraver Ignaz Cornelius, and nephew of Cornelius the painter, was born at Mainz, 24th December 1824. In his childhood's days his bent was towards languages, though his musical gifts were carefully cultivated by Scharrer the singer, Panny the Hungarian violinist, and Heinrich Esser. Cornelius the elder, anxious for his son to become an actor, himself taught the boy the elements which can be learnt. These theatrical studies, however, were interrupted early by a visit paid by Peter Cornelius to England as second violin in the Mainz orchestra. On returning home young Cornelius made his stage début as John Cook in *Kean*. But after two more appearances, as the lover in the comedy *Das War Ich* and as Perin in Moreto's *Donna Diana*, he practically abandoned the stage for music, his idea being to become a comic opera composer. In 1843 his father died. Hitherto Cornelius's musical studies had been unsystematic. Now opportunity served to remedy this, for his relative, Cornelius the painter, summoned him in 1844 to Berlin, and enabled him a year later to become a pupil of Dehn, counterpoint and theory generally being worked at laboriously. After leaving Dehn, Cornelius proved his independence by writing a trio in A minor, a quartet in C, as well as two comic opera texts. In 1847 he returned to Dehn and immediately composed an enormous mass of music, including a second trio, 30 vocal canons, several sonatas, a Mass, a Stabat Mater; he also wrote a number of translations of old French poems, which are classics of their kind. In 1852 he first came in touch with Liszt, through his uncle's instrumentality. At Weimar, whither he went in 1852, he heard Berlioz's delightful *Benvenuto Cellini*, a work which ultimately exercised great influence over him. For the time, however, he devoted himself, on Liszt's advice, to further Church compositions, the influence of the Church on him at that time being so great that he applied, but vainly, for a place in a Jesuit college. Still his mind was bent on the production of a comic opera, but the composition was long delayed by the work of translating the prefaces for Liszt's symphonic poems and the texts of works by Berlioz and Rubinstein. Between October 1855 and September in the following year, Cornelius wrote the book of the *Barbier von Bagdad*, and on December 15, 1858, the opera was produced at Weimar under Liszt, and hissed off the stage. Thereupon Liszt resigned his post, and shortly afterwards Cornelius went to Vienna and Munich, and still later came very much under Wagner's influence. Cornelius's *Cid* was completed and produced at Weimar in 1865. For the last nine years of his life (1865–1874) Cornelius was occupied with his opera *Gunlöd* and other compositions, besides writing ably and abundantly on Wagner's music-dramas. In 1867 he became teacher of rhetoric and harmony at the Musik-Schule, Munich, and married Berthe Jung. He died 26th October 1874. Not the least of Cornelius's many claims to fame was his remarkable versatility. Many of his original poems, as well as his translations from the French, rank high. Among his songs, the lovely "Weihnachtslieder" are conspicuous; many of the best are unknown in England, but a great impression has been made in recent years by his "Vatergruft," an unaccompanied vocal work for baritone solo and choir. (R. H. L.)

**Cornell University,** Ithaca, New York, was founded by Ezra Cornell, and opened in 1868. Beside the founder's endowment, it received 990,000 acres of public land, and subsequently gifts from private benefactors. In 1890 its invested funds amounted to $6,756,370, and its total income to $722,210. Its buildings and equipment are valued at $3,242,715, exclusive of the Medical College in New York, valued at $1,000,000. Its library contained, in 1900, 238,376 volumes and 38,400 pamphlets; its average annual growth is 13,000 volumes. The book funds amount to $300,000. The instructing staff numbers 265, including 32 non-resident lecturers, beside 94 in the Medical College in New York City. The total attendance in 1900–1901 (including 83 students in the winter school in Agriculture, and 445 in the summer session of 1899) numbers 3005. Of these, 192 were in the Graduate Department, 744 in the Academic Department, 176 in the College of Law, 336 in the Medical College, 179 in the College of Civil Engineering, 654 in the College of Mechanical Engineering, and 204 in the Colleges of Architecture, Agriculture, Veterinary Medicine, and Forestry. Somewhat more than half of the students come from New York State. Free tuition is annually given to 512 state students, and there are 36 university scholarships of $200, each for two years, awarded by competition to freshmen. Seventeen graduate scholarships of $200 each, 21 fellowships of $500 each, and 2 of $600 are annually granted to graduate students. (See also the articles UNIVERSITIES and EDUCATION.) (J. G. S*.)

**Corneto Tarquinia,** an Italian town in the province of Rome, 13 miles north from Civitavecchia by rail. The church of Santa Maria, in the citadel of the Countess Matilda of Tuscany, has recently been restored. New buildings are the town-hall and municipal museum, particularly rich in archæological treasures, many of them

taken since 1881 out of the cave tombs of the ancient Etruscan town of *Tarquinii*. There is another collection of Etruscan antiquities in the Bruschi palace. Population (1901), 7219.

**Corning,** a city of Steuben county, New York, U.S.A., situated in 42° 08′ N. lat. and 77° 03′ W. long., in the southern part of the state, on Chemung river, at an altitude of 942 feet. It has three railways, the Delaware, Lackawanna, and Western, the Erie, and the New York Central and Hudson River. The surrounding country produces much tobacco. Population (1880), 4802; (1890), 8550; (1900), 11,061.

**Cornu, Marie Alfred** (1841–1902), French physicist, was born on 6th March 1841, and after being educated at the École Polytechnique and the École des Mines, became in 1867 professor of experimental physics in the former institution, where he remained throughout his life. Although he made various excursions into other branches of physical science, undertaking, for example, with Baille about 1870 a repetition of Cavendish's experiment for determining the mean density of the earth, his original work was mainly concerned with optics and spectroscopy. In particular he was known for his redetermination of the velocity of light by Fizeau's method, which he improved in various ways, adding greatly to the accuracy of the results. Among the honours which this achievement won for him were membership of the Academy of Sciences in France and the Rumford medal of the Royal Society in England (both in 1878). In 1899, at the jubilee commemoration of Sir George Stokes, he was Rede lecturer at Cambridge, his subject being the undulatory theory of light and its influence on modern physics; and on that occasion the honorary degree of D.Sc. was conferred on him by the University. He died on 11th April 1902.

**Cornwall,** a peninsular county of England, at the extreme south-west of Great Britain, surrounded on all sides by the sea except on the east and north-east, where it marches with Devon, and the boundary line is formed mainly by the river Tamar.

*Area and Population.*—The area of the ancient and administrative county was given in the census returns of 1891 as 868,208 acres, or 1357 square miles, with a population in 1881 of 330,686, and in 1891 of 322,571, of whom 149,259 were males, and 173,312 females, the number of persons per square mile being 238, and of acres to a person 2·69. In 1901 the population was 322,857. The area of the registration county is 886,372 acres, with a population in 1891 of 318,583, of whom 113,538 were urban, and 205,045 rural.

The following table gives the marriage-, birth-, and death-rates per 1000 persons living, with the percentages of illegitimate births, for a series of years:—

| | 1870-79. | 1880. | 1880-89. | 1890. | 1889-98. | 1899. |
|---|---|---|---|---|---|---|
| Marriage-rate . . . | 12·9 | 12·1 | 13·2 | 13·4 | 13·4 | 13·8 |
| Birth-rate . . . | 30·4 | 29·0 | 28·7 | 26·6 | 27·1 | 25·5 |
| Death-rate . . . | 20·4 | 21·4 | 19·1 | 19·6 | 18·2 | 18·1 |
| Percentage of illegitimacy | 6·3 | 6·8 | 6·1 | 5·7 | 5·4 | 4·9 |

The birth-rate was considerably below the average for England, but the death-rate only a very little below it, while the percentage of illegitimate births was rather high.

*Constitution and Government.*—The ancient county is divided into 6 parliamentary divisions, and it also includes the parliamentary burgh of Penryn and Falmouth, returning one member. The administrative county contains 11 municipal boroughs: Bodmin (5151), Falmouth (12,791), Helston (3198), Launceston (4345), Liskeard (3984), Lostwithiel (1379), Penryn (3256), Penzance (12,432), St Ives (6094), Saltash (2745), and Truro (11,131). The following are urban districts: Camborne (14,700), Hayle (1172), Looe (2454), Ludgvan (2334), Madron (2761), New Quay (1891), Padstow (1546), Paul (5977), Phillack (3979), Redruth (10,324), St Austell (3477), St Just (6119), and Wadebridge (1868). The county is in the western circuit, and assizes are held at Bodmin. The boroughs of Bodmin, Falmouth, Helston, Launceston, Liskeard, Penryn, Penzance, St Ives, and Truro have separate commissions of the peace, and the borough of Penzance has in addition a separate court of quarter sessions. In matters relating to mines the county is under the jurisdiction of the Duchy of Cornwall, of which the Heir Apparent is hereditary duke. The executory court of the duchy is called the Stannary court, its jurisdiction also including West Devon. The ancient county, which is in the diocese of Truro, contains 227 entire ecclesiastical parishes and parts of one other.

*Education.*—There is a residential training college for schoolmasters (Exeter Diocesan) at Truro. The number of elementary schools on 31st August 1899 was 339, of which 179 were board, and 160 voluntary schools, the latter including 136 National Church of England schools, 17 Wesleyan, 2 Roman Catholic, and 5 "British and other." The average attendance at board schools was 26,506, and at voluntary schools 18,517.

*Agriculture.*—Within recent years the area under cultivation has considerably increased, but it is still less than three-fourths of the total acreage. Of the cultivated area only about one-fifth is under corn crops, and nearly two-fifths under permanent pasture, in addition to which there are nearly 55,000 acres of hill pasture, over 31,000 acres under woods, and about 5000 acres under orchards. The acreage under wheat has greatly diminished, oats now occupying about one-half the total acreage under corn crops, and wheat and barley each about one-fourth. Nearly three-fourths of the acreage under green crops is occupied by turnips, swedes and mangold, and in addition cabbage occupies about one-fifth, while less than one-eighth is occupied by potatoes. The following table gives the main divisions of the cultivated area in 1880 and 1900:—

| Year. | Total Acreage under Cultivation. | Corn Crops. | Green Crops. | Clover. | Permanent Pasture. | Fallow. |
|---|---|---|---|---|---|---|
| 1880 | 551,221 | 137,297 | 56,399 | 154,566 | 182,633 | 20,329 |
| 1900 | 606,139 | 125,115 | 47,349 | 189,313 | 238,806 | 3,933 |

The principal live-stock in 1880 and 1899 were as follows:—

| Year. | Total Horses. | Total Cattle. | Cows or Heifers in Milk or in Calf. | Sheep. | Pigs. |
|---|---|---|---|---|---|
| 1880 | 31,527 | 163,604 | 55,145 | 426,550 | 60,193 |
| 1899 | 31,096 | 203,983 | 69,500 | 399,756 | 88,559 |

*Industries and Trade.*—According to the annual report for 1898 of the chief inspector of factories (1900), the total number of persons employed in factories and workshops in 1897 was 10,923. The number of persons employed in mines and quarries in 1899 was 11,410. In 1899 the amount of igneous rocks raised was 222,614 tons valued at £97,008, and of slate 31,923 tons. The more valuable minerals in 1890 and 1899 were as follows:—

| Year. | Arsenic. | | China Clay. | | Copper. | | Tin. | |
|---|---|---|---|---|---|---|---|---|
| | Tons. | Value. | Tons. | Value. | Tons. | Value. | Tons. | Value. |
| 1890 | 3143 | £26,503 | 393,500 | £268,000 | 5271 | £15,301 | 14,867 | £780,017 |
| 1899 | 1361 | 13,295 | 506,228 | 290,620 | 5172 | 21,487 | 6,389 | 440,299 |

Large quantities of herring are obtained on the Cornwall coasts, along which there are numerous fishing stations. The valuable pilchard fisheries also retain their importance. The total quantity of fish landed at all stations in 1899 was over 400,000 cwts., valued at over £200,000; but much fish from Cornwall is landed at Plymouth in Devon.

AUTHORITIES.—Among later works are BANNISTER. *Glossary of Cornish Names.* London, 1878.—HARTING. *Birds of Cornwall.* London, 1880.—DUNKIN. *Monumental Brasses of Cornwall.* London, 1882.—SYMONS. *Sketches of the Geology of Cornwall.* London, 1884.—COURTNEY. *Parliamentary Representation of Cornwall to 1832.* London, 1889.—BOASE. *Collectanea Cornubiensia.* Truro, 1890.—BORLASE. *Early Christianity in Cornwall.* London, 1893; and QUILLER-COUCH (M. and L. M.). *Ancient Wells of Cornwall.*

(T. F. H.)

**Cornwall,** the capital of the united counties of Stormont, Dundas, and Glengarry, Ontario, Canada, 65 miles south-west of Montreal, on the left bank of the river St Lawrence. It is an important station on the Grand Trunk and the Ottawa and New York Railways, and is a port of call for all steamers plying between Montreal and Lake

Ontario ports. The surplus water from the Cornwall Canal furnishes excellent water privileges for its large factories, which include cotton and woollen mills and grist and saw mills. Population (1881), 4468; (1901), 6500.

**Corot, Jean-Baptiste Camille** (1796–1875), French landscape painter, was born in Paris, in a house on the Quai by the Rue du Bac, now demolished, on 26th July 1796. His family were well-to-do bourgeois people, and whatever may have been the experience of some of his artistic colleagues, he never, throughout his life, felt the want of money. He was apprenticed to a draper, but hated commercial life and despised what he called its "business tricks," yet he faithfully remained in it until he was twenty-six, when his father at last consented to his adopting the profession of art. Corot visited Italy on three occasions: two of his Roman studies are now in the Louvre. He was a regular contributor to the Salon during his lifetime, and in 1846 was "decorated" with the knighthood of the Legion of Honour. He was promoted to be Officer in 1867. His many friends considered nevertheless that he was officially neglected, and in 1874, only a short time before his death, they presented him with a personal medal. He died in Paris in 1875 and was buried at Père Lachaise. Of the painters classed in the Barbizon School it is probable that Corot will live the longest, and will continue to occupy the highest position. His art is more individual than Rousseau's, whose works are more strictly traditional; more poetic than that of Daubigny, who is, however, Corot's greatest contemporary rival; and in every sense more beautiful than J. F. Millet, who thought more of stern truth than of æsthetic feeling.

Corot's works are somewhat arbitrarily divided into periods, but the point of division is never certain, as he often completed a picture years after it had been begun. In his first style he painted traditionally and "tight"—that is to say, with minute exactness, clear outlines, and with absolute definition of objects throughout. After his fiftieth year his methods changed to breadth of tone and an approach to poetic power, and about twenty years later, say from 1865 onwards, his manner of painting became full of "mystery" and poetry. In the last ten years of his work he became the Père Corot of the artistic circles of Paris, in which he was regarded with personal affection, and he was acknowledged as one of the five or six greatest landscape painters the world has ever seen, along with Hobbema, Claude, Turner, and Constable. During the last few years of his life he earned large sums by his pictures, which became greatly sought after. In 1871 he gave £2000 for the poor of Paris (where he remained during the siege), and his continued charity was long the subject of remark. Corot's works are spread over Europe and America. The Louvre possesses several important pictures by him, and there are examples in Lille, Bordeaux, Rouen, Rheims, Toulouse, and other centres. In England the "Macbeth" in the Wallace Collection is the only one in a public museum, but it is not characteristic of his best period; and in Scotland there is the splendid "Souvenir d'Italie" in the Glasgow Gallery. Besides landscapes, of which he painted several hundred, Corot produced a number of figure pictures which are now much prized. These were mostly studio pieces, executed, probably with a view to keep his hand in with severe drawing rather than with the intention of producing pictures. Yet many of them are fine in composition, and in all cases the colour is remarkable for its strength and purity. Corot also executed a few etchings and pencil sketches. In his landscape pictures Corot was more traditional in his method of work than is usually believed. If even his latest tree-painting and arrangement are compared with such a Claude as that which hangs in the Bridgewater Gallery, it will be observed how similar is Corot's method and also how masterly are his results.

The works of Corot are scattered over France and the Netherlands, Great Britain, and America, and it would be impossible except in a very extended list to name them. The following may be considered as the first half-dozen:—*Une Matinée* (1850), now in the Louvre; *Macbeth* (1859), in the Wallace Collection; *Le Lac* (1861); *L'Arbre Brisé* (1865); *Pastorale—Souvenir d'Italie* (1873), in the Glasgow Corporation Art Gallery; *Biblis* (1875). Corot had a number of followers who called themselves his pupils. The best known are Boudin, Lepine, Chintreuil, Français, and Le Roux.

AUTHORITIES.—H. DUMESNIL. *Souvenirs Intimes.* Paris, 1875.—ROGER—MILÈS. *Les Artistes Célèbres: Corot.* Paris, 1891.—ROGER—MILÈS. *Album Classique des Chefs-d'œuvres de Corot.* Paris, 1895.—J. ROUSSEAU. *[illegible] d'art moderne: Camille Corot.* Paris, 1884.—J. CLARETIE. *Peintres et Sculpteurs Contemporains: Corot.* Paris, 1884.—CH. BIGOT. *Peintres Français Contemporains: Corot.* Paris, 1888.—GEO. MOORE. *Ingres and Corot in Modern Painting.* London, 1893.—DAVID CROAL THOMSON. *Corot.* 4to. London, 1892.—MRS SCHUYLER VAN RENSSALAER, "Corot," *Century Magazine* (June 1889).—COROT. *The Portfolio*, 1870 (p. 60), 1875 (p. 146).—R. A. M. STEVENSON. "Corot as an Example of Style in Painting," *Scottish Art Review*, Aug. 1888.

(D. C. T.)

**Corpus Christi,** capital of Nueces county, Texas, U.S.A. It is a seaport, with a fine harbour, and is situated in the southern part of the state, on Corpus Christi Bay. Two railways, the Mexican National and the San Antonio and Aransas Pass, enter it. Population (1880), 3257; (1890), 4387; (1900), 4703.

**Correggio,** a town of Emilia, Italy (province Reggio), on a canal connecting the Secchia and the Po, 11 miles by rail north-east from Reggio. It has an old castle, and a fine monument (1880) to the painter Antonio Allegri, better known as Correggio, who was born here in 1494 and died here in 1534. Cheese and hats are manufactured. Population of commune (1881), 12,587; (1901), 14,437.

**Correnti, Cesare** (1815–1888), Italian revolutionist and politician, was born, 3rd June 1815, at Milan. While employed in the Public Debt administration he flooded Lombardy with revolutionary pamphlets designed to excite hatred against the Austrians, and in 1848 proposed the general abstention of the Milanese from smoking, which gave rise to the insurrection known as the Five Days. During the revolt he took part in the council of war and directed the operations of the insurgents. Until the fall of Milan he was Secretary-General of the Provisional Government, but after the restoration of Austrian rule he fled to Piedmont, whence he again distributed his revolutionary pamphlets throughout Lombardy. Elected deputy in 1849, he worked strenuously for the national cause, supporting the Crimea expedition and organizing a new revolt in Milan, which, however, was forestalled by the victory of Magenta. After the annexation of Lombardy he was made commissioner for the liquidation of the Lombardo-Venetian debt, and in 1860 was appointed Councillor of State. In 1867, and again in 1869, he held the portfolio of Public Instruction, taking considerable part in the events consequent upon the occupation of Rome, and helping to draft the Law of Guarantees. As Minister he suppressed the theological faculties in the Italian Universities, but eventually resigned office and allied himself with the Left on account of Conservative opposition to his reforms. His defection from the Right


"SKETCH OF A LANDSCAPE" BY COROT.

(*From an Engraving by M. Pastre.*)

ultimately assured the advent of the Left to power; and while declining office, he remained chief adviser of Depretis until the latter's death. On several occasions—notably in connexion with the redemption of the Italian railways, and of the Paris Exhibition of 1878—he acted as representative of the Government. In 1877 he was given by Depretis the lucrative sinecure of the Secretaryship of the Order of Saints Maurice and Lazarus, and in 1886 was created Senator. He died at Rome on 4th October 1888.

**Corrèze,** a department in the interior of France, traversed by the ramifications of the central plateau, and watered by the Dordogne, the Vezère, and the Corrèze.

Area, 2273 square miles, with 29 cantons and 287 communes. The population decreased from 326,494 in 1886 to 304,718 in 1901. Births in 1899, 7395, of which 299 illegitimate; deaths, 6263; marriages, 2451. In 1896 there were 761 schools, with 51,000 pupils, and 8 per cent. of the population was illiterate. The area under cultivation in 1896 amounted to 1,030,466 acres, 425,036 acres of which were plough-land, 276,767 acres natural pastures and grass lands, and 296,536 acres forests. The wheat return is low (£240,700), but in 1898 the rye crop yielded a value of £524,270, and the natural grass lands produced the value of £617,120. Chestnuts and walnuts are also an important crop, yielding in 1899 the value of £240,000. The live-stock amounted in 1899 to 990,200, of which 579,570 were sheep. There is not much working in metals, the department having but few mineral beds. Other industries are also little developed. Tulle, the capital, had a population of 17,000 in 1896.

**Corrientes,** a province of the Argentine Republic, south of Paraguay and west of the territory of Chaco. The official area at the census of 1895 was 32,579 square miles. The population in 1895 was 239,618. The province is divided into twenty-five departments. The capital, Corrientes, on the Paraná, 844 miles from Buenos Aires, had a population of 16,129 in 1895. In 1895 there were 13,632 farms and 136,119 acres planted in cereals, 424,483 head of horses, and 2,893,256 head of cattle.

**Corrigan, Michael Augustine** (1839–1902), third archbishop of the Roman Catholic archdiocese of New York, in the United States, was born in Newark, N.J., on 17th August 1839. In 1859 he began his studies for the priesthood as one of the twelve students with whom the American College at Rome was opened. On 19th September 1863, a year before the close of his theological studies, he was ordained priest, and in 1864 obtained the degree of D.D. Returning to America, he was appointed Professor of Dogmatic Theology and Sacred Scripture, and Director of the ecclesiastical seminary of Seton Hall College; soon after he was made vice-president of the institution; and in 1868, although hardly twenty-eight years of age, was appointed president of the college, one of the foremost of the Catholic educational institutions in the United States. When Archbishop Bayley was transferred to the see of Baltimore in 1873, Pius IX. appointed Father Corrigan bishop of Newark. In 1880 Bishop Corrigan was made coadjutor, with the right of succession, to Cardinal M'Closkey, archbishop of New York, under the title of Archbishop of Petra; and thereafter nearly all the practical work of the archdiocese fell to his hands. He was at the time the youngest archbishop in the Catholic Church in America. He died on 5th May 1902. On the death of Cardinal M'Closkey in 1885 Archbishop Corrigan became metropolitan of the diocese of New York.

**Corry,** a city of Erie county, Pennsylvania, U.S.A., situated in the north-western part of the state, on the Western New York and Pennsylvania, the Erie, and the Pennsylvania Railways, at an altitude of 1434 feet. It is within the limits of the great oil-fields of Western Pennsylvania and Southern New York, and it is to petroleum that it owes its existence and whatever measure of prosperity it enjoys. It was a place of much importance during the oil excitement between 1860 and 1870, and in the latter year had a population of 6809. As the excitement abated, however, its population diminished, so that in 1880 it numbered but 5277, in 1890 it was 5677, and in 1900, 5369.

**Corsica,** an island in the Mediterranean, forming a department of France; area, 3368 square miles, occupied by high mountains, and distributed among 62 cantons and 364 communes. The population in 1896 numbered 290,168, as compared with 278,501 in 1886. Births in 1899, 6947, of which 504 illegitimate; deaths, 5582; marriages, 1625. In 1896 the schools numbered 1170, with 46,000 pupils, and 15 per cent. of the population was illiterate. The total area under cultivation in 1896 amounted to 1,593,886 acres, of which 919,265 acres were arable land. In 1899 the wheat crop returned a value of only £57,800, while the produce of rye and oats together hardly exceeded £21,000; but the vine, which is making progress in the island, yielded a value of £278,000. In 1899 the crop of chestnuts was of the value of £154,000; oranges, £2820; citrons, £1640; cedrates, £22,000. The production of silkworm cocoons amounted in 1899 to 5813 cwt. The live-stock in 1899 included 10,730 horses, 9130 mules, 8730 asses, 157,990 cattle, 408,650 sheep, 74,300 pigs, and 215,920 goats. Corsica has no coal-pits, but some copper and lead mines, yielding 1100 metric tons in 1898, and some salt-pans, producing, in 1898, 520 metric tons of salt. The industries are in a backward state. The railway, of recent construction, goes from Bastia to Ajaccio, sending off a branch line to Calvi. The line had in 1899 a length of 182 miles.

**Corsicana,** capital of Navarro county, Texas, U.S.A., situated towards the north-eastern part of the state, at an altitude of 426 feet, on the Houston and Texas Central and the St Louis South-Western Railways. It is in a region largely devoted to the cultivation of cotton, for which staple it serves as a compressing- and shipping-point. Population (1880), 3373; (1890), 6285; (1900), 9313.

**Corti, Lodovico,** Count (1823–1888), Italian diplomatist, born at Gambarano 28th October 1823. Early involved with Cairoli in anti-Austrian conspiracies, he was exiled to Turin, where he entered the Foreign Office. After serving as artillery officer through the campaign of 1848, he was in 1850 appointed Secretary of Legation to London, whence, with the rank of Minister, he passed to Stockholm, Madrid, The Hague, Washington, and, in 1875, as Ambassador to Constantinople. Called by Cairoli to the direction of Foreign affairs in 1878, he took part both in the preliminary negotiations to the Congress of Berlin and in the Congress itself, but unwisely declined Lord Derby's offer for an Anglo-Italian agreement in defence of common interests. At Berlin he sustained the cause of Greek independence, but in all other respects remained isolated. While other Powers secured extensions of territory, he declined the German suggestion for an Italian occupation of Tunis, and excited the wrath of his countrymen by returning to Italy with "clean hands." For a time he withdrew from public life, but in 1881 was again sent to Constantinople by Cairoli, where he presided over the futile Conference of Ambassadors upon the Egyptian question. In 1886 he was transferred to the London Embassy, but was recalled by Crispi in the following year through a misunderstanding. He died at Rome on 9th April 1888.

**Cortland,** a village of New York, U.S.A., and capital of Cortland county, situated in the central part of the state, on Tioughnioga river, at the junction of its

east and west branches, at an altitude of 1122 feet. It has three railways, the Delaware, Lackawanna, and Western, the Erie and Central New York, and the Lehigh Valley. Population (1880), 4050; (1890), 8590; (1900), 9014.

**Cortona,** a town and episcopal see of Tuscany, Italy (province Arezzo), 30 miles north-west from Perugia by rail. The church of St Domenic, built about 1250, should be mentioned because of its fine paintings by Luca Signorelli, Fra Angelico, and others. Here is a technical school. Silk is manufactured. Population (1901), 29,343.

**Corunna,** a maritime province in the extreme north-west of Spain. The coast, which is very dangerous to navigation, is a succession of bays and estuaries, which are very picturesque, and often in close proximity to more rugged parts that are in reality the last spurs of the Cantabric chain. The province is very well watered by a great many small rivers and streams. Hills and mountain-sides are covered with forests and pastures. The climate is mild, with comparatively no extremes of cold or heat. The rains are quite as abundant as in the rest of Galicia, and even more so than in Asturias and the Basque provinces. It has an area of 3078 square miles, divided into 14 administrative districts and 97 parishes. The population was 596,436 in 1877, and 631,419 in 1897.

In very few provinces of the kingdom is the birth-rate so high, nor the proportion of illegitimates so great; the slow progress of the population, the death-rate being moderate, is attributed to the fact that emigration carries off on an average 3250 per annum. Education is in a backward condition, as in 1897, out of 129,976 children of both sexes, ranging from 4 to 14 years of age, only 46,603 were enrolled on the school registers, and only 29,487 ever attended the classes.

The railway lines actually open are only 45 miles. Other lines are being constructed. There were 63 unproductive mines in 1897, and 5 mines that were being worked. The latter were—1 arsenic pyrites, 2 iron, and 2 that showed traces of gold. The live-stock in 1897 included 25,565 horses, 3863 mules, 3250 asses, 104,147 sheep, 10,364 goats, 92,006 pigs, and 169,480 cattle. The rearing of cattle, formerly one of the most important industries of the province, has declined with the decrease of exportation, in particular to England; even to France and the interior of Spain it is not what it used to be. The yield of the principal crops in 1898 was—wheat, 2,087,395 bushels; rye, 1,091,086; beans, 54,596; chick peas, 1,177,650; maize, 2,190,444, the latter showing a falling off of over 2,500,000 bushels. Only about 1890 acres are covered with vines, that produce strongly alcoholic wine (491,392 gallons in 1898). The wheat crop covers 270,000 acres; rye, 170,000; maize, 70,000. As in the rest of Spain, the cultivation of beetroot has been started in the province for the sugar factories and to feed cattle. (A. E. H.)

**Corunna,** a seaport and the capital of the above province. The population was 37,240 in 1887, and 38,927 in 1897. The trade and commerce of Corunna depended so much on the Spanish colonies, especially Cuba and Porto Rico, that the loss of these seriously affected the exports and imports. The total value of the articles exported in 1898 amounted to £86,316 as against £185,061 in 1897, while the imports decreased to £205,602 from £352,323. The chief exports were flour, potatoes, beans, bacon and hams, tinned provisions, chocolate, wine, eggs; the imports were chiefly coals from England, and drugs, hides, metals, machinery, timber, cotton, maize, sugar, coffee, petroleum. The return of shipping during 1898 showed a total of 1157 vessels, and 983,121 aggregate tonnage. The harbour has been considerably improved. The new quay wall has been completed, and dredgers have been used successfully to deepen the anchorage. The depth of water is now 19 feet 6 inches at the quay walls at low tide, and powerful cranes have been erected on the wall to unload vessels. A lighthouse has been established at Cape Torinana. Corunna is the head of the railway line direct between Galicia and Madrid, and will soon be the terminus of lines in different directions in North-West Spain and Portugal.

**Corvey,** an abbey of Germany. See Hoxter.

**Cos,** or Kos (Italian, *Stanchio*; Turkish, *Istan-keui*, from ἐς τάν κῶ), an island separated from Cape Krio, near the south-west corner of Asia Minor, by a narrow strait. Under the name of Lungo it became part of the maritime state founded by the knights of Rhodes. In 1523, after the fall of Rhodes, it was annexed to the Osmanli Empire. The estimated population is 10,000: Moslems, 500; Greeks, 9500.

**Cosenz, Enrico** (1812–1898), Italian soldier, was born at Gaeta, 12th January 1812. As captain of artillery in the Neapolitan army he took part in the expedition sent by Ferdinand II. against the Austrians in 1848; but after the *Coup d'Etat* at Naples he followed General Pepe in disobeying Ferdinand's order for the withdrawal of the troops, and proceeded to Venice to aid in defending that city. As commandant of the fort of Marghera, Cosenz displayed distinguished valour, and after the fall of the fort assumed the defence of the Piazzale, where he was twice wounded. Upon the fall of Venice he fled to Piedmont, where he remained until, in 1859, he assumed the command of a Garibaldian regiment. In 1860 he conducted the third Garibaldian expedition to Sicily, defeated two Neapolitan brigades at Piale (August 23), and marched victoriously upon Naples, where he was appointed Minister of War, and took part in organizing the *plébiscite*. During the war of 1866 his division saw but little active service. After the war he repeatedly declined the portfolio of War. In 1881, however, he became chief of the general staff, and held that position until a short time before his death at Rome on 7th August 1898.

**Cosenza,** a town and episcopal see of Calabria, Italy, capital of the province Cosenza, 43 miles by rail south-south-west from Sibari, a junction on the railway along the east coast. It consists of the old town, with steep, narrow streets, and a better built new town, and is surrounded by villas of the provincial landowners. The town suffered severely from earthquakes in 1638, 1783, 1854, and 1870. Population (1881), 16,686; (1901), 21,420.

**Coshocton,** capital of Coshocton county, Ohio, U.S.A., on the Muskingum river, at the mouth of Tuscarawas river, and on the Ohio Canal. Three railways intersect at this place. Population (1890), 3672; (1900), 6473.

**Cosne,** chief town of arrondissement, department of Nièvre, France, 33 miles north-north-west of Nevers, on railway from Paris to Lyon. Its potteries are now important, and there is wool-spinning, and the preparation of phosphate is carried on in the vicinity; with commerce in wine, hemp, wood, iron, wool, and leather. Population (1881), 5241; (1891), 5737; (1901), 8580.

**Cossa, Pietro** (1830–1880), Italian dramatist, was born at Rome in 1830, and claimed descent from the family of Pope John XXIII., deposed by the council of Constance. He manifested an independent spirit

from his youth, and was expelled from a Jesuit school on the double charge of indocility and patriotism. After fighting for the Roman republic in 1849, he emigrated to South America, but failing to establish himself, returned to Italy, and lived precariously as a literary man until 1870, when his reputation was established by the unexpected success of his first acted tragedy, *Nero*. From this time to his death in 1880 Cossa continued to produce a play a year, usually upon some classical subject. *Cleopatra*, *Messalina*, *Julian*, enjoyed great popularity, and his dramas on subjects derived from Italian history, *Rienzi* and *The Borgias*, were also successful. *Plautus*, a comedy, was preferred by the author himself, and is more original. Cossa had neither the divination which would have enabled him to reconstruct the ancient world, nor the imagination which would have enabled him to idealize it. But he was an energetic writer, never tame or languid, and at the same time able to command the attention of an audience without recourse to melodramatic artifice; while his sonorous verse, if scarcely able to support the ordeal of the closet, is sufficiently near to poetry for the purposes of the stage. (R. G.)

**Cossacks** (Russian, *Kazak*; plural, *Kazaki*), the name given to considerable portions of the population of the Russian Empire, endowed with certain special privileges, and bound in return to give military service, all at a certain age, under special conditions. They constitute ten separate *Voiskos*, settled along the frontiers: Don, Kuban, Terek, Astrakhan, Ural, Orenburg, Siberian, Semiryechensk, Amur, and Usuri. The primary unit of this organization is the *stanitsa*, or village, which holds its land as a commune, and may allow persons who are not Cossacks (excepting Jews) to settle on this land for payment of a certain rent. The assembly of all householders in villages of less than 30 households, and of 30 elected men in villages having from 30 to 300 households (one from each 10 households in the more populous ones), constitutes the village assembly, similar to the *mir*, but having wider attributes, which assesses the taxes, divides the land, takes measures for the opening and support of schools, village grain-stores, communal cultivation, and so on, and elects its *ataman* (elder) and its judges, who settle all disputes up to £10 (or above that sum with the consent of both sides). Military service is obligatory for all men, for 20 years, beginning with the age of 18. The first 3 years are passed in the preliminary division, the next 12 in active service, and the last 5 years in the reserve. Every Cossack is bound to procure his own uniform, equipment, and horse (if mounted)—the Government supplying only the arms. Those on active service are divided into three equal parts according to age, and the first third only is in real service, while the two others stay at home, but are bound to march out as soon as an order is given. The officers are supplied in the usual way by the military schools, in which all Cossack *Voiskos* have their own vacancies, or are non-commissioned Cossack officers, with officers' grades. In return for this service the Cossacks have received from the State considerable grants of land, for each *Voisko* separately.

The total Cossack population in 1893 was 2,648,049 (1,331,470 women), and they owned nearly 146,500,000 acres of land, of which 105,000,000 acres were arable and 9,400,000 under forests. This land was recently divided between the *stanitsas*, at the rate of 81 acres per each soul, with special grants to officers (personal to some of them, *in lieu* of pensions), and leaving about one-third of the land as a reserve for the future. The income which the Cossack *Voiskos* receive from the lands which they rent to different persons, also from various sources (trade patents, rents of shops, fisheries, permits of gold-digging, &c.), as also from the subsidies they receive from the Government (about 712,500 l. in 1893), is used to cover all the expenses of State and local administration. They have besides a special reserve capital of about 2,600,000 l. The expenditure of the village administration is covered by village taxes. The general administration is kept separately for each *Voisko*, and differs with the different *Voiskos*. The central administration, at the Ministry of War, is composed of representatives of each *Voisko*, who discuss the proposals of all new laws affecting the Cossacks. In time of war the ten Cossack *Voiskos* are bound to supply 890 mounted *sotnias* or squadrons (of 125 men each), 108 infantry *sotnias* or companies (same number), and 236 guns, representing 4267 officers and 177,100 men, with 170,695 horses. In time of peace they keep 314 squadrons, 54 infantry *sotnias*, and 20 batteries containing 108 guns (2574 officers, 60,532 men, 50,054 horses). Altogether, the Cossacks have 328,705 men ready to take arms in case of need. As a rule, popular education amongst the Cossacks stands at a higher level than in the remainder of Russia. They have more schools and a greater proportion of their children go to school. In addition to agriculture, which (with the exception of the Usuri Cossacks) is sufficient to supply their needs and usually to leave a certain surplus, they carry on extensive cattle and horse breeding, vine culture in Caucasia, fishing on the Don, the Ural, and the Caspian, hunting, bee-culture, &c. The extraction of coal, gold, and other minerals which are found on their territories is mostly rented to strangers, who also own most factories.

The numerical forces and the territories of each *Voisko*, as also their war-footing, in 1894 (only slightly increased since) were as follows:—

| Voisko. | Territory—Acres. | Cossack Population. | War-Footing. |
|---|---|---|---|
| Amur, 1858 . . | c 2,750,000 | 19,700 | 6 squadrons, 3 companies infantry (33 off., 1529 men, 1070 horses). |
| Astrakhan . . | 2,080,000 | 26,627 | 13 squadrons (48 off., 2167 men, 2322 horses). |
| Don . . . . | 29,695,000 | 966,869 | 354 sq., 23 batt., 16 detachments (1627 off., 64,069 men, 65,793 horses, 140 guns). |
| Kuban . . . | 18,000,000 | 702,432 | 136 sq., 14 batt., 7 inf. detachm., 1 compy. militia (47,617 men, 37,895 horses, 30 guns). |
| Orenburg, 1755 . | 23,000,000 | 350,614 | 110 sq., 7 batt., 3 inf. det. (429 off., 20,639 men, 22,717 horses, 40 guns). |
| Semiryechensk, 1867 | c. 1,500,000 | 25,369 | 12 sq. (45 off., 1965 men, 2106 horses). |
| Siberian, xvii. c. (narrow strip from Orenburg to Irtysh and Bukhtarma; also in Kirghiz Steppe) | c. 15,000,000 | 113,546 | 54 sq. (189 off., 8901 men, 9477 horses). |
| Terek . . . | 5,400,000 | 162,156 | 70 sq., 2 inf. det., 2 batt. (342 off., 12,372 men, 13,543 horses, 12 guns). |
| Transbaikalia, 1822, 1851 | c. 8,150,000 | 181,474 | 18 sq., 30 compy., 3 batt. (231 off., 9319 men, 4050 horses, 12 guns). |
| Ural . . . . | c. 17,500,000 | 110,986 | 38 sq., 2 inf. det. (198 off., 8724 men, 9229 horses). |
| Usuri, 1858 . . | Undetermined | 7,040 | 5 sq. (12 off., 583 men, 624 horses). |
| Total, . . . | Over 120,000,000 | 2,666,813 | 816 sq., 70 inf. coy. and inf. det., 49 batt. (3157 off., 177,885 men, 236 guns). |

A military organization similar to that of the Cossacks has lately been introduced into certain districts, which supply a number of mounted infantry *sotnias*. Their peace-footing is as follows:—Daghestan, 6 regular squadrons and 3 of militia; Kuban Circassians, 1 *sotnia*; Terek, 8 *sotnias*; Kars, 3 *sotnias*; Batum, 2 infantry and 1 mounted *sotnia*; Turkomanes, 3 *sotnias*; total, 25 squadrons and 2 companies.

(P. A. K.)

**Costa, Sir Michael** (properly **Michele**) (1810–1884), musical conductor and composer, son of Cav. Pasquale Costa, a Spaniard, was born at Naples, on 4th February 1810. He early became a free scholar of the Royal Music School at Naples, and at sixteen he wrote his first opera, *Il Delitto punito*, at seventeen *Il Sospetto funesto*, a mass, and an oratorio. In 1828–29 he further composed *Il Carcere d'Ildegonda* and *Malvina* for the Teatro Nuovo and San Carlo, and in this latter year he visited Birmingham to conduct Zingarelli's "Cantata Sacra," a setting of some verses from the book of Isaiah. Instead, however, of conducting, he sang the tenor part. From that time he settled in England, and became naturalized, receiving the honour of knighthood in 1869. He conducted the opera at Her Majesty's from 1832 till 1846, when he seceded to the Italian Opera at Covent Garden; he was conductor of the Philharmonic Society from 1846 to 1854, of the Sacred Harmonic Society from 1848, and of the Birmingham Festival from 1849. In 1855 Costa wrote *Eli*, and in 1864 *Naaman*, both for Birmingham. Meanwhile he had conducted the Bradford (1853) and Handel Festivals (1857–1880), and the Leeds Festivals from 1874 to 1880. On 28th April 1884, he died at Brighton. Costa's compositions have passed into oblivion, with the exception of the least admirable of them—his arrangement of the National Anthem. He was a man of restricted musical and human sympathies (witness his animosity against Sterndale Bennett); but he was a great conductor within well-defined limits.

(R. H. L.)

**Costa Rica,** a country of Central America, lying between 8° and 11° 16′ N. lat. and 80° 35′ and 85° 40′ W. long. The boundary dispute with Nicaragua, alluded to in the 9th edition article, was referred to the arbitration of the President of the United States, who, by his award in 1888, gave the whole of Lake Nicaragua and the upper waters of the San Juan river to Nicaragua, and the lower San Juan, down to the Atlantic and the Bay of Salinas, on the Pacific, to Costa Rica. Disputes respecting the demarcation of this boundary have been settled under treaty of 1896, and the delimitation is now nearly complete. The line of frontier towards Colombia was referred for arbitration to the President of the French Republic, who gave his award on 15th September 1900. The boundary begins at Cape Mona on the Atlantic, and, generally following lines of watershed, touches the Pacific at Burica Point (see COLOMBIA).

The climate of Costa Rica is tempered by the proximity of the country to two great oceans, the average temperature at Jan José being about 68° F. The hottest months are usually May and June, and the coldest usually January, but, according to observations extending over the year 1896 at Jan José, the maximum of 90° F. was reached in March, and the minimum of 50° F. in February. The rainfall at San José from May to November averages about 12 inches a month, and during the year from 70 to 80 inches. Port Limon is said to have an annual rainfall of 89 inches, and Colon 120 inches.

*Area and Population.*—According to the most recent official estimate, Costa Rica has an area of 23,000 square miles; but, according to planimetric calculations at Gotha, the area is 20,900 square miles. The population in 1892, according to the census, numbered 243,205, of whom 122,480 were male and 120,725 female. Allowance being made for probable omissions, the total number of inhabitants was 262,700, or about 11 to the square mile. The population in 1899 was estimated at 310,000. The census population in 1892 was distributed over the five provinces and two comarcas (or territories) as follows:—San José, 76,718; Alajuela, 57,203; Cartago, 37,973; Heredia, 31,611; Guanacaste, 20,049; Puntarenas (comarca), 12,167; Limon (comarca), 7484. The predominant element in the population consists of whites, many of them of pure blood, descended from Galician Spaniards. They live mostly in the capital and other towns in the highlands, and in the commercial ports. The coast regions are occupied by negroes and a mixed population, while in the interior there are uncivilized Indians, estimated at about 3500, living by themselves. The foreign population at the date of the census numbered 6289, of whom 831 were Spanish, 622 Italian, 342 German, 246 British, and 204 from the United States. There were also 634 British subjects (coloured) from the West Indies. The total births recorded in 1897 numbered 13,012; deaths, 9925; marriages, 1763. The principal towns are San José, the capital of the Republic, with about 25,000 inhabitants, and the provincial capitals of like names with the provinces. Limon, the principal port, has about 4000 inhabitants.

*Constitution.*—According to the Constitution, which received its most recent modification in 1882, the legislative power resides in a Congress of one house, consisting of deputies (1 for every 8000 of population), chosen for four years, half the number retiring every two years. They are chosen in electoral assemblies returned by the votes of all citizens who are able to support themselves. The President is similarly elected, and holds office for four years. For the administration of justice there are a Supreme Court and subordinate tribunals.

*Religion and Education.*—In 1892 the Protestants numbered 2245. The Jesuits were expelled in 1884. Elementary education is compulsory, and is provided at the cost of the Government. In 1898 there were 383 primary schools with 917 teachers and 23,134 enrolled pupils. Higher education is given in a *liceo* with 206 students, a college for ladies with 223 students, and three other institutions. There are also schools of medicine and of law. The Government encourages higher education by maintaining ten Costa Rican youths at European universities, and steps are being taken towards the formation of a National University. The expenditure of Government on public instruction in the year 1899–1900 amounted to 679,843 pesos (£54,387).

*Defence.*—All citizens from 18 to 50 years of age are liable to military service. Those under 40 are comprised in the "active service," the remainder in the "reserve." The national guard consists of all citizens outside of these age limits, but capable of bearing arms. On war footing, the military force would exceed 34,000 men. The Republic has a gunboat and a torpedo boat.

*Finance.*—Of the revenue of Costa Rica about 47 per cent. is derived from customs, 25 per cent. from spirit monopoly, 8 per cent. from the tobacco tax, and smaller proportions from stamps, the post office, railways, and other sources. The most important spending departments are those of Internal Development, Instruction, and Government. Outside of these, large amounts are devoted to the national debt. The revenue and expenditure for six years ending March 31 (at $12\frac{1}{2}$ pesos = £1) were:—

| Years. | Revenue. | Expenditure. | Years. | Revenue. | Expenditure. |
|---|---|---|---|---|---|
| 1895 | £489,910 | £489,720 | 1898 | £673,930 | £665,080 |
| 1896 | 502,320 | 495,030 | 1899 | 673,060 | 644,850 |
| 1897 | 594,850 | 535,790 | 1900 | 658,010 | 595,600 |

The external debt, according to arrangements made in 1885 and 1897, consists of a New Consolidated Debt of £2,000,000, at $2\frac{1}{2}$ and 3 per cent.; but there are now, in addition, arrears of interest amounting to £85,000. The service of this debt costs about £58,200 annually. The internal debt amounts to about 1,116,800 pesos, or about £89,340, and costs 252,127 pesos, or £20,170 annually.

*Production and Industry.*—The principal industries are agricultural. To a large extent the soil is owned and occupied by small landowners, industrious and peaceable, who form the backbone of the population. In the interior coffee-growing is prosperous, the produce being of excellent quality and commanding a high price in the market. The annual yield has increased from 20,216,000 lb in 1883 to 25,172,400 lb in 1893, 30,040,900 lb in 1897, 42,869,500 lb in 1898, 33,806,680 lb in 1899. Next to coffee the most important culture is that of bananas, which are grown on the Atlantic coast region, the crop in 1898 amounting to 2,962,770 bunches, and in 1899 to 3,594,700. Sugar, tobacco (formerly a Government monopoly), rice, beans, potatoes, and other crops are grown for local consumption, and there are some cocoa plantations. In the forests the natural timber and dye-woods are cut, and rubber

is collected for exportation. The working of the gold and silver mines has been largely discontinued. The minor industries within the Republic comprise a foundry and national workshop, at San José, where machinery, farming implements, tools, &c., are manufactured, and a silk and cotton factory, and a few other establishments. The live-stock in 1892 consisted of 345,665 cattle, 77,043 horses, 2765 sheep, and 62,328 swine.

*Commerce.*—The imports into Costa Rica are mainly textiles, provisions, iron goods, and live animals; while coffee, bananas, wood hides, and (recently) rubber are exported. The following have been the values of the imports and exports (the gold peso being taken at 4s.):—

| Years. | Imports. | Exports. |
|---|---|---|
| 1896 . . | £950,000 | £1,120,000 |
| 1897 . . | 1,092,000 | 1,095,000 |
| 1898 . . | 906,000 | 1,132,000 |
| 1899 . . | 827,000 | 986,000 |

In 1899 the coffee exports amounted to the value of £593,000; bananas, £236,000; timber and dye-woods, £68,000; hides, £21,000; rubber, £21,000. Of the imports in the same year, 54 per cent. in value were from the United States, 20 per cent. from Great Britain, 15 per cent. from Germany; of the exports of coffee, 55 per cent. went to Great Britain, 26 per cent. to the United States, and 15 per cent. to Germany. All the banana exports were to the United States.

*Shipping and Communications.*—The trade of the Republic passes through the ports of Limon on the Atlantic, and Puntarenas on the Pacific. Limon is visited monthly by 26 steamers providing communication with Europe, the United States, and the West Indies, while from 8 to 10 steamers plying on the Pacific coast call monthly at Puntarenas. In 1898, 449 vessels entered the two ports. In some districts within the Republic there are fairly good cart roads maintained by the Government, which in the year 1896–97 spent more than £15,500 on roads and bridges. The railway from Limon to San José and Alajuela, belonging partly to the Government but mainly to an English company, has, with its branches, a length of 138 miles, and carried in 1898, 601,198 passengers and 160,000 tons of goods. The Pacific railway from San José to Tivives, which is being constructed for the Government, is completed to the length of 12 miles and partially constructed for 40 miles, 19 miles being not yet begun. Within the Republic there are 83 post offices, through which, in 1898, 4,226,000 pieces of mail passed. The telegraph line in 1897 had a length of 917 miles, and was served by 43 telegraph offices. About 203 miles of telephone wire connect San José with other localities. The nearest telegraph cable station is at San Juan del Sur, on the Pacific in Nicaragua.

*Money and Credit.*—Within the Republic there are 2 important banks, the Anglo-Costa Rican Bank and the Bank of Costa Rica, with capital of 1,200,000 and 2,000,000 pesos respectively. On April 25, 1900, a new law was enacted for the regulation of the constitution, capital, note emission, and metallic reserves of banks. On October 24, 1896, an Act was passed for the adoption of a gold coinage, and the execution of this Act was decreed on April 17, 1900. The monetary unit is the gold colon weighing ·778 grammes, ·900 fine, and thus worth about 23d. It will be legally equivalent to the silver peso, which will continue in circulation. The metallic currency, as stated in the President's message, consists of 5,000,000 gold colons and 1,000,000 in silver money, while the circulating notes of the Bank of Costa Rica, exchangeable for gold, amount to 3,000,000 colons. The gold coins of the United States, Great Britain, France, and Germany are legally current.

The metric system of weights and measures was introduced by law in 1884, but the old Spanish system is still in use.

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(W. W. R.; C. E. A.)

**Côte-d'Or,** a department in the east of France, traversed by the hills of Côte-d'Or, and divided between the basins of the Seine and of the Saône.

Area, 3392 square miles. The population, 381,574 in 1886, numbered only 361,626 in 1901. Births in 1899, 6362, of which 524 were illegitimate; deaths, 7279; marriages, 2389. Dijon, the capital, had in 1896 67,000 inhabitants. In 1896 the schools numbered 1170, with 52,000 pupils, and 1 per cent. of the population was illiterate. Agriculture forms the principal wealth of Côte d'Or. The area under cultivation in 1896 comprised 2,001,625 acres, 1,057,628 acres of which were plough-land and 59,306 acres vineyards. The wheat produce in 1898 amounted to the value of £1,847,000; rye, £86,520; barley, £197,920; oats, £700,300. Potatoes returned a value of £446,795, and mangold-wurzel £173,500. The grass lands of all kinds, including the lands growing trefoil, lucern, and sainfoin, yielded the value of £809,000, while the produce of beetroot amounted to the value of £38,500. The vineyards returned a value in 1898 of £1,385,200. The livestock in 1899 included 47,200 horses, 157,420 cattle, 288,480 sheep, and 63,810 pigs. The department mines a small quantity of coal, and much limestone and marble. The metallurgy registered in 1898 4800 metric tons of iron and 11,300 tons of steel, which, with the other industries, amounted to the value of £137,000. The distillation of alcohol in 1898 amounted to 352,000 gallons.

**Côte-du-Nord,** a department in the west of France, bordering on the English Channel.

Area, 2787 square miles, with 48 cantons and 390 communes. The population decreased from 628,256 in 1886 to 609,349 in 1901. Births in 1899, 16,780, of which 642 were illegitimate; deaths, 13,571; marriages, 4527. There were, in 1896, 982 schools, with 95,000 pupils. The illiterate, who are strongly represented in this department, amounted to between 9 and 10 per cent. St Brieuc, the capital, had in 1896 a population of 21,000; the sub-prefectures are Dinan, Guingamp, Lannion, and Loudéac. The total area under cultivation in 1896 comprised 1,386,311 acres, of which 1,109,542 acres were plough-land. The vine has no place in the statistical returns. The wheat crop yielded in 1899 the value of £1,183,000; rye, £211,000; barley, £183,000; buckwheat, £315,400; oats, £713,800. The potato crop of 1899 was of the value of £613,000, and the natural pastures gave a return of £908,000. Côtes-du-Nord produced flax to the value, including both harl and seed, of £73,000, thus taking the first rank in 1899 among the departments of France in the culture of flax. Cider-apples in 1899 produced 206,126 cwts. of the value of £50,000. The live-stock comprised 92,800 horses, 317,000 cattle, 76,300 sheep, and 148,300 pigs. The department is famed for its horses. The value of milk products in 1899 was £2,040,000. The mining industry produced in 1898 613 metric tons of iron, and the working in metals 8700, of the value of a little less than £30,000.

**Cotrone,** a fortified town and seaport and bishop's see of Calabria, Italy (province Catanzaro), on the east coast, 148 miles north-east from Reggio by rail. There is a small but good harbour, protected by two moles, with a coasting trade (360 vessels of 74,319 tons cleared in 1897) in wine, olive oil, fruits, and liquorice. Population (1881), 7689; (1900), 9610.

**Cottbus,** or KOTTBUS, a town of Prussia, on the Spree, 72 miles south-south-east of Berlin by rail. It has four Protestant churches, a Catholic church, and a synagogue, a gymnasium, a higher grade, a technical, and other special schools. Population (1890), 34,900; (1900), 39,327.

**Cotton Printing.**—Recent progress in cotton printing has been mainly in the direction of expedition. This applies to printed cretonne, chintz, velvet, linen, or whatever the fabric which has in turn come into fashion. To a great extent machine printing has taken the place of hand work; the readier process of "steaming," as it is called, has been adopted in place of first printing in mordants and then dyeing; and the natural vegetable dyes have been superseded by artificial products of the

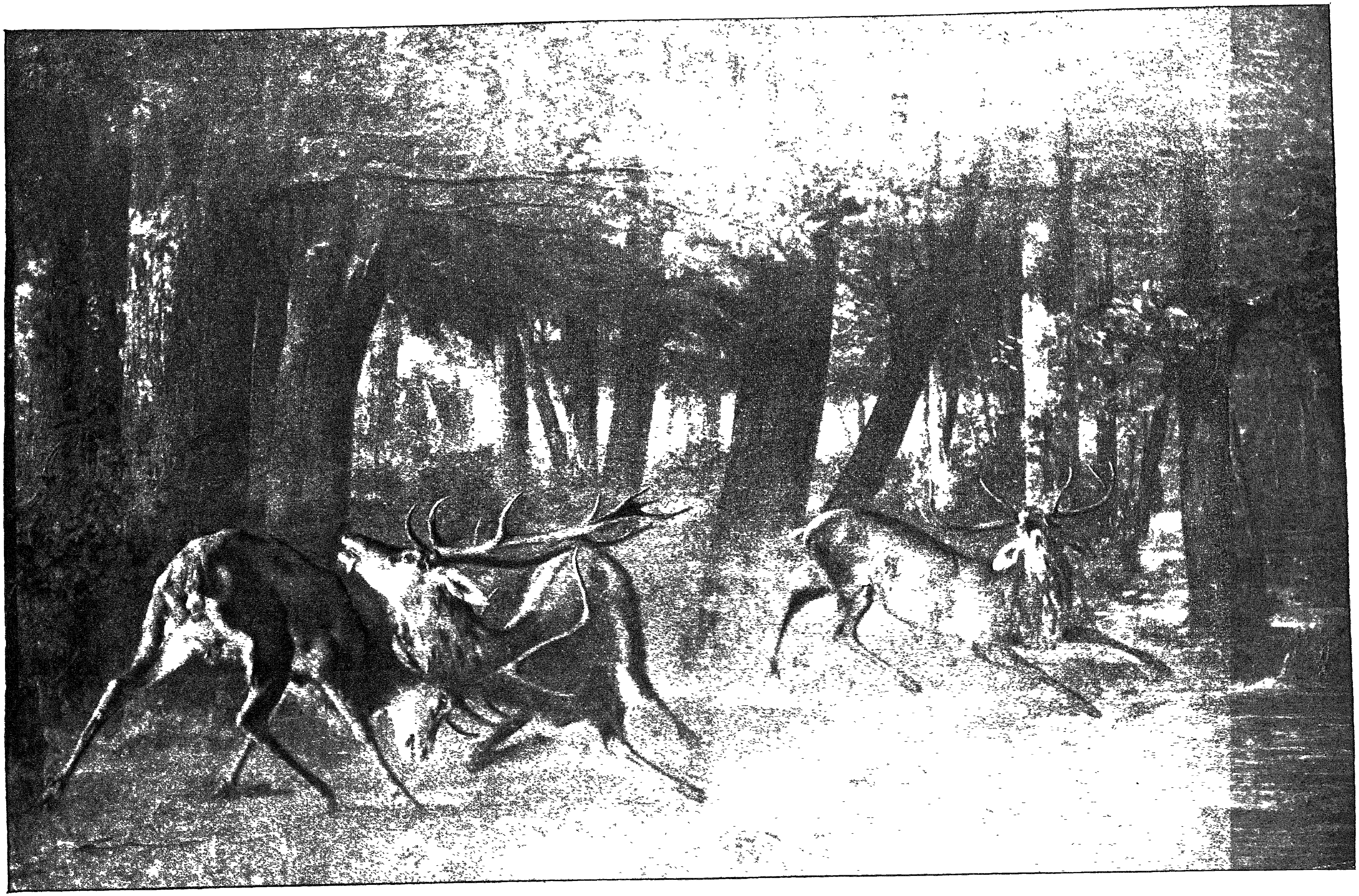
laboratory. From the point of view of commerce this is all to the good. From the artistic standpoint it is not so. It led, indeed, to a condition of things which went far to justify the contention that all this "improvement" amounted in effect to the degradation of handicraft to the level of trade. When it was boasted by the manufacturer that a machine printed with more precision than a hand block, the artist pointed out that the result was mechanical; when it was claimed that the "steaming" process was cheap, it was answered that it was proportionately nasty; when it was urged that aniline gave brighter colours than vegetable dyes, it was complained that they were crude. And there was truth in these retorts: the precision of machine printing is not altogether an artistic gain; the rough and ready process of mixing dye and mordant into one printing paste, and allowing them, as it were, to fight it out between them in the steam-box, does not result in the purest of prints; and the possibility of getting out of coal-tar unmitigated shades of colour led to the shocking abuse of garish greens, purples, &c. Moreover, the method (at first adopted) of attaching the pigments to the cloth by means of albumen did not make them fast; and, in fading, they did not simply mellow or sadden like the fugitive tints of old tapestry, but grew sickly, and passed through various unwholesome shades of difference to decay. All this naturally aroused artistic animosity, and there was something like a crusade against artificial dyestuffs. William Morris, who was at the head of this movement, went further than mere protest against the new methods, and himself set to work at printing according to the old, and more or less obsolete, practice; and his cottons found ready acceptance at the hands of artists and others better qualified to admire the beauty and originality of his design than to form any just opinion as to the relative value of the method of dyeing it pleased him to adopt. They took it too readily for granted that all pleasant colour was produced from vegetable dyes, and that all artificial dyes, therefore, were ugly.

The truth is that the ancient art of dyeing with vegetable stains had in the course of ages been perfected. The more fugitive and otherwise untrustworthy substances had been found out, the really serviceable had been tested, and a dyer knew what he had to depend upon, and for what he could depend upon it. On the other hand, when new dyestuffs came everyday to be produced in the laboratory, all use of them was experimental; and it is only after many failures that satisfactory results begin to be achieved. The failures in aniline dyeing were obvious. Arsenite of alumina proved a more efficient fixative than albumen, but was open to the objection of the poisonous nature of arsenic—an objection not applicable to tannic acid, which is now mixed with the colour, and when treated (after steaming) with tartrate of antimony forms a quite insoluble dye. With the introduction of alizarine and of what is known as the "direct" series of colours (which have such affinity with cotton as to require no mordant), printing in artificial dyestuffs entered upon a stage of success already marked enough to show that the falling back upon old-world methods was a counsel of despair, not warranted by the actual condition of things. An artist's sympathy with his material leads him, rightly, to work on the lines determined by it; and the palette offered by vegetable dyes is in a sense sufficient for him; but dye printing is not simply an art: it is an industry, supported by folks who neither know nor care about the limitations of vegetable tinctures; and, now that chemistry comes with its promise of so much wider scope in colour, it would show little enterprise on the part of the printer were he content to accept limitations no longer binding on him. As a matter of fact, the ideal of a range of colours, practically unlimited, all from one base, all to be printed at one operation, all to be developed and fixed by one process, seems on the way to no very distant realization. The last word of science is to the effect that alizarine colours are more permanent than vegetable dyes. At the very end of the 19th century these have produced artificially an indigo practically indistinguishable from the natural product. It does not, however, appear that modern methods can ever do quite what was done by the old. By the leisurely process of block-printing, in vegetable dyes, the printer gets a purity of delicate tint not as yet approached by rapid roller-printing in artificial dyestuffs—and there are obvious reasons, mechanical and chemical, why this should be so. To get the old effects it is necessary (and perhaps always will be) to adopt the old methods. But these effects are not the only ones that are beautiful. And, though they are proper to the old way of printing, there are other effects, beautiful also, quite as proper to the new. It is these which the astute printer seeks, knowing that so long as he aims at what has been done, and better done than his means allow, he puts himself at a disadvantage. The artistic development of cotton printing on the scale of a great industry must depend upon a full appreciation of what new and scientific methods can and cannot do, and upon the production of designs not only conceived in the spirit of art but schemed with the practical purpose of making much of the capacities of the industry under the conditions, commercial and other, which it is bound to obey. Probably the most considerable development of dye-printing in recent years has been in the extended use of "discharge"—dyeing rich grounds, discharging the pattern, and printing it in colours—all but impossible to the printer except in collaboration with the designer. Considerable improvement in the design of cotton prints has followed upon the revived interest in applied art characteristic of the latter part of the 19th century; even up-to-date extravagance may pass for evidence of vitality; but the aim is more often mere novelty than beauty. Moreover, too great a readiness on the part of the printer to meet demands made in ignorance of the conditions governing good work has led of late years to a departure from the ways of technique, which are indeed also the ways of art in so far as art is possible in cotton printing. (L. F. D.)

**Cotton,** and **Cotton-seed.** See AGRICULTURE (*United States*).

**Couillet,** a town of Belgium, in the province of Hainaut, 24 miles south-south-east of Mons, with a station on the railway between Charleroi and Namur. It has forges and furnaces and important ironworks. Population (1880), 7142; (1897), 9339.

**Council Bluffs,** capital of Pottawattamie county, Iowa, U.S.A., situated in 41° 16′ N. lat. and 95° 51′ W. long., in the western part of the state, in the bottom land at the foot of the bluffs, on the east side of Missouri river, at an altitude of nearly 1000 feet. It is the second largest and most important city of western Iowa, and a railway centre of the first importance, being the converging-point of five great systems from the east. These are the Chicago, Burlington, and Quincy, the Chicago, Milwaukee, and St Paul, the Chicago, Rock Island, and Pacific, the Illinois Central, and the Chicago and North-Western; while the Union Pacific comes from the west. The point of junction of these lines is at Transfer Station, just outside the city, on the bank of the Missouri. It is connected with Omaha, on the opposite bank of the river, by two iron bridges and by steam and electric cars. It is a railway,



"The Stag Fight." By Courbet.

*(From a Photograph by Neurdein.)*

rather than a manufacturing, city. In 1890 its capital invested in manufactures was $1,292,283, and the value of its products was $2,527,388. Population (1880), 18,063; (1900), 25,802, including 240 negroes.

**Coupon,** a certificate entitling its owner to some payment, share, or other benefit; more specifically, one of a series of interest certificates or dividend warrants attached to a bond running for a number of years. The word coupon (a piece cut off) possesses an etymological meaning so comprehensive that, while on the Stock Exchange it is only used to denote such an interest certificate or a certificate of stock of a joint-stock company, it may be as suitably, and elsewhere is perhaps more frequently, applied to tickets sold by tourist agencies and others. The coupons by means of which the interest on a bond or debenture is collected are generally printed at the side or foot of that document, to be cut off and presented for payment at the bank or agency named on them as they become due. They pass by delivery, and are as a rule exempt from stamp duty. Coupons for the payment of dividends are also attached to the share warrants to bearer issued by some joint-stock companies. The coupons on the bonds of most of the principal foreign loans are payable in London in sterling as well as abroad. (S. D. H.)

**Courbet, Gustave** (1819–1877), French painter, was born at Ornans (Doubs) on the 10th June 1819. He went to Paris in 1839, and worked at the studio of Steuben and Hesse; but his independent spirit did not allow him to remain there long, as he preferred to work out his own way by the study of Spanish, Flemish, and French painters. His first works, an "Odalisque," suggested by Victor Hugo, and a "Lélia," illustrating George Sand, were literary subjects; but these he soon abandoned for the study of real life. Among other works he painted his own portrait with his dog, and "The Man with a Pipe," both of which were rejected by the jury of the Salon; but the younger school of critics, the neo-romantics and realists, loudly sang the praises of Courbet, who by 1849 began to be famous, producing such pictures as "After Dinner at Ornans" and "The Valley of the Loire." The Salon of 1850 found him triumphant with the "Burial at Ornans," the "Stone-Breakers," and the "Peasants of Flazey." His style still gained in individuality, as in "Village Damsels" (1852), the "Wrestlers," "Bathers," and "A Girl Spinning" (1852). Though Courbet's realistic work is not devoid of importance, it is as a landscape and sea painter that he will be most honoured by posterity. Sometimes, it must be owned, his realism is rather coarse and brutal, but when he paints the forests of Franche-Comté, the "Stag-Fight," "The Wave," or the "Haunt of the Does," he is inimitable. When Courbet had made a name as an artist he grew ambitious of other glory; he tried to promote democratic and social science, and under the Empire he wrote essays and dissertations. His refusal of the Cross of the Legion of Honour, offered to him by Napoleon III., made him immensely popular, and in 1871 he was elected, under the Commune, to the Chamber. Thus it happened that he was responsible for the destruction of the Vendôme column. A council of war, before which he was tried, condemned him to pay the cost of restoring the column, 300,000 francs (£1200). To escape the necessity of working to the end of his days at the orders of the State in order to pay this sum, Courbet went to Switzerland in 1873, and died at La Tour du Peilz, 31st December 1877, of a disease of the liver aggravated by intemperance. An exhibition of his works was held in 1882 at the École des Beaux-Arts.

See CHAMPFLEURY. *Les grandes figures d'hier et d'aujourd'hui.* Paris, 1861.—MANTZ. "G. Courbet," *Gaz. des Beaux-Arts.* Paris, 1878.—ZOLA. *Mes Haines.* Paris, 1879.—C. LEMONNIER. *Les Peintres de la Vie.* Paris, 1888. (H. FR.)

**Courbevoie,** a town in the arrondissement of St Denis, department of Seine, France, 5 miles west-north-west of Paris, on railway to Versailles. It is a residential suburb of Paris, and has a fine avenue opening on the Neuilly Bridge, and forming with it a continuation of the Champs Elysées. It has manufactures of waggons and awnings. Port traffic, 1899, amounted to 88,074 tons. Population (1881), 13,094; (1901), 25,330.

**Courcelles,** a town of Belgium, in the province of Hainaut, 21 miles east of Mons by rail. It has a coal-mining industry, and manufactures linen and articles of iron. Population (1880), 11,190; (1890), 12,654; (1897), 14,494.

**Courland,** one of the Baltic provinces of Russia, bounded by the Baltic on the W., the Gulf of Riga and the Western Düna (Livonia and Vitebsk) on the N.E., and Kovno on the S. The Mitau Plain divides it into two parts, of which the western is fertile and thickly inhabited, excepting in the north, where there is another patch of lowlands, while the eastern is much less so. It is undulating elsewhere, and covered with spurs of the plateau of Lithuania, a hilly and picturesque tract of land which separates the Düna from the Aa, and is known as Upper Courland. Another range of heights stretches along the Windau. Neither exceeds 600 feet in altitude. The province consists mainly of Devonian rocks, besides Jurassic as far as Windau, both thickly covered with glacial deposits. Large parts are occupied by marshes, often clothed with forests, and they are sandy tracts and downs on the seashore. The marshes are drained, and the sands covered with plantations of trees. Nearly one-third of the surface is still forest, watered by nearly a hundred rivers, of which only the Düna, the Aa below Mitau, and the Windau are navigable. They all flow north-westwards and enter the Baltic Sea. The sea-coast is poor in harbours, and the only ports are Libau, Windau, and Polangen, there being none on the Courland coast of the Gulf of Riga. Population (1897), 672,634 (345,756 women), of whom, according to Rittich, 8 per cent. only are Germans, the remainder being Letts (49 per cent.), Coures (30 per cent.), Jews (6 per cent.), Russians (2 per cent.), Poles, Lithuanians, and Lives. Urban population, 148,134.

The land laws in the Baltic provinces being different from those of Russia, the land is mostly in private ownership, and 2,616,740 acres belong to 535 landlords, mostly nobles, two-fifths of whom own estates of more than 2700 acres each; 2,356,800 acres are owned or held by the peasants; and 1,354,560 acres belong to the Crown. In 1863 special laws were issued in order to enable the Letts to acquire the farms which they held, and special banks were founded. With their aid nearly 12,000 farms were bought by the peasants settled on landlords' estates, but it is estimated that nearly 300,000 Letts remain landless, and are hired labourers (*knechts*) on the farms and estates, occupying a very low position in the social scale. Agriculture reaches a high degree of perfection on the landlords' estates, and although the wet climate of Courland prevents droughts, artificial irrigation from artesian wells (about 200) is resorted to. 1,660,000 acres are arable land, of these 918,000 being under corn crops, 351,000 under flax, 67,500 under potatoes; and 2,078,000 under meadows and pasturages. Cattle-breeding is on a small scale, but excellent breeds of horned cattle, sheep, and swine are kept; also 141,100 horses. The factories numbered 315 in 1893, employing 6000 persons, and yielding returns of about £1,300,000, Libau and Mitau being the main industrial centres. There are also ironworks, agricultural machinery, tanneries, glass and soap works. Flax spinning is yet in the stage of a domestic industry. Navigation on the Düna and Aa is important for export, and still more the traffic on the railways which lead from Central Russia to Riga and Libau, the latter being one of the chief Russian ports. The Government is well provided with schools, and education is obligatory. The chief towns of the ten districts are:—Mitau

(Doblenskiy district), capital of the Government (35,011 inh.); Bauske (6543); Friedrichstadt (6800); Goldingen (9733); Grobin (1489); Hasenpoth (3338); Illuxt (2340); Talsen (1485); Tuckum (7542); Windau (7132). (P. A. K.)

**Courtney, Leonard Henry** (1832——), English politician and man of letters, eldest son of Mr T. S. Courtney, a banker at Penzance, was born at Penzance on 6th July 1832. At Cambridge he was Second Wrangler and First Smith's Prizeman, and was elected a Fellow of his College, St John's. He was called to the Bar at Lincoln's Inn in 1858, was Professor of Political Economy at University College from 1872 to 1875, and in December 1876, after a previous unsuccessful attempt, was elected to Parliament for Liskeard in the Liberal interest. He continued to represent the borough, and the district into which it was merged by the Reform Act of 1885, until 1900, when his differences with the majority of his constituents on the South African question —on which he was one of the foremost of the so-called "Pro-Boer" party—compelled his retirement. Until 1885 he was a devoted adherent of Mr Gladstone, particularly in finance and foreign affairs. In 1880 he was Under Secretary of State for the Home Department, in 1881 for the Colonies, and in 1882 Secretary to the Treasury; but Mr Courtney has always been a stubborn fighter for principle, and upon finding that the Government's Reform Bill in 1884 contained no recognition of the scheme for proportional representation, to which he was deeply committed, he resigned office. Mr Courtney manifested the same fidelity to his convictions by refusing to support Mr Gladstone's Home Rule Bill in 1885, and was one of those Liberal Unionists who chiefly contributed to its rejection, and whose reputation for unbending integrity and intellectual eminence gave solidity to the section of Liberals who followed Lord Hartington. In 1886 Mr Courtney was elected Chairman of Committees in the House of Commons, and his efficiency in this arduous office seemed to many to mark him out for the Speakership when a vacancy occurred in 1895. A Liberal Unionist, however, could only be elected by Conservative votes, and he had made himself objectionable to a large section of the party by his independent attitude on various questions, on which his Liberalism outweighed his party loyalty. He would in any case have been incapacitated by an affection of the eyesight, which for a while threatened to withdraw him from public life altogether. After 1895 Mr Courtney's divergences from the Unionist party on questions other than Irish politics became gradually more marked. He became known in the House of Commons principally for his candid criticism of the measures introduced by his nominal leaders, and he was rather to be ranked among the Opposition than as a Ministerialist; and when the crisis with the Transvaal came in 1899, Mr Courtney's views, which remained substantially what they were when he supported the settlement after Majuba in 1881, had plainly become incompatible with his position even as a nominal follower of Lord Salisbury and Mr Chamberlain. Besides numerous essays in the principal reviews, Mr Courtney was the author of the article on "Banking" in the 9th edition of the *Encyclopædia Britannica*, and of the survey of recent British finance in Mr T. H. Ward's *Reign of Queen Victoria* (1887). In his earlier years he was a regular contributor to *The Times*.

**Courtrai,** a town of Belgium, in the province of West Flanders, 27 miles south of Bruges by rail. The foremost industry of the town is the manufacture of linen, but the trade in oil is increasing in importance. Flax is extensively grown in the district. All the large Ulster spinners send delegates to Courtrai, to visit the farmers and attend the marts where raw flax is to be bought in its various qualities, in order to ship it off to their mills under the most advantageous conditions. Population (1880), 26,943; (1890), 30,383; (1897), 32,949.

**Cousins, Samuel** (1801-1887), English mezzotint engraver, was born at Exeter on 9th May 1801. He was pre-eminently the interpreter of Sir Thomas Lawrence, his contemporary. During his apprenticeship to S. W. Reynolds he engraved many of the best amongst the three hundred little mezzotints illustrating the works of Sir Joshua Reynolds which his master issued in his own name. In the finest of his numerous transcripts of Lawrence, such as "Lady Acland and her Sons," "Pope Pius VII.," and "Master Lambton," the distinguishing characteristics of the engraver's work, the brilliancy and force of effect in a high key, corresponded exactly with similar qualities in the painter. After the introduction of steel for engraving purposes in 1823, Cousins and his contemporaries were compelled to work on it, because the soft copper previously used for mezzotint plates did not yield a sufficient number of fine impressions to enable the method to compete commercially against line engraving, from which much larger editions were obtainable. The painter-like quality which distinguished the 18th century mezzotints on copper was wanting in his later works, because the hardness of the steel on which they were engraved impaired freedom of execution and richness of tone, and so enhanced the labour of scraping that he accelerated the work by stipple, etching the details instead of scraping them out of the "ground" in the manner of his predecessors. To this "mixed style," previously used by Richard Earlom on copper, Cousins added heavy roulette and rocking-tool textures, tending to fortify the darks, when he found that the "burr" even on steel failed to yield enough fine impressions to meet the demand. The effect of his prints in this method after Reynolds and Millais was mechanical and out of harmony with the picturesque technique of these painters, but the phenomenal popularity which Cousins gained for his works at least kept alive and in favour a form of mezzotint engraving during a critical phase of its history. Raimbach, the line engraver, dated the decline of his own art in England from the appearance in 1837 of Cousins's print (in the "mixed style") after Landseer's "Bolton Abbey." Such plates as "Miss Peel" after Lawrence (published in 1832); "A Midsummer Night's Dream," after Landseer (1857); "The Order of Release" and "The First Minuet," after Millais (1854 and 1865); "The Strawberry Girl" and "Lavinia, Countess Spencer," after Reynolds; and "Miss Rich," after Hogarth (1873-1877), represent various stages of Cousins's mixed method. It reached its final development in the plates after Millais's "Cherry Ripe" and "Pomona," published in 1881 and 1882, when the invention of coating copper-plates with a film of steel to make them yield larger editions led to the revival of pure mezzotint on copper, which has since rendered obsolete the steel plate and the mixed style which it fostered. The fine draughtsmanship of Cousins was as apparent in his prints as in his original lead-pencil portraits exhibited in London in 1882. In 1855 he was elected a full member of the Royal Academy, to which institution he later gave in trust £15,000 to provide annuities for superannuated artists who had not been so successful as himself. One of the most important figures in the history of British engraving, he died in London, unmarried, on 7th May 1887.

See GEORGE PYCROFT, M.R.C.S.E. *Memoir of Samuel Cousins, R.A., Member of the Legion of Honour.* Published for private circulation by E. E. Leggatt, London, 1899.—ALGERNON GRAVES.

*Catalogue of the Works of Samuel Cousins, R.A.* Published by H. Graves and Co., London, 1888. (G. P. R.)

**Couza, Alexander John** (1820–1873), PRINCE OF RUMANIA, was born 20th March 1820 at Husch, and was educated in Paris, Pavia, and Bologna. He entered the diplomatic service of his country, and became Stadtholder of Galatz, and head of a department in the Ministry of the Interior. By his marriage with a daughter of the Boyar Rosetti he became allied to the higher nobility of the country, and in 1848 he joined the patriotic party. On the entry of the Russians he was imprisoned, but managed to escape on an Austrian steamer to Vienna. After their departure he entered the army, and again rose with great rapidity. Elected in 1858 to the Assembly of Moldavia, he became in the same year Minister of War of the united principalities. In the debates upon the Constitution he was chief speaker on the Unionist side, and in 1859 he assumed the government under the title of Prince Alexander John I. He was not recognized by the Porte until 23rd December 1861, on which day the union of the two principalities under the name of Rumania was proclaimed. The Prince made every effort to secure unity and relieve taxation. He suppressed the *corvée*, introduced the Code Napoleon, and caused the adoption of a system of free education and the foundation of the universities of Jassy and Bucarest. His zeal for reforms and for absolute centralization led to incessant conflict and discontent; financial distress supervened; a military conspiracy forced him to abdicate on 23rd February 1866, and led to the election of Prince Carol I. After his abdication, Prince Alexander John spent the remainder of his life chiefly in Paris, Vienna, and Wiesbaden. He died at Heidelberg on 15th May 1873. (G. F. B.)

**Coventry**, a municipal, county, and parliamentary borough of Warwickshire, England, on the Sherbourne, an affluent of the Avon, 94 miles by rail north-north-west of London. A canal communicates with the Trent and Mersey and Birmingham Canal. The derivation of the name from a convent of 1043 seems no longer tenable. A county of itself till 1843, the city in 1888 became a county borough. The corporation consists of a mayor, 10 aldermen, 30 councillors, a treasurer, town clerk, and other officers. In 1885 the parliamentary representation was reduced to one. In 1894 a suffragan bishop, under the See of Worcester, was appointed with the title of bishop of Coventry. Among recent erections are a Baptist, a Congregational, a Primitive Methodist, and a Catholic chapel. A statue (1883) of Sir Thomas White, Lord Mayor of London 1532-33, founder of St John's College, &c., an opera house, and baths. The cemetery, planned by Sir Joseph Paxton, was extended in 1887. The present buildings of the Free Grammar School were opened in 1885. A technical school (1887) was enlarged in 1894. Besides Swanswell (1883) and Spencer Park (1883), there is a recreation ground (1880) of twelve acres. A daily paper is issued. Area of municipal borough, 3093 acres. Population (1881), 44,831; (1891), 52,724; (1901), 69,877.

**Coventry**, a town of Kent county, Rhode Island, U.S.A., with an area of 17 square miles of hill country, interspersed with ponds. It contains a few small villages, but the population is mainly rural. It is traversed by the New England Railway. Population (1900), 5279.

**Covilhã,** a town of Portugal, district Castello Branco, on the east versant of the Serra da Estrella, near the river Zezere, 30 miles north from Castello Branco. some 4000 operatives are employed in manufacturing cloth. Population (1900), 15,527.

**Covington,** a city of Kenton county, Kentucky, U.S.A. It is situated in 39° 05′ N. lat. and 84° 36′ W. long., on the south bank of the Ohio river, opposite Cincinnati, with which it is connected by three bridges and by ferries. Two railways, the Chesapeake and Ohio and the Louisville and Nashville, pass through it. In 1890 the capital invested in manufactures was $6,900,000, the number of hands employed was 7600, and the output was valued at $16,000,000. In 1899 the assessed valuation of all property, real and personal, was $21,468,444, the tax rate $30.25 per $1000, and the net debt $2,195,544. To its proximity to Cincinnati, of which it is practically a suburb, it owes its rapid growth. Population (1880), 29,720; (1890), 37,371; (1900), 42,938, including 2487 negroes. The death-rate in 1900 was 20·2.

**Cowasjee Jehanghier Readymoney,** SIR (1812–1878), "the Peabody of Bombay." Early in the 18th century three Parsee brothers moved from Nowsaree, near Surat, in Gujarat, to Bombay, and became the pioneers of a lucrative trade with China. They gained the sobriquet of "Readymoney," which they adopted as a surname. Only Heerjee Jewanjee Readymoney left issue, two daughters, the elder of whom married a Banajee, and the younger a Dady Sett. The son of the former, Jehanghier Heerjee, married Meerbae, the daughter of the latter, and was made the heir not only of his grandfather but of his two grand-uncles. The younger of their two sons was Cowasjee Jehanghier. His only English education was at the then well-known school kept by Serjeant Sykes in the Fort of Bombay. At the age of 15 he entered the firm of Duncan, Gibb, & Co. as "godown keeper," or warehouse clerk. In 1837 he was promoted to the highly responsible and lucrative appointment of "guarantee broker" to two of the leading European firms of Bombay. In 1846 he was able to begin trading on his own account. He was made a J.P. for the town and island of Bombay, and a member of the Board of Conservancy; and in 1866 was appointed a Commissioner of Income Tax, his tactful management being largely responsible for the fact that this tax, then new to Bombay and most unpopular, was levied with unexpected financial success. He was made C.S.I. in 1871; and in 1872 he was created a Knight Bachelor of the United Kingdom, and his statue, by T. Woolner, R.A., was erected in the town-hall. His donations to the institutions of Bombay amounted to close on £200,000. His health broke down in 1871, and he died in 1878, being succeeded by his son, Sir J. Cowasjee Jehanghier [Readymoney], who was himself created a Knight Bachelor in 1895. (M. M. BH.)

**Cowdenbeath,** a mining town and police burgh of Fifeshire, Scotland, situated near the Cowdenbeath station of the North British Railway, 5 miles east-north-east of Dunfermline. The town is mainly occupied by miners. It possesses a public hall. The Police Act was adopted in 1890. Population (1891), 4249; (1901), 7466.

**Cowen, Frederic Hymen** (1852——), English musical composer, was born at Kingston, Jamaica, on 29th January 1852. At four years old he was brought to England, where his father became treasurer to the opera at Her Majesty's Theatre, and private secretary to the Earl of Dudley. His first teacher was Henry Russell, and his first published composition appeared when he was but six years old. He studied the piano with Benedict, and composition with Goss; in 1865 he was at Leipzig under Hauptmann, Moscheles, Reinecke, and Plaidy. Returning home on the outbreak of the Austro-Prussian War, he appeared as a composer for the orchestra in an overture played at the Promenade Concerts at Covent Garden in

September 1866. In the following autumn he went to Berlin, where he was under Kiel, at Stern's conservatorium. A symphony and a piano concerto were given in St James's Hall in 1869, and from that time Cowen has been recognized as primarily a composer, his talents as a pianist being subordinate, although his public appearances were numerous for some time afterwards. His cantata, *The Rose Maiden*, was given in London in 1870, his second symphony by the Liverpool Philharmonic Society in 1872, and his first festival work, *The Corsair*, in 1876 at Birmingham. In that year his opera, *Pauline*, was given by the Carl Rosa Company with moderate success. In 1884 he conducted five concerts of the Philharmonic Society, and in 1888, on the resignation of Sullivan, became the regular conductor of the society, resigning the post in 1892. In the year of his appointment, 1888, he went to Melbourne as the conductor of the daily concerts given in connexion with the Exhibition there. In 1896 Cowen was appointed conductor of the Liverpool Philharmonic Society and of the Manchester orchestra, in succession to Sir Charles Hallé. In 1899 he was reappointed conductor of the Philharmonic Society. His works include:—Operettas: *Garibaldi* (1860) and *One Too Many* (1874); operas: *Pauline* (1876), *Thorgrim* (1890), *Signa* (Milan, 1893), and *Harold* (1895); oratorios: *The Deluge* (1878), *St Ursula* (1881), *Ruth* (1887), *Song of Thanksgiving* (1888), *The Transfiguration* (1895); cantatas: *The Rose Maiden* (1870), *The Corsair* (1876), *The Sleeping Beauty* (1885), *St John's Eve* (1889), *The Water Lily* (1893), *Ode to the Passions* (1898), besides a large number of short cantatas for female voices; an enormous number of songs, ranging from the popular "ballad" to really artistic lyrics, anthems, part-songs, duets, &c.; six symphonies, among which No. 3, the "Scandinavian," has had the greatest success; four overtures; suites, *The Language of Flowers* (1880), *In the Olden Times* (1883), *In Fairyland* (1896); four English dances (1896); a concerto for piano and orchestra, and a fantasia for the same played by M. Paderewski (1900); a quartet in C minor, and a trio in A minor, both early works; pianoforte pieces, &c. Cowen is never so happy as when treating of fantastic or fairy subjects; and whether in his cantatas for female voices, his charming *Sleeping Beauty*, his *Water Lily*, or his pretty overture, *The Butterfly's Ball* (1901), he succeeds wonderfully in finding graceful expression for the poetical idea. His dance music, such as is to be found in various orchestral suites, is refined, original, and admirably instrumented; and if he is seldom as successful in portraying the graver aspects of emotion, the vogue of his semi-sacred songs is a thing that cannot be ignored. That none of his operas has been permanently successful is a mischance which they share with most of the serious dramatic music of Great Britain; but even in more favourable conditions their lack of the great qualities, of the sincere emotion that comes from the heart and goes to the heart, would seriously impede their popularity. Charmingly melodious as he always is in his lighter moods, Cowen often contents himself with musical ideas that are less than beautiful in writing for the stage.

**Cowen, Joseph** (1831–1900), English politician, son of Sir Joseph Cowen, a prominent citizen and mine-owner of Newcastle-on-Tyne, was born in 1831, and was educated at Edinburgh University. In 1874 he was elected member of Parliament for the borough on the death of his father, who had held the seat as a Liberal since 1865. Joseph Cowen was at that time a strong Radical on domestic questions, an advocate of co-operation, an admirer of Garibaldi, Mazzini, and Kossuth, a sympathizer with Irish Nationalism, and one who in speech, dress, and manner identified himself with the North-country mining class. Short in stature and uncouth in appearance, his individuality first shocked and then by its earnestness impressed the House of Commons; and his sturdy independence of party ties, combined with a gift of rough but genuine eloquence (of which his speech on the Royal Title Bill of 1878 was an example), rapidly made him one of the best known public men in the country. He was, moreover, an Imperialist and a Colonial Federationist at a time when Liberalism was tied and bound to the Manchester traditions; and, to the consternation of the official wire-pullers, he vigorously supported Disraeli's foreign policy, and in 1881 opposed the Gladstonian settlement with the Boers. His independence (which his detractors attributed in some degree to his alleged susceptibility to Tory compliments) brought him into collision both with the Liberal caucus and with the party organization in Newcastle itself, but Cowen's personal popularity and his remarkable powers as an orator triumphed in his own birthplace, and he was again elected in 1885 in spite of Liberal opposition. Shortly afterwards, however, he retired both from Parliament and from public life, professing his disgust at the party intrigues of politics, and devoted himself to conducting his newspaper, the *Newcastle Daily Chronicle*, and to his private business as a mine-owner. In this capacity he exercised a wide influence on local opinion, and the revolt of the Newcastle electorate in later years against doctrinaire Radicalism was largely due to his constant preaching of a broader outlook on national affairs. He continued behind the scenes to play a powerful part in forming North-country opinion until his death on 17th February 1900. (H. CH.)

**Cowes,** or West Cowes, a town, railway station, and seaport in the Isle of Wight parliamentary division of Hampshire, England, on the north coast of the island, west side of the Medina estuary, 11½ miles south-south-east of Southampton, and in daily communication with the mainland. A new esplanade has been formed, and a new public pier constructed. At East Cowes, on the opposite side of the Medina, a recreation ground has been opened, and a home for aged seamen provided. Each town forms a parish under an Urban District Council (1894). Area of West Cowes, 576 acres. Population (1891), 7690; (1901), 8654. Area of East Cowes, 510 acres. Population (1891), 2934; (1901), 3180. The harbour between the two towns is now subject to an elective body of commissioners. The registered shipping at the end of 1899 amounted to 258 vessels of 11,284 tons. In 1899, 25,984 vessels of 2,483,969 tons entered, and 25,929 of 2,480,093 tons cleared.

**Cowpens,** a village of Spartanburg county, South Carolina, U.S.A., situated in the northern part of the state. It was here, in 1781, during the Revolution, that General Morgan defeated the British under Colonel Tarleton, when the latter lost 800 men in killed, wounded, and prisoners, and the Americans 72.

**Cox, Rev. Sir George William,** 14TH BART. (1827–1902), English historian, son of Mr G. H. Cox, and nephew of the thirteenth baronet, was born 10th January 1827 at Benares, India, and was educated at Rugby and Trinity College, Oxford. In 1850 he was ordained, and worked as a curate till 1860, when he took a mastership at Cheltenham College, which he only held for a year. He had already contributed to the *Edinburgh Review*, and had published (1850) *Poems, Legendary and Historical* (with Edward A. Freeman), and (1853) a *Life of St Boniface*. In 1861 he became literary adviser to Messrs Long-

man, and devoted himself to literary work, connected chiefly with history and comparative mythology. His published books include (1861) *Tales from Greek Mythology*, (1867) *A Manual of Mythology*, (1870) *Latin and Teutonic Christendom*, and *The Mythology of Aryan Nations*, (1874) *History of Greece*, 2 vols., (1876) *The Athenian Empire*, (1876) *General History of Greece*, (1881) *History of British Rule in India*, and *Introduction to Comparative Mythology*, (1886) *Lives of Greek Statesmen*, (1887) *Concise History of England*. Of these works, some of them avowedly written for popular purposes and successful in that object, the most important was the larger *History of Greece*, begun in 1874, which, though showing the inspiration of Grote, was at the same time a conscientious rehandling of the materials as they then existed. Similarly his studies in mythology were inspired by Max Müller, but his treatment of the subjects was his own. Sir George Cox (who succeeded to the baronetcy in 1877) was a Broad Churchman, and became known as a prominent supporter of Bishop Colenso in 1863–65; and five years after Colenso's death he published (1888) his *Life* of the Bishop. In 1881 Sir G. Cox was made vicar of Scrayingham, York, but resigned the living in 1897. In 1896 he was given a Civil List Pension. He died at Walmer on 9th February 1902.

**Coxe, Henry Octavius** (1811–1881), Bodley's librarian at Oxford, was born at Bucklebury, in Berkshire, 20th September 1811, and was educated at Westminster School and Worcester College, Oxford. Immediately on taking his degree in 1833 he began work in the Manuscript Department of the British Museum, became in 1838 sub-librarian of the Bodleian, and in 1860 succeeded Dr Bandinel as head librarian, an office he held until his death in 1881. Having proved himself an able palæographer, he was sent out by the British Government in 1857 to inspect the libraries in the monasteries of the Levant, and his investigations determined the character of the existing remains in the districts he visited. One valuable result of his travels was the detection of the forgery attempted by M. Simonides. He was the author of various catalogues, and under his direction that of the Bodleian, in more than 720 volumes, was completed. He published *Rogeri de Wendover Chronica*, 5 vols. (1841–44); the *Black Prince, an historical poem written in French by Chandos Herald* (1842); and *Report on the Greek Manuscripts yet remaining in the Libraries of the Levant* (1858). He was not only an accurate librarian but an active and hard-working clergyman, and was for the last twenty-five years of his life in charge of the parish of Wytham, near Oxford. He was likewise honorary fellow of Worcester and Corpus Christi Colleges. He died on 8th July 1881.

**Cracow** (Polish, *Kraków*; German, *Krakau*), the second city of the Austrian crownland of Galicia. Population in 1890, 74,593; in 1900, 91,310, chiefly Polish and Roman Catholic (estimated to have 7 per cent. German and 15 per cent. Czech; 28 per cent. Jewish, 1 per cent. Greek Catholic, and 1 per cent. Protestant). It is one of the strongest Austrian fortresses (of which there are two in Galicia, the second being Przemysl), with a garrison of 6000 men. In 1889 the Catholic bishop was raised to the rank of prince. Cracow now contains, in addition to its 39 churches and numerous chapels, 7 synagogues and 25 religious communities. Many of the old buildings have been restored, such as the Church of St Mary, decorated by the celebrated Polish artist Matejko, and the Tuchhaus, which now contains a collection of pictures by Polish painters; while important new structures have been erected. The latter comprise the new university (1881–87), an imposing Gothic edifice which accommodates the Polish Academy of Science (founded in 1872), a library, and archæological and other collections; together with a new theatre (1891–93) in the late Renaissance style. The university, in which the Polish language has been in exclusive use since 1870, has a staff of 157 professors and lecturers, and is attended by 1300 students. The other educational institutions include a theological seminary, 2 training colleges, 3 gymnasia, a realschule, 3 technical and special schools, and an academy of fine art, which was under the control of the painter Matejko up to the time of his death. Industry, which has undergone little change, now comprises the manufacture of machinery, wax candles, matches, and oil, together with brewing and corn-milling, in addition to its staples, cloth and leather. Its commerce is of greater importance, and includes corn, timber, salt and wine, pigs and textiles, eggs and butter, together with a considerable transit and commission trade with Hungary, Silesia, and other parts of Galicia. The Jewish population has an exceptionally large share in the high proportion of illegitimacy, 44 per cent. While the illegitimate births among the Catholics were less than one-third, they formed over two-thirds of the whole among the Jews. On the other hand, the Jewish death-rate (20·87 per thousand) is comparatively low as compared with that of the entire Christian population (24·82). (Æ. O'N.)

**Cradock,** a town of Cape Colony, in the upper valley of the Great Fish River, nearly due north of Port Elizabeth, and about midway between that place and Colesberg, with both of which it is connected by rail. It is one of the chief centres of the wool trade, and in 1891 had a population of 4390. In the neighbouring district still survive a few herds of quaggas, which are now protected by the game laws.

**Craik, Dinah Maria** (1826–1887), English novelist, better known by her maiden name of Mulock, and still better as "the author of *John Halifax, Gentleman*," was the daughter of Thomas Mulock, an eccentric religious enthusiast of Irish extraction, and was born on 20th April 1826 at Stoke-upon-Trent, in Staffordshire, where her father was the minister of a small congregation. She settled in London about 1846, determined to obtain a livelihood by her pen, and, beginning with fiction for children, advanced steadily until *John Halifax, Gentleman* (1857), placed her in the front rank of the female novelists of her day. *A Life for a Life* (1859), though inferior, maintained a high position, but she afterwards wrote little of importance except some very charming tales for children. Her most remarkable novels, after those mentioned above, were *The Ogilvies* (1849), *Olive* (1850), *The Head of the Family* (1851), *Agatha's Husband* (1853). There is much passion and power in these early works, and all that Mrs Craik wrote was characterized by high-mindedness, principle, and deep, warm feeling. Some of the short stories in *Avillion, and other Tales* also exhibit a fine imagination. She also published poems distinguished by genuine lyrical spirit, narratives of tours in Ireland and Cornwall, and *A Woman's Thoughts about Women*. She married Mr G. L. Craik, publisher, in 1864, and died at Shortlands, near Bromley, 12th October 1887.

**Craiova** or **Krajova,** a town in Rumania, the ancient capital of Little Wallachia, now seat of the prefect of the district of Dolj. It is of considerable commercial importance, the province of which it is the capital being very rich in grain, pasturage, and vegetable products, besides containing extensive forests. Near Craiova is a large military tannery (penitentiary), besides rope and carriage factories. There are 27 Orthodox churches, 1 Roman Catholic, 1 Protestant church, and 5 synagogues. Craiova is also the seat of a Court of Appeal, a Court of

First Instance, and a Chamber of Commerce, as well as the headquarters of the first Army Corps. The ancient bans of Craiova had the right of striking their coins with their own effigies, whence the designation "bani" (centimes) given to the copper coinage of Rumania. The monetary unit "leu" (*leo*, lion) also comes from this district. The principal exports are cereals and fish, linen, pottery, and leather. The principal trade carried on consists of agricultural products and cattle. Population (1895), 41,000; (1900), 45,438, of whom about 3000 are Jews.

**Cranbrook, Gathorne Gathorne-Hardy,** 1st Earl of (1814——), British statesman, born at Bradford, in Yorkshire, 1st October 1814, was the son of John Hardy, for many years one of the members for the borough. This circumstance seemed to give him a claim upon the suffrages of the electorate, and upon entering upon active political life in 1847, eleven years after his graduation at Oxford, and nine years after his call to the Bar, he offered himself as a candidate, but was unsuccessful. In 1856 he was returned for Leominster, and in 1865 defeated Mr Gladstone at Oxford. In 1866 he became President of the Poor Law Board in Lord Derby's new administration. When in 1867 Mr Walpole resigned, from dissatisfaction with Mr Disraeli's Reform Bill, Mr Gathorne-Hardy succeeded him at the Home Office. In 1874 he was Secretary for War; and when in 1878 Lord Salisbury took the Foreign Office upon the resignation of Lord Derby, Viscount Cranbrook (as Mr Hardy became within a month afterwards) succeeded him at the India Office. In Lord Salisbury's administrations of 1885 and 1886 Lord Cranbrook was President of the Council, and upon his retirement from public life concurrently with the resignation of the Cabinet in 1892 he was raised to an earldom.

**Cranston,** a town of Providence county, Rhode Island, U.S.A., with an area of 30 square miles. It contains several villages, among them Cranston, Pontiac, and Natick. It is traversed by branches of the New York, New Haven, and Hartford Railway. Population (1880), 5940; (1890), 8099; (1900), 13,343.

**Crawford, Francis Marion** (1854——), American author, was born at Lucca, Italy, on 2nd August 1854, being the son of the American sculptor Thomas Crawford (long a resident of Italy), and the nephew of Julia Ward Howe, the American poet. He studied successively at St Paul's School, Concord, New Hampshire; Cambridge University; Heidelberg; and Rome. In 1879 he went to India, where he edited the Allahabad *Indian Herald*, meanwhile noting the effect of Indian life upon British subjects. Returning to America, he studied Sanscrit and Zend at Harvard University for a year, contributed to various periodicals, and in 1882 produced—at the suggestion of his uncle Samuel Ward, a New York club-man and *raconteur*—his first novel, *Mr Isaacs, a Tale of Modern India*, in which he mingled character sketches of two races, romanticism, supernaturalism, and plain realism in a manner which gave the story an immediate place in contemporary fiction. After a brief residence in New York and Boston, Crawford, in 1884, returned to Italy, where he made his permanent home, thenceforward producing volume after volume in rapid succession. *An American Politician* (1884) may be taken as representative of his tales of American life; *A Roman Singer* (1884), *Saracinesca* (1887), and its sequel *Sant' Ilario* (1889), and *A Cigarette-Maker's Romance* (1890), being examples of his dealing with Italian subjects; while of books not fiction the most conspicuous is *Ave Roma Immortalis* (1898), a survey of the history, architecture, and characteristics of Rome—bird's-eye views to which Crawford brought sympathy and knowledge, writing at once as a Roman Catholic and a cosmopolitan.

**Crawfordsville,** capital of Montgomery county, Indiana, U.S.A., situated on Sugar Creek, in the western part of the state, at an altitude of 780 feet. It is on three great railway lines, the Vandalia, the Cleveland, Cincinnati, Chicago, and St Louis, and the Chicago, Indianapolis, and Louisville. Wabash College, a non-sectarian institution, founded here in 1832, had in 1899 a faculty of 21 professors and an attendance of 189. Population (1880), 5251; (1900), 6649.

**Creatianism and Traducianism.**—Traducianism is the doctrine about the origin of the soul which was taught by Tertullian in his *De Anima*—that souls are generated from souls in the same way and at the same time as bodies from bodies: Creatianism is the doctrine that God creates a soul for each body that is generated. The Pelagians taunted the upholders of original sin with holding Tertullian's opinion, and called them Traduciani (from *tradux*: *vid.* Du Cange *s.vv.*), a name which was perhaps suggested by a metaphor in *De An.* 19, where the soul is described "velut surculus quidam ex matrice Adam in propaginem deducta." Hence we have formed "traducianist," "traducianism," and by analogy "creatianist," "creatianism." St Augustine denied that Traducianism was necessarily connected with the doctrine of original sin, and to the end of his life was unable to decide for or against it. St Jerome condemned it, and said that the other was the opinion of the Church, though he admitted that most of the Western Christians held Traducianism. The question has never been decided, but Creatianism, which had always prevailed in the East, became the general opinion of the mediæval theologians, and Peter Lombard's *creando infundit animas Deus et infundendo creat* was an accepted formula. Luther, like St Augustine, was undecided, but Lutherans have as a rule been Traducianists. Calvin favoured Creatianism.

Peter Lombard's phrase perhaps shows that even in his time it was felt that some union of the two opinions was needed, and St Augustine's toleration pointed in the same direction, for the Traducianism he thought possible was one in which God *operatur institutas administrando non novas instituendo naturas* (*Ep.* 166. 5. 11). Modern psychologists teach that while "personality" can be discerned in its "becoming," nothing is known of its origin. Lotze, however, who may be taken as representing the believers in the immanence of the divine Being, puts forth—but as a "dim conjecture"—something very like Creatianism (*Microcosmus*, bk. iii. chap. v. *ad fin.*). It is still, as in the days of St Augustine, a question whether a more exact division of man into body, soul, *and spirit* may help to throw light on this subject. See indices to *Augustine*, vol. xi., and *Jerome*, vol. xi., in Migne's *Patrologia, s.v.* "Anima"; Delitzsch, *Biblical Psychology*, ii. § 7; sections on "Tertullian and Pelagianism" in Neander's *Hist. Ch.*; Liddon, *Elements of Religion*, Lect. iii.; Mason, *Faith of the Gospel*, iv. §§ 3, 4, 9, 10.

(A. N*.)

**Crediton,** a market-town in the South Molton parliamentary division of Devonshire, England, on the Creedy, 8 miles north-west of Exeter by rail. The ancient church has been restored, and in 1897 Crediton became the head of a suffragan bishopric. Recent structures are a temperance hall, the town-hall (rebuilt), and water-works. Tanning and the making of confectionery and cider have been introduced. Area of urban district, 947 acres. Population (1881), 4165; (1901), 3974.

**Creede,** capital of Mineral county, Colorado, U.S.A., situated in a narrow cañon tributary to the Rio Grande, in the San Juan Mountains, in the south-western part of the state. It owes its existence to rich silver mines developed in 1891 in its vicinity. Within two years it had acquired a population of several thousands, and a branch of

the Denver and Rio Grande Railway had been extended to it. In 1892 most of the business portion was destroyed by fire. Soon afterwards the reduction in the price of silver caused the closing down of most of the mines, and in 1900 the place had a population of only 938.

**Creeds.**—I. *The Apostles' Creed.*—Recent researches have confirmed the importance of Ussher's discovery that the creed presented by Marcellus, bishop of Ancyra, to Julius, bishop of Rome, in 341, was the Old Roman Creed (cited as R), which Rufinus some fifty years later compared with the creed of the Church of Aquileia. R is the archetype of all Western forms. It preserves the simplicity of the catechetical teaching given in the early years of the 2nd century, to which it can be traced back in quotations by Novatian, Dionysius, Tertullian. Even the heretic Marcion may be called as a witness to the fact that the words "holy Church" were found in this the creed of his baptism (before 145). The relation of R to Eastern creeds is disputed. Some writers (Kattenbusch, Harnack) maintain that it is the sole archetype, having been brought to Antioch in the 3rd century and spread by the influence of the school of Lucian the Martyr. Others (Zahn, Sanday) find traces of an Eastern archetype in Justin Martyr and Irenæus, to be traced with R to a common origin in "a baptismal confession which had already assumed a more or less stereotyped form in early apostolic times." The question is complicated by the discovery of new materials (*e.g.*, creeds of Marcus, hermit of Ancyra, and Serapion, bishop of Thmuis in Egypt), which are said to confirm the theory that local creeds existed in the 3rd century which were independent of R. Increasing value is set on the baptismal formula (Matt. xxviii. 19) as the seed-thought of later creeds, though there is reason to believe that the Eunuch's creed, interpolated in the text of Acts viii. 37: "I believe that Jesus is the Son of God," was the creed of the apostles (cp. Rom. x. 9; 1 Cor. xii. 3; 1 John iv. 15, v. 5; Heb. iv. 14). It was known to Irenæus (iii. 12. 8), and represents the form of baptismal confession used in the Church of Asia Minor, from which he drew his tradition. The history of the received text of the Apostles' Creed is still obscure. The additional phrases, which distinguish it from R, are found in Gallican creeds of the 5th century, with one exception, "maker of heaven and earth." This had found a place in the Dacian Creed of Niceta, bishop of Remesiana (*c.* 400). The received text is found in a group of documents containing liturgical pieces and sermons of mixed Roman and Gallican origin (so-called Gallican Missal and Gallican Sacramentary), then in the treatise of the Benedictine monk Pirminius (*c.* 730). The usual opinion is that it was brought under the influence of a Frankish emperor from Gaul to Rome, where (as some suppose) the Nicene Creed (Constantinopolitan form) had been substituted for R. But the evidence of a Psalter attributed to Pope Gregory III. (*c.* 731), indications that Pirminius used the Roman service of Baptism, and some evidence that R had not been given up, have led to the suggestion that R was enlarged by the Roman Church (Burn).

II. *The Nicene Creed* of the Liturgies is the old Baptismal Creed of Jerusalem as taught in the Catechetical Lectures of Cyril (*c.* 345), revised after 360 by the insertion of phrases from the Creed of the Nicene Council of 325. It was quoted by Epiphanius in his *Ancoratus* (374), and in 381 found a place in the minutes of the Council of Constantinople, from which it was quoted at Chalcedon as "the exposition of the 150 Fathers," being regarded as an improved recension of the first Nicene Creed. It was brought before the Council of 381, either to vindicate the orthodoxy of Cyril, its author (Hort), or as the Baptismal Confession of Nektarius, who (though unbaptized) was elected president after the death of Meletius (Kunze). The question is still undecided, but there is reason to believe that it was used as the Baptismal Creed of Constantinople after 383, and was accepted as such by the Monophysites, who rejected the Definition of the Council of Chalcedon. At Chalcedon it was approved by the Pope's legates, probably as containing in the words "incarnate by the Holy Ghost and the Virgin Mary" a parallel to the teaching of R, on which Leo laid stress in his letter to Flavian. If the Stowe Missal represents the Roman Liturgy of the 5th century (Probst), the creed was introduced into that Liturgy much earlier than is usually supposed.

III. *The Athanasian Creed.*—A MS. has lately been found in the library of the Marist Fathers at Lyons, which was given by Bishop Leidrad (†814) to the Altar of St Stephen, with an autograph inscription. It contains this creed in a collection which he apparently used on his journey into Spain to confute the Adoptionists. This one MS. disproves the argument (Swainson, Lumby) that the creed in its present form was not known to theologians during the 8th century. Some eight other MSS. may be assigned to the 8th century. Behind these MSS. are early commentaries which quote the text, the earliest (Fortunatus) probably of the 6th century. The more important quotations from both parts of the creed by the Council of Toledo in 633, Cæsarius of Arles (†543), Avitus of Vienne (†523), enable us to trace it back in its present form to the 5th century. A new theory of growth from an unpolished sermon like that in the Trèves fragment (Loofs), is based on the doubtful supposition that it was unknown to Isidore, who presided over the Council of Toledo in 633, but assumes the original unity of the document. The authorship is unknown, but the names of Vincentius (Ommanney) and Honoratus, founder of the monastery of Lerins (Burn), have been suggested. Internal evidence shows that it was written as an Instruction on the Faith, probably before the condemnation of Nestorius in 431. It was not introduced into Psalters as a canticle till *c.* 800.

The history of later confessions of faith is not disputed.

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III. G. D. W. OMMANNEY. *Early Commentaries.* London, 1880.—*A Critical Dissertation.* Oxford, 1897.—F. LOOFS. Art. "Athanasianum" in Hauck's *Realencyclopädie.*—A. E. BURN. *The Athanasian Creed.* Cambridge, 1895.—On the growing sense of the value of creeds, see HARVEY GOODWIN. *Foundations of the Creed.* London, 1889.—S. G. GREEN. *The Christian Creed and the Creeds of Christendom.* London, 1898. (A. E. B.)

**Crefeld,** a town of Prussia, in the Rhine province, 34 miles by rail north-north-west from Cologne and 4 miles west from the Rhine. It is the chief centre in Germany for the manufacture of velvets and silks; in addition to which there are dyeworks, stuff printing and stamping works, engineering and machine shops, chemical, sugar, and other factories, distilleries, tanneries, &c. The town-hall has been decorated with frescoes by P. Janssen, and the royal weaving school with mural paintings by A. Baur illustrating the development of the silk industry. The Emperor William Museum was opened in 1897. There are monuments to Moltke, Bismarck, K. Wilhelm (com-

poser of *Die Wacht am Rhein*), and the war of 1870–71. The places of worship include a Mennonite church and a synagogue. Population (1885), 90,236; (1900), 106,887.

**Creighton, Mandell** (1843–1901), English historian and Bishop of London, was born at Carlisle on 5th July 1843, being the eldest son of Robert Creighton, a merchant of that city. He was educated at Durham Grammar School and at Merton College, Oxford, where he was elected to a postmastership in 1862. He obtained a first class in classical moderations in 1864, followed by a first in *literæ humaniores* and a second in law and modern history in 1866. In the same year he was elected fellow of Merton, becoming tutor immediately afterwards. He was ordained deacon, on his fellowship, in 1870, and priest in 1873; in 1872 he had married Louise, daughter of Robert von Glehn, a London merchant (herself a writer of several successful books of history), the marriage being a very happy one. Meanwhile he had rapidly come to the fore in the university as a profound student of men and things, a brilliant teacher, and a wise and trustworthy friend; and before he left Oxford he had attained to a position and an influence which was "exceptional and even pre-eminent." He had already published several smaller historical works, but his crowded life left little room for writing; and in 1875, with rare wisdom and self-restraint, he left Oxford to become vicar of Embleton, a parish on the coast of Northumberland, near Dunstanburgh, and within reach of the fine library in Bamburgh Keep, with an ancient and beautiful church and a fortified parsonage house. Here he remained for nearly ten years, devoting himself to his parish and acquiring that intimate knowledge of parochial work which afterwards stood him in such good stead, taking private pupils, studying and writing, as well as taking an active part in diocesan business. Amongst his parishioners was Sir George Grey of Fallodon, Home Secretary at the time of the Chartist riots; he and Creighton became close friends, and on his death the vicar wrote a beautiful memoir of him which was privately printed. Here too he planned and wrote the first two volumes of his chief historical work, the *History of the Papacy*; and it was in part this which led to his being elected in 1884 to the newly founded Dixie Professorship of Ecclesiastical History at Cambridge. Creighton visited Cambridge in the Michaelmas term of 1884, but did not come into residence till early in 1885. He found in his new university, as he said, not a *noverca* but an *alma mater*, and one perhaps in some ways more congenial than Oxford. His influence at once made itself felt. To him more than to any other was due the reorganization of the historical school at Cambridge, which was at first far too narrowly political, on broader and more truly historical lines. His lectures and conversation classes were extraordinarily good, and no man could have been more generous in helping students, men and women, than he was. He was a born teacher, and unlike some other great teachers, he had the gift of imparting truth and kindling enthusiasm without in any way curbing the individuality of those who came under his influence. In 1886 he combined with other leading historians to found the *English Historical Review*, which during his five years of editorship acquired the high standard of excellence which it has since maintained. In 1886, too, he represented Emmanuel College at the centenary of its offshoot, Harvard College in Massachusetts. Meanwhile, the vacations were spent at Worcester, where he had been nominated a Canon Residentiary in 1885, and where his sermons and courses of historical lectures were greatly valued. In 1891 he was made Canon of Windsor; but he never went into residence, for in the same year, with great searchings of heart and after anxious consultation of friends, he accepted the see of Peterborough. He threw himself eagerly into his new work, visiting and preaching in every part of his diocese, lecturing in great towns and conferring with working men (he became an Oddfellow that he might be in fuller sympathy with them), using his influence with churchmen and dissenters alike, and in social work of all kinds. Nor did the diocese absorb his energies: he found time to preach and lecture elsewhere, and to deliver remarkable speeches at social functions; he worked hard with Archbishop Benson on the Parish Councils Bill (1894); he became the first president of the Church Historical Society (1894), and continued in that office till his death; he took part in the Laud Commemoration (1895); he represented the English Church at the coronation of the Tsar (1896). He even found time for academical work, delivering the Hulsean Lectures (1893–94) and the Rede Lecture (1894) at Cambridge, and the Romanes Lecture at Oxford (1896).

On the translation of Dr Temple to Canterbury, Bishop Creighton was, in accordance with general expectation, called to London; and his election was confirmed on January 15, 1897. In accepting the see he fully realized the immensity of a burden which circumstances had made exceptionally great. During Dr Temple's bishopric ritual divergencies of all kinds had grown up, which left a very difficult task to his successor. More especially was this the case in view of the public clamour on the subject, partly political and partly fanatical, which was just then arising. Of all this agitation Creighton naturally bore the brunt. He set himself to work without undue haste, investigating and experimenting, studying the facts and endeavouring to grasp their real significance, and meanwhile dealing with particular points as they arose. He knew how to suffer fools gladly: he knew how to enter into a point of view that was not his own. As was only natural, his studied fairness and moderation did not satisfy partisans on either side; and his efforts towards conciliation, marked by an unusual appreciation of the aims of both parties, laid him open to much misunderstanding. His administration has been subjected to hostile criticism from various and contradictory points of view; but it did much, in a period of almost unexampled difficulty, to preserve peace and foster the spirit of loyalty. He is credited with having suggested the reference to the Archbishops of the questions of Reservation and the use of Incense; and it was his express direction, when the hearing took place, that those who appeared on his behalf should do everything possible to elucidate the truth. He strained every nerve to induce his clergy to accept his ruling in accordance with the Archbishops' opinion; but when, during his last illness, a prosecutor brought proceedings against the clergy of five recalcitrant churches, the Bishop, on full consideration, and on the advice of his Archdeacons, interposed his veto. One other effort on behalf of peace may be mentioned. In accordance with a vote of the Diocesan Conference, the Bishop arranged a "Round Table Conference" between representative members of various parties, to be held at Fulham in October 1900, on "the doctrine of the Holy Eucharist and its expression in Ritual," and a report of its proceedings was published with a preface by him.

No mistake could be greater, however, than to regard things of this kind as the chief events of his episcopate. What concerned him most in them was not the fact of agitation against particular usages, but the fact that principles of true liberalism seemed to have prevailed so little, and that people were so anxious to withhold from others the very liberty which they claimed for themselves. The

true work of his episcopate was positive, not negative; and the gifts which made him a good historian made him also a great bishop. He knew how to rule, and he ruled in stately fashion, wearing cope and mitre on great occasions. All who came to consult him found him a tender-hearted and sympathetic counsellor, whose fatherly wisdom was only the more conspicuous for its unassuming simplicity and its sound common sense. His chairmanship turned the London Church Congress of 1899, which had been regarded as a doubtful experiment, into an unqualified success. He realized as few did the office and message of the English Church in Christendom, and its witness on behalf of something greater than either sectarianism or undenominationalism. He was never tired of reiterating the essential truths to which the English Church bears witness, of directing attention to the great principles which underlie details of practice. Here too his position lay open to obvious misunderstanding, as being a mere glorification of insular Anglicanism. But his discernment of the truths which the English Church aims at presenting never blinded him to the faults of the presentation, and no man was less insular than he. There was yet another side to his work which was wider still. His interests and his sympathies extended to every side of human life; and from the first he took a foremost part in almost every good work that went on in his diocese, social or educational, political or religious. To describe this in detail would be impossible; but it went on continuously, and through it his influence with thinking men and women increased steadily. No period could well have been fuller of fruitful work than the four years of his episcopate, and certainly nothing could have been fuller of promise for the future. But the promise was not destined to be fulfilled. By degrees the work, and especially the routine work, began to tell on him. He fell seriously ill in the late summer of 1900, and the illness developed into ulceration of the stomach. At length, on 14th January 1901, he passed away, and was buried in St Paul's Cathedral on January 17.

Bishop Creighton's publications are too numerous to be spoken of in detail; they range in size from an excellent little primer of Roman History to his *History of the Papacy*, a work of great and enduring value. He was a notable preacher: a Greek ecclesiastic who heard him frequently, knowing then little English, said that there were two words which recurred constantly in his sermons, *sympathy* and *character*; and the implied description is a true one. He was a man of striking presence, with a resonant voice, and clear-cut delicate features, recalling those of the great Englishmen of Tudor days. He was a man of such unusual brilliance (people used to call him "the Admirable Crichton") that many failed to see all that lay beneath it. His irrepressible and often daring humour, his frank distaste for much conventional religious phraseology, and his readiness to accept people at their own standard and make the best of them, caused him to be little appreciated by some good people. But beneath it all there was profound wisdom and piety, extraordinarily wide sympathy, and a holy love of truth. He grew visibly with each new call upon him, and few modern bishops have made so wide and so deep an impression on their age as he did. (W. E. CO.)

**Creil,** a town of France, arrondissement of Senlis, in the department of Oise, on the river Oise, 22 miles in direct line south-east of Beauvais, and an important junction on the railway from that place to Paris. The manufacture of machinery, heavy iron goods and nails, and copper and iron founding, are important industries; earthenware is also manufactured. The church is a mediæval structure, the earlier parts of which date from the 12th century, and there are ruins of a collegiate church of St Everemont on an island in the river, and some traces of a castle built by Charles V. The port traffic in 1899 amounted to 41,185 tons. Population (1881), 7099; (1901), 9123.

**Cremation.**—A brief but interesting summary of the ancient usages among different nations in relation to the disposal of the body after death, and particularly to that by cremation, is given in the ninth edition of this work; and a few particulars are added of its introduction into the United Kingdom at an early period. It is the design of the present writer to continue the narrative to the present date. As there stated, Sir Henry Thompson was the first to introduce the practice, and to perform it experimentally on animals; advocating the procedure in an article which appeared in the *Contemporary Review* of January 1874, which excited considerable notice at home and abroad. He had seen Brunetti's results at the Vienna Exhibition in 1873, and his own were obtained in the manner described. At a very early date steps were taken to form an English Society to promote the practice of cremation. A declaration of its objects was drawn up and signed on 13th January 1874 by the following persons:—Shirley Brooks, William Eassie, Ernest Hart, the Rev. H. R. Haweis, G. H. Hawkins, John Cordy Jeaffreson, F. Lehmann, C. F. Lord, W. Shaen, A. Strahan, Henry Thompson, Major Vaughan, Rev. C. Voysey, and T. Spencer Wells; and they frequently met to consider the necessary steps in order to attain their object. The laws and regulations having been thoroughly discussed, the membership of the Society was constituted by an annual contribution for expenses, and a subscription to the following declaration:—

> "We disapprove the present custom of burying the dead, and desire to substitute some mode which shall rapidly resolve the body into its component elements by a process which cannot offend the living, and shall render the remains absolutely innocuous. Until some better method is devised, we desire to adopt that usually known as cremation."

Finally, on 29th April a meeting was held, a Council was formed, Sir H. Thompson was elected President and Chairman, an office he still held in 1901. Mr Eassie was at the same time elected secretary.[1]

In 1875 the following were added:—Mrs Rose Crawshay, Mr Higford Burr, Rev. J. Long, Mr W. Robinson, and the Rev. Brooke Lambert. Subsequently, and in order of date of appointment, followed the Rt. Hon. Lord Bramwell; Sir Chas. Cameron, M.P.; Dr Farquharson, M.P.; Sir Douglas Galton; Rt. Hon. Lord Playfair; Mr Martin Ridley Smith; Mr James A. Budgett; Mr Edmund Yates; Mr J. S. Fletcher; Mr J. C. Swinburne-Hanham; His Grace the Duke of Westminster (on Lord Bramwell's death); and Sir Arthur Arnold, L.C.C.

On account of difficulties and prejudices which cannot be further referred to here,[2] the Council was unable to purchase a freehold until 1878, when an acre was obtained at Woking, not far distant from the Cemetery. At this time the furnace employed by Professor Gorini of Lodi, Italy, appeared to be the best for working with on a small scale; and he was invited to visit this country to superintend its erection. This was completed in 1879, and the body of a horse was cremated rapidly and completely without any smoke or effluvia from the chimney. No sooner was this successful step taken than the President

[1] This was the first society formed in Europe for the promotion of cremation.

[2] For a full account of these, see *Modern Cremation: Its History and Practice to the Present Date*. By Sir H. Thompson, Bart., F.R.C.S., &c. Fourth edition. Smith & Elder, Waterloo Place, 1901.

received a communication from the Home Office, which resulted in a personal interview with the Home Secretary; the issue of which was that if the Society desired to avoid direct hostile action, an assurance must be given that no cremation should be attempted without leave first obtained from the Minister. This of course was given, no further building took place, and the Society's labours were confined to employing means to diffuse information on the subject. Sir Spencer Wells brought it before the annual meeting of the British Medical Association in 1880, when a petition to the Home Secretary for permission to adopt cremation was largely signed by the leading men in town and country, but without any immediate result. The next important development was an application to the Council in 1882, by Captain Hanham in Dorsetshire, to undertake the cremation of two deceased relatives who had left express instructions to that effect. The Home Secretary was applied to, and refused. The bodies were preserved, and Captain Hanham erected a crematorium on his estate, and the cremation took place there. He himself, dying a year later, was cremated also; in both cases the result was attained under the supervision of Mr J. C. Swinburne-Hanham, who succeeded Mr Eassie in 1888 as Secretary to the Society. The Government took no notice. But in 1883 a cremation was performed in Wales by a man on the body of his child, and legal proceedings were taken against him. Mr Justice Stephen, in February 1884, delivered his well-known judgment at the Assizes there, declaring cremation to be a legal procedure, provided no nuisance were caused thereby to others. The Council of the Society at once declared themselves absolved from their promise to the Home Office, and publicly offered to perform cremation, laying down strict rules for careful inquiry into the cause of death in every case. They stated that they were fully aware that the chief practical objection to cremation was that it removed traces of poison or violence which might have caused death. Declining to trust the very imperfect statement generally made respecting the cause of death in the ordinary death certificate (unless a coroner's inquest had been held), they adopted a system of very stringent inquiry, the result of which in each case was to be submitted to the President, to be investigated and approved by him before cremation could take place, with the right to decline or order an inquest if he thought proper; and this course has been followed ever since the first cremation.

It was on 26th March 1885 that the first cremation took place, the subject being a lady.[1] In 1888 it became necessary, nearly 100 bodies having been by this date cremated, to build a large hall for religious service, as well as waiting-rooms, in connexion with the crematorium. The Dukes of Bedford and Westminster headed the appeal for funds, each with £105. The former especially took great interest in the progress of the Society, and offered to furnish further donations to any extent necessary. During the next two years he generously defrayed costs to the amount of £3500, and built a smaller crematorium adjacent for himself and family. The latter building was first used on 18th January 1891, a few days after the death of His Grace (the ninth duke of Bedford). The number of cremations slowly increased year by year, and the total at the end of 1900 was 1824. Many of these were persons of distinction—by rank, or by attainments in art, literature, and science, or in public life.

The Council next turned their attention to the need for a national system of death certification, to be enforced by law as an essential and much needed reform in connexion with cremation. On 6th January 1893 the Duke of Westminster introduced a deputation to the Secretary of State for the Home Department, Mr Asquith, and the President of the Cremation Society opened the case, showing that no less than 7 per cent. of the burials in England took place without any certificate, while in some districts it was far greater. In consequence of this the Home Secretary appointed a Select Committee of the House of Commons, which was presided over by Sir Walter Foster, of the Local Government Board, "to inquire into the sufficiency of the existing law as to the disposal of the dead . . . and especially for detecting the causes of death due to poison, violence, and criminal neglect." After a prolonged inquiry and careful consideration of the evidence, a full report and conclusions drawn therefrom were unanimously agreed to, and published as a blue-book in the autumn of 1893.[2]

The following conclusions are quoted from this volume :—Page iii. "So far as affording a record of the true cause of death and the detection of it in cases where death may have been due to violence, poison, or where criminal neglect is concerned, the class of certified deaths leaves much to be desired." Page iv. Certification is extremely important as a deterrent of crime, and numerous proofs are given at length in support of the statement. . . . "Contrast this class with that of uncertified deaths, when the result is such as to force upon your Committee the conviction that vastly more deaths occur annually from foul play and criminal neglect than the law recognizes." Page viii. Great uncertainty in resorting to the coroner's court, and want of system in connexion with the practice of it, are affirmed to exist. Page x. It is stated that the opportunity for perpetrating crime is great in the considerable class of uncertified cases . . . "in short, the existing procedure plays into the hands of the criminal classes." "Your Committee are much impressed with the serious possibilities implied in a system which permits death and burial to take place without the production of satisfactory medical evidence of the cause of death." Page xii. "Your Committee have arrived at the conclusion that the appointment of medical officials, who should investigate all cases of death which are not certified by a medical practitioner in attendance, is a proposal which deserves their support."

In considering cremation, the Committee reported as follows :—Page xxii. "Your Committee are of opinion that there is only one question in connexion with this method of disposing of a dead body to which it is necessary for them to refer. That question is the supposed danger to the community arising from the fact that with the destruction of the body the possibility of obtaining evidence of the cause of death by *post-mortem* examination also disappears." The mode of proceeding adopted by the Cremation Society of England having been described, "your Committee are of opinion that with the precautions adopted in connexion with cremation, as carried out by the Cremation Society, there is little probability that cases of crime would escape detection, but inasmuch as these precautions are purely voluntary, your Committee consider that in the interests of public safety such regulations should be enforced by law."

After this, it could only be a question of time before the admitted demands for official inquiry were enforced by law in every case of death; when that is done, the general employment of cremation may safely follow. In August 1894 the President of the Society laid the results of the Select Committee before the British Medical Association at Bristol, and a unanimous vote was obtained in favour of the suggestions made by it. In November a second deputation waited on Mr Asquith, in which the President of the Society begged him to carry out the system recommended. The Home Secretary replied that the business belonged to the Department of the Local Government Board, and that it was already dealing with the question and bringing it to a satisfactory solution. Soon afterwards, however, the Government changed, other questions became pressing, and further consideration of the subject was postponed.

It is most desirable to put in force by Act of Parliament the recommendations of the Select Committee before mentioned. The

[1] *Times*, 27th March 1885.

[2] *Reports on Death Certification*, 1893. Eyre & Spottiswoode, London (373, 472).

chief provisions have been carefully considered by the Council of the Society, and the regulations necessary for registration of death and the disposal of the dead may be outlined as follows:— 1. That no body should be buried, cremated, or otherwise disposed of without a medical certificate of death signed, after personal knowledge and observation, or by information obtained after investigation made by a qualified medical officer appointed for the purpose. 2. A qualified medical man should be appointed as official certifier in every parish, or district of neighbouring parishes, his duty being to inquire into all cases of death and report the cause in writing, together with such other details as may be deemed necessary. This would naturally fall within the duties of the medical officer of health for the district, and registration should be made at his office. 3. If the circumstances of death obviously demand a coroner's inquest, the case should be transferred to his court and the cause determined, with or without autopsy. If there appears to be no ground for holding an inquest, and autopsy be necessary to the furnishing of a certificate, the official certifier should make it, and state the result in his report. 4. No person or company should be henceforth permitted to construct or use an apparatus for cremating human bodies without licence from the Local Government Board or other authority. 5. No crematory should be so employed unless the site, construction, and system of management have been approved after survey by an officer appointed by Government for the purpose. But the licence to construct or use a crematory should not be withheld if guarantees are given that the conditions required are or will be complied with. All such crematories to be subject at all times to inspection by an officer appointed by the Government. 6. The burning of a human body, otherwise than in an officially recognized crematory, should be illegal, and punishable by penalty. 7. No human body should be cremated unless the official examiner added the words "Cremation permitted." This he should be bound to do if, after due inquiry, he can certify that the deceased has died from natural causes, and not from ill-treatment, poison, or violence.

Undoubtedly in populous communities and in crowded districts the burial of dead bodies is liable to be a source of danger to the living. As early as 1840 a Commission had been appointed, including some of the earliest authorities on sanitary science,—namely, Drs Southwood Smith, Chadwick, Milroy, Sutherland, Waller Lewis, and others,—to conduct a searching inquiry into the state of the burial-grounds of London and large provincial towns. By the report[1] the existence of such a danger was strikingly demonstrated, and intramural interments were in consequence made illegal. The advocates of burial then declared that interment in certain light soils would safely and efficiently decompose the putrefying elements which begin to be developed the moment death takes place, and which rapidly become dangerous to the living, still more so in the case of deaths from contagious disease. But these light dry soils and elevated spots are precisely those best adapted for human habitation; to say nothing of their value for food-production. Granted the efficiency of such burial, it only effects in the course of a few years what exposure to a high temperature accomplishes with absolute safety in an hour. In a densely populated country the struggle between the claims of the dead and the living to occupy the choicest sites becomes a serious matter. All decaying animal remains give off effluvia—gases—which are transferred through the medium of the atmosphere to become converted into vegetable growth of some kind—trees, crops, garden produce, grass, &c. Every plant absorbs these gases by its leaves, each one of which is provided with hundreds of stomata—open mouths—by which they fix or utilize the carbon to form woody fibre, and give off free oxygen to the atmosphere. Thus it is that the air we breathe is kept pure by the constant interaction between the animal and vegetable kingdoms. It may be taken as certain that the gaseous products arising from a cremated body—amounting, although invisible, to no less than 97 per cent. of its weight, 3 per cent. only remaining as solids, in the form of a pure white ash—become in the course of a few hours integral and active elements in some form of vegetable life. The result of this reasoning has been that, by slow degrees, crematoria have been constructed at many of the populous cities in Great Britain and abroad. In Manchester a large one was opened in 1892, in Glasgow in 1894, in Liverpool in 1896, in Hull in 1899. In Birmingham another is in progress of formation.

[1] *A Special Inquiry into the Practice of Interment in Towns*, by Edwin Chadwick (London, 1843), is replete with evidence, and should be read by those who desire to pursue the inquiry further.

The subject of employing cremation for the bodies of those who die of contagious disease is a most important one. Sir H. Thompson advocated this course in a paper read before the International Congress of Hygiene held in London in 1891; and a resolution strongly approving the practice was carried unanimously at a large meeting of experts and medical officers of health. Such diseases are small-pox, scarlet fever, diphtheria, consumption, malignant cholera, enteric, relapsing, and puerperal fevers, the annual number of deaths from which in the United Kingdom is upwards of 80,000. Complete disinfection takes place by means of the high temperature to which the body is exposed. Heated air suffices, and the chamber of a Siemens regenerative gas-furnace, where no flame enters, is the most perfect form for accomplishing the process. It will probably, at no distant period, supersede the furnaces now employed. At the present day it is compulsory to report any case in the foregoing list, whenever it occurs, to the medical officer of health for the district; and it is customary to disinfect the rooms themselves, as well as the clothes and furniture used by the patient if the case be fatal; but the body, which is the source and origin of the evil, and is itself loaded with the germs of a specific poison, is left to the chances which attach to its preservation in that condition, when buried in a fit or unfit soil or situation.

The process of preparing a body for cremation requires a brief notice. The plan generally adopted is to place it (in the usual shroud) in a light pine shell, discarding all heavy oak or other coffin, and to introduce it into the furnace in that manner. For the purpose of transit such a shell is convenient and appropriate; but it is best to discard the linen shroud—the combustion of which, together with the shell, produces a quantity of black charcoal, which has subsequently to be separated, not without some trouble, from the white ashes of the body—in favour of one of a stout woollen material; this, being an animal product, is destroyed and dissipated by cremation, and is so made that the body may be easily cremated without the shell. A sheet of flannel is provided, say 10 feet by 5 or 6 feet for an adult of average size, in which the body is placed; the sides of the sheet are then to be folded across the body, one overlapping the other, so as to cover it entirely. Thus the folded ends of the sheet will extend some 2 feet or so above and below the head and feet of the body respectively. Above each of these points a piece of stout wide strong tape or web should be firmly tied round the folded sheet, and in at least two places round the covered body also, so as to maintain the sheet *in situ*. These ends are then turned over when the body has been placed in the shell, before the lid is adjusted for removal. Immediately before the act of cremation commences, the shell should be opened, the body be carefully and reverently lifted out by a bearer at each end of the sheet, a third supporting the centre, and be placed on the frame which enters the crematorium.

The following statistics show the history of modern cremation and its progress at home and abroad to the present date:—

*Foreign Countries.*—The first experiment in Italy was made by Brunetti in 1869, his second and third in 1870. Gorini and Polli published their first cases in 1872. Brunetti exhibited his at Vienna in 1873. All were performed in the open air. The next in Europe was a single case at Breslau in 1874. Soon after, an English lady was cremated in a closed apparatus (Siemens) at Dresden. The next cremation in a closed receptacle took place at Milan in 1876. In the same year a Cremation Society was formed, a handsome building was erected, and two Gorini furnaces were at work in 1880. In 1899 the total number of cremations was 1355. Other crematoria were subsequently erected at Lodi, Cremona, Brescia, Bologna, Varese, Padua, and Venice. At Bologna the total

cremations numbered 155 up to December 31, 1900. At Venice the total cremations numbered 45 in May 1899. One crematorium began in Rome in 1883, and the cremations numbered 800 up to May 1899. At the present time 28 crematoria exist in Italy.

In Germany the first crematorium was erected at Gotha; it began in 1879, and the total cremations in December 31, 1900, numbered 2468. At Ohlsdorf, Hamburg, the crematorium began in November 1892, and the total cremations up to December 31, 1900, numbered 646. At Heidelburg the crematorium started in 1891, and the total cremations up to November 28, 1900, numbered 895. A crematorium started working at Offenbach on December 13, 1899, and at the end of its first year (December 13, 1900) had cremated 113 bodies. Throughout the German Empire there are forty societies for promoting cremation, numbering about 40,000 members.

Other societies now exist in Denmark, Holland, Belgium, Sweden, Norway, and Switzerland. At the crematorium recently constructed at Copenhagen 28 bodies were cremated in 1899, the same in 1900; the total being 56. The Stockholm crematorium began in October 1887, and the total cremations up to May 1899 numbered 495. The Gothenburg crematorium (also in Sweden) began in January 1890, and the total cremations up to May 1899 was 120.

In Paris a Cremation Society was founded in 1880, and in 1886–87 a large crematorium was constructed by the Municipal Council at Père Lachaise, containing three Gorini furnaces. It was first used in October 1887 for two men who died of small-pox. The demand became large; an improved furnace was soon devised, the unclaimed bodies at the hospitals and the remains at the dissecting rooms being cremated there, besides a large number of embryos. In 1890 the total number, including the last-named class, exceeded 3000; in 1895, 4000; numbering 4554 at the end of 1899; and the number for the year 1900 was rather larger. The total number of incinerations in private life exceeds the previous record, being, up to December 31, 1900, 197; but the employment of cremation for the purposes named has deterred a resort to it by many. Had a separate establishment been organized for the public, its success would have been greater; the error is now obvious and may be rectified soon, for a magnificent edifice is in course of construction by the municipality of Paris for the conservation of the ashes, &c., which will form a larger and more imposing columbarium than has yet been seen. Lastly, the construction of crematoria in all the great provincial centres of France—Lyons, Lille, Rheims, Nice, Marseilles, Toulouse, and Bordeaux—is being completed or is commencing. At Rouen it is already in operation with good results, the low damp soil there being unfit for burial.[1]

In Buenos Ayres, since 1844, the bodies of all persons dying of contagious disease are cremated, and there is also a separate establishment for the use of the public.

At Tokio in Japan no less than twenty-two crematoria exist, and about an equal number of cremations and burials in earth take place.

*United Kingdom.*—The following is the report from the crematorium at Woking for each year, commencing with the first in 1885 and concluding with that ending December 31, 1900.

*Cremations at Woking.*

| Year. | Number. | Year. | Number. |
|---|---|---|---|
| 1885 | 3 | 1894 | 125 |
| 1886 | 10 | 1895 | 150 |
| 1887 | 13 | 1896 | 137 |
| 1888 | 28 | 1897 | 173 |
| 1889 | 46 | 1898 | 240 |
| 1890 | 54 | 1899 | 240 |
| 1891 | 99 | 1900 | 301 |
| 1892 | 104 | | |
| 1893 | 101 | Total | 1824 |

The Manchester crematorium began in 1892, and the total cremations to December 31, 1900, numbered 475. The Glasgow crematorium began in 1895, and the total cremations up to December 31, 1900, numbered 75. The Liverpool crematorium began in 1896, and the total cremations up to December 31, 1900, numbered 102. The Hull crematorium was opened on January 2, 1901. It is the first crematorium erected in England under municipal authority. Seven cremations took place within a month of its opening. The Birmingham crematorium is not yet in operation. The capital is subscribed, but a proper site has not yet been met with.

[1] The writer is indebted for the history of cremation in France and its departments to the *Bulletin de la Soc pour la Propagation de l'Incinération*, Paris, by M. Georges Salomon, secretary from its foundation in 1880 up to the end of 1900; and also for the reports from South America and Japan. The present writer has visited Père Lachaise several times, and the above report is partly based on his personal observation.

The Cremation Society of England has been long endeavouring to obtain a site on which to establish a crematorium within convenient driving distance of Central London; and in December 1899 a company was formed for the purpose, its title being "The London Cremation Company Ltd."

The only crematorium at present available to the inhabitants of London is that at Woking, the property of, and managed by, the Cremation Society of England; but a freehold site, 12 acres in extent, has been purchased about 5 miles distant from the Marble Arch, surrounded by open country, and on one of the best main roads north of London, and here it is intended to erect crematoria on the newest and the most approved principle, with a chapel, waiting-rooms, and attendants' lodges, together with private and public columbaria for the reception of cinerary urns. The land not so occupied will be laid out as a garden, with lawns, trees, and shrubs, becoming a place of increasing interest and beauty from year to year: where ample space will be afforded for the erection of monuments, and provision made for the interment of ashes for those who prefer it.

*United States.*—There are twenty-five crematoria in the United States. At Fresh Pond, New York, the first crematorium was erected in 1885, and the total number of cremations to December 31, 1900, was 3903. At Buffalo, N.Y., the first cremation took place in 1885, and the total number up to December 31, 1900, was 484. At Troy (Earl Crematorium), N.Y., the first cremation took place in 1890, and the total number up to December 31, 1900, was 146. At Swinburne Island, N.Y., cremations commenced in 1890, total to 1898 being 106. At Waterville, N.Y., cremations commenced in 1893, total to December 31, 1900, being 38. At St Louis, Missouri, cremations commenced in 1888, total to December 31, 1900, being 1054. At Philadelphia, Penn., cremations commenced in 1888, total to December 31, 1900, being 914. At San Francisco, Cal. ("Odd Fellows"), commenced in 1895, total to December 31, 1900, being 1535. At San Francisco, Cal. ("Cypress Lawn"), commenced in 1893, total to December 31, 1900, being 632. At Los Angelos, Cal., commenced in 1888, total to 1898 being 352. At Boston, Mass., commenced in 1893, total to December 31, 1900, being 1057. At Cincinnati, Ohio, commenced in 1887, total to December 31, 1900, being 647. At Chicago, commenced in 1893, total to December 31, 1900, being 695. At Detroit, Michigan, commenced in 1887, total to December 31, 1900, being 371. At Pittsburg, Penn., commenced in 1886, total to December 31, 1900, being 216. At Baltimore, commenced in 1889, total to December 31, 1900, being 180. At Lancaster, Penn., commenced in 1884, total to December 31, 1900, being 95. At Davenport, Iowa, commenced in 1891, total to December 31, 1900, being 134. At Milwaukee, commenced in 1896, total to October 1900 being 170. At Washington, commenced in 1897, total to December 31, 1900, being 109. The Le Moyne (Washington) Crematory, the first in the United States, was erected by Dr F. Julius Le Moyne in 1876 for private use. The first cremation was that of the Baron de Palin of New York, December 6, 1876. Dr F. Julius Le Moyne died October 1879, and his remains were cremated in his own crematory. Total number cremations since, to February 1901, being 42. At Pasadena, Cal., commenced in 1895, total to end of 1898 being 55. At St Paul, Minn., commenced in 1897, total to December 31, 1900, being 55. At Fort Wayne, Ind., commenced in 1897, total to December 31, 1900, being 14. From the remaining crematorium at Middletown, Conn., statistics have not been received.

The sum total of the above incinerations at the twenty-five crematoria in America amounts to 13,004 up to December 31, 1900.

(H. TH.)

**Cremer, Jakobus Jan** (1837–1880), Dutch novelist, born at Arnhem, September 1837, started life as a painter, but soon exchanged the brush for the pen. The great success of his first novelettes (*Betuwsche Novellen* and *Overbetuwsche Novellen*), published about 1855—reprinted many times since, and translated into German and French—showed Cremer the wisdom of his new departure. These short stories of Dutch provincial life are written in the quaint dialect of the Betuwe, the large flat Gelderland island, formed by the Rhine, the name recalling the presumed earliest inhabitants, the Batavi. Cremer is strongest in his delineation of character. His picturesque humour, coming out, perhaps, most forcibly in his numerous readings of the Betuwe novelettes, soon procured him the name of the "Dutch Fritz Reuter." In his later novels Cremer abandons both the language and the slight love-stories of the Betuwe, depicting the Dutch life of other centres in the national tongue. The

principal are: *Anna Rooze* (1867), *Dokter Helmond en zijn Vrouw* (*Dr H. and his Wife*, 1870), *Hanna de Freule* (*The Honourable Miss Hannah*, 1873), *Daniel Sils*, &c. Cremer was less successful as a playwright, and his two comedies, *Peasant and Nobleman* and *Emma Bertholt*, did not enhance his fame; nor did a volume of poems, published in 1873. He died at The Hague in June 1880. His collected novels have appeared at Leyden. An English novel, founded by Albert Vandam upon *Anna Rooze*, considered by many his best work, was published in London (1877, 3 vols.) under the title of *An Everyday Heroine*. (H. TI.)

**Cremona**, a fortified town and episcopal see of Lombardy, Italy, capital of the province Cremona, on the left bank of the Po, 51 miles by rail south-east from Milan, an important railway junction in the middle of North Italy. Amongst the public buildings should be particularly mentioned the Renaissance churches of St Sigismund (begun in 1463) and St Peter (1549), the baptistery (*circa* 900, but rebuilt in 1167), the Palace of the Jurisconsults (1292), and the Ala-Ponzone Museum, containing works of the native school of painters, and archæological collections. There are also statues to Garibaldi, Victor Emmanuel, and the musician Ponchielli (1893). Cremona has two technical schools and a school of singing. Its manufactures embrace the rearing of silkworms and silk-throwing, with ironworks and foundries. Population (1881), 31,930; (1901), 37,661.

**Cremona, Luigi** (1830——), Italian mathematician, was born at Pavia 7th December 1830. In 1848, when Milan and Venice rose against Austria, Cremona, then only a lad of seventeen, joined the ranks of the Italian volunteers, and remained with them, fighting on behalf of his country's freedom, till, in 1849, the capitulation of Venice put an end to the hopeless campaign. He then returned to Pavia, where he pursued his studies at the university under the distinguished mathematician Brioschi, and determined to seek a career as teacher of mathematics. His first appointment was as elementary mathematical master at the Gymnasium and Lyceum of Cremona, and he afterwards obtained a similar post at Milan. In 1860 he was appointed to the professorship of Higher Geometry at the University of Bologna, and in 1866 to that of Higher Geometry and Graphical Statics at the Higher Technical College of Milan. In this same year he competed for the Steiner Prize of the Berlin Academy, with a treatise entitled "Memoria sulle superficie di terzo ordine," and shared the award with Professor Sturm. Two years later the same prize was conferred on him without competition. In 1873 he was called to Rome to organize the College of Engineering, and was also appointed Professor of Higher Mathematics at the university. Cremona's reputation had now become European, and in 1879 he was elected a corresponding member of the Royal Society. In the same year he was made a senator of the Kingdom of Italy. As early as 1856 Cremona had begun to contribute to the *Annali di Scienze matematiche e fisiche*, and to the *Annali di Matematica*, of which he became afterwards joint editor. Papers by him have appeared in the mathematical journals of Italy, France, Germany, and England, and he has published several important works, many of which have been translated into other languages. His manual on *Graphical Statics* and his *Elements of Projective Geometry* have been published in English by the Clarendon Press. His life has been devoted to the study of higher geometry and reforming the more advanced mathematical teaching of Italy. He is a follower of Steiner, preferring synthetic to analytic methods. In his *Introduction to a Geometrical Theory of Plane Curves* he develops by a uniform method many new results, and proves synthetically all important results hitherto reached by analysis. The theory of the transformation of curves, and of the correspondence of points on curves, was extended by him to three dimensions. He has devoted special attention to ruled surfaces, surfaces of the second order, space-curves of the third order, and the general theory of surfaces.

**Creston**, capital of Union county, Iowa, U.S.A., on the high prairie (whence its name), at an altitude of 1312 feet. It is at the intersection of two branches of the Chicago, Burlington, and Quincy Railways. Population (1880), 5081; (1900), 7752.

**Creswick**, a borough of Victoria, Australia, in the county of Talbot, on the Tullaroop Creek, 85½ miles by rail north-west of Melbourne, and 11 miles north of Ballarat. Much of the surrounding district is fertile and well timbered. The quartz and alluvial gold mines of the district are important, employing about 1300 persons. Population (1881), 3731; (1900), about 4700.

**Crete.**—During the past half-century the affairs of Crete have repeatedly occupied the attention of Europe. Owing to the existence of a strong Mussulman minority among its inhabitants, the warlike character of the natives, and the mountainous configuration of the country, which enabled a portion of the Christian population to maintain itself in a state of partial independence, the island has constantly been the scene of prolonged and sanguinary struggles in which the numerical superiority of the Christians was counterbalanced by the aid rendered to the Moslems by the Ottoman troops. This unhappy state of affairs was aggravated and perpetuated by the intrigues set on foot at Constantinople against successive governors of the island, the conflicts between the Palace and the Porte, the duplicity of the Turkish authorities, the dissensions of the representatives of the Great Powers, the machinations of Greek agitators, the rivalry of Cretan politicians, and prolonged financial mismanagement. A long series of insurrections—those of 1821, 1833, 1841, 1858, 1866-1868, 1878, 1889, and 1896 may be especially mentioned—culminated in the general rebellion of 1897, which led to the interference of Greece, the intervention of the Great Powers, the expulsion of the Turkish authorities, and the establishment of an autonomous Cretan government under the suzerainty of the sultan. According to the new autonomous constitution, the supreme power is vested in Prince George of Greece, acting as high commissioner of the protecting Powers. The authority thus conferred is confided exclusively to the present high commissioner, and is liable to modification by law in the case of his successor. The prince is irresponsible, but his decrees, except in certain specified cases, must be countersigned by a member of his Council. He convokes, prorogues, and dissolves the Chamber, sanctions laws, exercises the right of pardon in case of political offences, represents the island in its foreign relations, and is chief of its military forces. The Chamber (βουλή), which is elected in the proportion of one deputy to every 5000 inhabitants, meets for a session of two months every two years. Ten of its members are nominated by the prince. A new election is held before each session, and when the Chamber assembles a budget for a period of two years is submitted. The Chamber exercises a complete financial control, and no taxes can be imposed without its consent. The prince is aided in the administration by a Cabinet of five members, styled "councillors" (σύμβουλοι), who superintend respectively the departments of justice, finance, education, public security, and the interior. The councillors, who are nominated and dismissed by the prince, are

responsible to the Chamber, which may impeach them before a special tribunal for any illegal act or neglect of duty. Large exceptional legislative and administrative powers were accorded to the prince at the opening of his rule. In general the Cretan constitution is characterized by a conservative spirit, and contrasts with the ultra-democratic systems established in Greece and the Balkan States. A further point of difference is the more liberal payment of public functionaries in Crete. For administrative purposes the departmental divisions existing under the Turkish Government have been retained. There are 5 *nomoi* or prefectures (formerly *sanjaks*) each under a prefect (*νομάρχης*), and 23 eparchies (formerly kazas) each under a sub-prefect (*ἔπαρχος*). All these functionaries are nominated by the prince. The prefects are assisted by departmental councils. The system of municipal and communal government remains practically unchanged. The island is divided into 86 communes, each with a mayor, an assistant-mayor, and a communal council. The mayors and their assistants were formerly elected; they are now appointed by the high commissioner, who also for the present nominates the members of the communal councils. The councils assess within certain limits the communal taxes, maintain roads, bridges, &c., and generally superintend local affairs. Public order is maintained by a force of gendarmery (*χωροφυλακή*) organized and at present commanded by 110 Italian officers, who in course of time will be succeeded by natives. The proposed strength was 1400 men, but this number has been reduced to 1246. The expenditure for the maintenance of this force forms the heaviest item in the budget. The constitution authorizes the formation of a militia (*πολιτοφυλακή*) to be enrolled by conscription, but in existing circumstances the embodiment of this force seems unnecessary. The administration of justice is on the French model. A supreme court of appeal, which also discharges the functions of a court of cassation, sits at Canea. There are two assize courts at Canea and Candia respectively with jurisdiction in regard to serious offences (*κακουργήματα*). Minor offences (*πλημμελήματα*) and civil causes are tried by courts of first instance in each of the five departments. There are 26 justices of peace, to whose decision are referred slight contraventions of the law (*πταίσματα*) and civil causes in which the amount claimed is below 600 francs. These functionaries also hold monthly sessions in the various communes. The judges are chosen without regard to religious belief, and precautions have been taken to render them independent of political parties. They are appointed, promoted, transferred, or removed by order of the council of justice, a body composed of the five highest judicial dignitaries, sitting at Canea. An order for the removal of a judge must be based upon a conviction for some specified offence before a court of law. The jury system has not been introduced. The Greek penal code has been adopted with some modifications. The Ottoman civil code is maintained for the present, but it is proposed to establish a code recently drawn up by Greek jurists which is mainly based on Italian and Saxon law. The Mussulman cadis retain their jurisdiction in regard to religious affairs, marriage, divorce, the wardship of minors and inheritance.

*Finance.*—The budget estimates for the year 1900, the first which had been made up for a complete year under the new autonomous government, were as given below. In addition to the regular revenues inscribed in the budget, a sum estimated at 3,700,000 dr. approximately remained available, derived from the issue of a new coinage and other exceptional sources. The four protecting Powers further advanced 1,000,000 fr. each to defray the initial expenses of the High Commissioner's Government. It was proposed to expend considerable sums on roadmaking

| *Receipts.* | Drachmæ. |
|---|---|
| Direct taxation | 1,524,320 |
| Indirect taxation (stamps, dues, &c.) | 662,737 |
| Monopolies | 124,000 |
| State domains, and other property | 132,638 |
| Export dues (1 per cent.) | 93,144 |
| Import dues (8 per cent.) and taxes on consumption | 1,312,894 |
| Other sources | 232,444 |
| | 4,082,177 |

| *Expenditure.* | Drachmæ. |
|---|---|
| High Commissioner | 200,000 |
| Financial administration | 594,000 |
| Interior | 485,000 |
| Gendarmery | 1,686,000 |
| Education | 832,000 |
| Justice | 577,000 |
| | 4,374,000 |

and public works. The Cretans are at present more lightly taxed than any people in Europe. The tithe has been replaced by an export tax on agricultural produce levied at the custom-houses, and the smaller peasant proprietors and shepherds of the mountainous districts are practically exempt from any contribution to the State. The communal tax does not exceed on the average 2 fr. annually for each family. The poorer communes are aided by a State subvention. Notwithstanding the havoc wrought during repeated insurrections, the impoverishment of the peasants, the desolation of the districts formerly inhabited by the Moslem agricultural population, and the drain of gold resulting from the sale of Moslem lands and emigration of the former proprietors, the financial prospects of the island were favourable, and a rapid recovery of prosperity was anticipated.

*Production and Industries.*—Owing to the volcanic nature of its soil, Crete is probably rich in minerals. Recent experiments lead to the conclusion that iron, lead, manganese, lignite, and sulphur exist in considerable abundance. Copper and zinc have also been found. A large number of applications for mining concessions have been received since the establishment of the autonomous government. The principal wealth of the island is derived from its olive groves; notwithstanding the destruction of many thousands of trees during each successive insurrection, the production is apparently undiminished, and will probably increase very considerably owing to the planting of young trees and the improved methods of cultivation which the Government is endeavouring to promote. The orange and lemon groves have also suffered considerably, but new varieties of the orange tree are now being introduced, and an impulse will be given to the export trade in this fruit by the removal of the restriction on its importation into Greece. Agriculture is still in a primitive condition; notwithstanding the fertility of the arable land the supply of cereals is far below the requirements of the population. A great portion of the central plain of Monofatsi, the principal grain-producing district, is lying fallow owing to the exodus of the Moslem peasantry. The cultivation of silk cocoons, formerly a flourishing industry, has greatly declined in recent years, but efforts are now being made to revive it. There are few manufactures. Soap is produced at fifteen factories in the principal towns, and there are two distilleries of cognac at Candia.

*Commerce.*—The commerce of the island was expected to develop rapidly under the new system of government. The total value of the exports for the year 1899 was 8,040,912 drachmæ. The principal exports were olive oil, value 4,361,029 dr.; soap, value 320,806; and hides, value 208,170 dr. Oranges, lemons, almonds, and valonia are exported in considerable quantities. The countries which accept the largest share of Cretan produce are Turkey, England, Egypt, Austria, and Russia, in the order named. The total value of imports in 1899 was 15,842,743 dr. Imports from Turkey are valued at 5,865,350 dr., from Greece at 5,147,193 dr., from Austria at 2,030,826 dr., from Roumania at 1,051,145 dr., from Egypt at 655,548 dr., from Italy at 463,833 dr., from France at 180,397 dr., from England at 149,986 dr., from Bulgaria at 107,503 dr. Cereals are imported from the Black Sea and Danubian ports, ready-made clothing from Austria and Germany, articles of luxury from Austria and France, and cotton textiles from England. Imports are charged 8 per cent., exports 1 per cent. *ad valorem* duty. According to a law published in 1899, Turkish merchandise is subjected to the same rates as that of foreign nations.

*Population.*—According to the census taken in 1881, the complete publication of which was interdicted by the Turkish authorities, the population of the island was 279,165, or 35·78 to the square kilometre. Of this total, 141,602 were males, 137,563 females; 33,173 were literate, 242,114 illiterate; 205,010 were orthodox Christians, 73,234 Moslems, and 921 of other

religious persuasions. The Moslem element predominated in the principal towns, of which the population was—Candia, 21,368; Canea, 13,812; Retimo, 9274. According to the census taken in June 1900, the population of the island was 301,273, the Christians having increased to 267,266, while the Moslems had diminished to 33,281. The population of Candia was 22,501; of Canea, 20,972; of Retimo, 9311.

*Archæological research: early Cretan civilization.*

Lying midway between three continents, Crete became a natural stepping-stone for the passage of early culture from the east and south to the west and north. Under the myths of Minos and Dædalos the Greeks proclaimed their indebtedness to Cretan sources in the domains of law and art. Recent researches have illustrated the truth of these traditions in many interesting ways. The ancient remains which abound throughout the island show conclusively that the days of its greatest civilization lie behind the prehistoric period. Even the remotest nooks are studded with the ruins of Cyclopean strongholds and tower-houses, and here and there, as at Goulas in the east and Hyrtakina in the west, a complete acropolis is found. Goulas especially, rising in a succession of huge terraces, presents a mass of prehistoric masonry hardly paralleled elsewhere. The ancient stone vases and engraved seals found on these sites supply definite traces of a contact with Egypt going back to the period of the 12th dynasty, and dating from at least the latter half of the third millennium B.C. An intermediate period follows, characterized by the appearance of painted clay vases of an indigenous kind, first discovered in a votive cave at Kamáres, on the southern slopes of Mount Ida, and subsequently in greater abundance at Knossós. But the most brilliant period of prehistoric Cretan civilization corresponds with the great age of Mycenæ (the 14th and 15th centuries B.C.), and the contents of a palace of this epoch, recently excavated on the acropolis of Knossós by Mr A. J. Evans, show that in sculpture and fresco-painting the artists of Minoan Crete equalled, if they did not surpass, those of the contemporary Peloponnesos. Of all the evidences of this early civilization now brought to light the most remarkable is the discovery of an elaborate system of writing. A series of signs, both of the linear and more pictographic class, had already been observed on early seal-stones, and other objects. In the palace at Knossós, however, have been found a large number of clay tablets, analogous in many respects to the cuneiform tablets of Babylonia, but inscribed with the indigenous Cretan character. They are apparently palace archives and lists of horses, chariots, and stores in the royal stables and arsenal. To this brilliant Mycenæan age succeeds the period of the Dorian emigration, characterized by the "geometric" type of art. The decline of civilization is marked by a falling off in artistic production, but to a less extent than on the Greek mainland, a certain continuity of ancient traditions being maintained. By about the 8th century B.C. there is a manifest artistic revival, best illustrated by some of the reliefs on the bronze shields discovered in the great cave of Zeus on Mount Ida, in which the native Cretan handiwork more than holds its own beside imported Cypro-Phœnician examples. During the so-called archaic period of Greek art, Crete, the ancient home of letters, shows itself especially rich in epigraphic materials. The great inscription of Gortyna, discovered by Halbherr and Fabricius, is the most important monument of early law hitherto brought to light in any part of the Greek world. A very interesting inscription found at Præsos in eastern Crete shows that the language of the pre-Hellenic population, the Eteocretes of Homer, survived in that region till at least the beginning of the 5th century B.C. Of early Greek buildings in Crete, the most remarkable yet discovered is the Pythion at Gortyna. Exploration in progress at Axos, where important bronze reliefs have been found, and elsewhere, promises to add to our knowledge of classical art in Crete: meanwhile it is best represented by a very interesting series of coin-types, which show a certain marked originality and picturesqueness of design, but at the same time give evidence of repeated lapses into barbarism, resulting from the internecine feuds of the various cities and their isolation from the rest of the Greek world. (See also MYCENÆAN CIVILIZATION.)

*Recent History.*—Cretan constitutional history may be said to date from 1868, when, after the suppression of an insurrection which had extended over three years, the Turkish Government consented to grant a certain measure of autonomy to the island. The privileges now accorded were embodied in what is known as the Organic Statute, an instrument which eventually obtained a somewhat wider importance, being proposed by Article XXIII. of the Berlin Treaty as a basis of reforms to be introduced in other parts of the Ottoman empire. Various privileges already acquired by the Christian population were confirmed; a General Council, or representative body, was brought into existence, composed of deputies from every district in the island; mixed tribunals were introduced, together with a highly elaborate administrative system, under which all the more important functionaries, Christian and Mussulman, were provided with an assessor of the opposite creed. The new constitution, however, proved costly and unworkable, and failed to satisfy either section of the population. The Christians were ready for another outbreak, when, in 1878, the Greek Government, finding Hellenic aspirations ignored by the Treaty of San Stefano, gave the signal for agitation in the island. During the insurrection which followed the usual barbarities were committed on both sides; the Christians betook themselves to the mountains and the Mussulman peasants crowded into the fortified towns. Eventually the Cretan chiefs invoked the mediation of England, which Turkey, exhausted by her struggle with Russia, was ready to accept, and the convention known as the Pact of Halepa was drawn up in 1878 under the auspices of Mr Sandwith, the British Consul, and Adossides Pasha, both of whom enjoyed the confidence of the Cretan population.

*Pact of Halepa.*

The privileges conferred by the Organic Statute were confirmed; the cumbersome and extravagant judicial and administrative systems were maintained; the judges were declared independent of the executive, and an Assembly composed of forty-nine Christian and thirty-one Mussulman deputies took the place of the former General Council. A parliamentary regime was thus inaugurated, and party warfare for a time took the place of the old religious antagonism, the Moslems attaching themselves to one or other of the political factions which now made their appearance among the Christians. The material interests of the island were neglected in the scramble for place and power; the finances fell into disorder, and the party which came off worst in the struggle systematically intrigued against the Governor-General of the day and conspired with his enemies at Constantinople. A crisis came about in 1889, when the "Conservative" leaders, finding themselves in a minority in the Chamber, took up arms and withdrew to the mountains. Though the outbreak was unconnected with the religious feud, the latent fanaticism of both creeds was soon aroused, and the island once more became a scene of pillage and devastation. Unlike the two preceding movements, the insurrection of 1889 resulted unfavourably for the Christians. The Porte, having induced the

Greek Government to persuade the insurgents not to oppose the occupation of several strategic posts, despatched a military governor to the island, proclaimed martial law, and issued a firman abrogating many important provisions of the Halepa Pact. The mode of election to the Assembly was altered, the number of its members reduced, and the customs revenue, which had hitherto been shared with the island, was appropriated by the Turkish Treasury. The firman was undoubtedly illegal, as it violated a convention possessing a quasi-international sanction, but the Christians were unable to resist, and the Powers abstained from intervention. The elections held under the new system proved a failure, the Christains refusing to go to the polls, and for the next five years Crete was governed absolutely by a succession of Mahommedan Valis. The situation went from bad to worse, the deficit in the budget increased, the gendarmery, which received no pay, became insubordinate, and crime multiplied. In 1894 the Porte, at the instance of the Powers, nominated a Christian, Karatheodory Pasha, to the governorship, and the Christians, mollified by the concession, agreed to take part in the Assembly which soon afterwards was convoked; no steps, however, were taken to remedy the financial situation, which became the immediate cause of the disorders that followed. The refusal of the Porte to refund considerable sums which had been illegally diverted from the Cretan treasury or even to sanction a loan to meet immediate requirements caused no little exasperation in the island, which was increased by the recall of Karatheodory (March 1895). Before that event an Epitropé, or "Committee of Reform," had appeared in the mountains—the harbinger of the prolonged struggle which ended in the emancipation of Crete. The Epitropé was at first nothing more than a handful of discontented politicians who had failed to find places in the administration, but some slight reverses which it succeeded in inflicting on the Turkish troops brought thousands of armed Christians to its side, and in April 1896 it found itself strong enough to invest the important garrison town of Vamos. The Moslem peasantry now flocked to the fortified towns and civil war began. Serious disturbances broke out at Canea on 24th May, and were only quelled by the arrival of foreign warships. The foreign consuls intervened in the hope of bringing about a peaceful settlement, but the Sultan resolved on the employment of force, and an expedition despatched to Vamos effected the relief of that town with a loss of 200 men. The advance of a Turkish detachment through the western districts, where other garrisons were besieged, was marked by pillage and devastation, and 5000 Christian peasants took refuge on the desolate promontory of Spada, where they suffered extreme privations. These events, which produced much excitement in Greece, quickened the energies of the Powers. An international blockade of the island was proposed by Austria but rejected by England. The ambassadors at Constantinople urged peaceful counsels on the Porte, and the Sultan, alarmed at this juncture by an Armenian outbreak, began to display a conciliatory disposition. The Pact of Halepa was restored, the troops were withdrawn from the interior, financial aid was promised to the island, a Christian Governor-General was appointed, the Assembly was summoned, and an Imperial Commissioner was despatched to negotiate an arrangement. The Christian leaders prepared a moderate scheme of reforms, based on the Halepa Pact, which, with a few exceptions, were approved by the Powers and eventually sanctioned by the Sultan. On 4th September 1896 the Assembly formally accepted the new Constitution and declared its gratitude to the Powers for their intervention. The Moslem leaders acquiesced in the arrangement, which the Powers undertook to guarantee, and, notwithstanding some symptoms of discontent at Candia, there was every reason to hope that the island was now entering upon a period of tranquillity. It soon became evident, however, that the Porte was endeavouring to obstruct the execution of the new reforms. Several months passed without any step being taken in this direction; difficulties were raised with regard to the composition of the international commissions charged with the reorganization of the gendarmery and judicial system; intrigues were set on foot against the Christian Governor-General; and the presence of a special Imperial Commissioner, who had no place under the constitution, proved so injurious to the restoration of tranquillity that the Powers demanded his immediate recall. The indignation of the Christians increased, a state of insecurity prevailed, and the Moslem peasants refused to return to their homes. A new factor now became apparent in Cretan politics. Since the outbreak in May 1896 the Greek Government had loyally co-operated with the Powers in their efforts for the pacification of the island, but towards the close of the year a secret society known as the Ethniké Hetæria began to arrogate to itself the direction of Greek foreign policy. The aim of the society was a war with Turkey with a view to the acquisition of Macedonia, and it found a ready instrument for its designs in the growing discontent of the Cretan Christians. Emissaries of the society now appeared in Crete, large consignments of arms were landed, and at the beginning of 1897 the island was practically in a state of insurrection. On 21st January the Greek fleet was mobilized. Affairs were brought to a climax by a series of conflicts which took place at Canea on 4th February; the Turkish troops fired on the Christians, a conflagration broke out in the town, and many thousands of Christians took refuge on the foreign warships in the bay. The Greek Government now despatched an ironclad and a cruiser to Canea, which were followed a few days later by a torpedo flotilla commanded by Prince George. The prince soon retired to Melos, but on the night of 14th February a Greek expeditionary force under Colonel Vassos landed at Kolymbari, near Canea, and its commander issued a proclamation announcing the occupation of the island in the name of King George. On the same day Georgi Pasha, the Christian Governor-General, took refuge on board a Russian ironclad, and, on the next, naval detachments from the warships of the Powers occupied Canea. This step paralysed the movements of Colonel Vassos, who after a few slight engagements with the Turks remained practically inactive in the interior. The insurgents, however, continued to threaten the town, and their position was bombarded by the international fleet (21st February). The intervention of Greece caused immense excitement among the Christian population, and terrible massacres of Moslem peasants took place in the eastern and western districts. The forces of the Powers shortly afterwards occupied Candia and the other maritime towns, while the international fleet blockaded the Cretan coast. These measures were followed by the presentation of collective notes to the Greek and Turkish Governments (2nd March) announcing the decision of the Powers that (1) Crete could in no case in present circumstances be annexed to Greece; (2) in view of the delays caused by Turkey in the application of the reforms Crete should now be endowed with an effective autonomous administration, intended to secure to it a separate government, under the suzerainty of the Sultan. Greece was at the same time summoned to remove its army and fleet from the island, while the Turkish troops

*Insurrection of 1896-97.*

*Greek intervention.*

*Decision of the Powers.*

were to be concentrated in the fortresses and eventually withdrawn. The Cabinet of Athens, however, declined to recall the expeditionary force, which remained in the interior till 9th May, when, after the Greek reverses in Thessaly and Epirus, an order was given for its return. Meantime Cretan autonomy had been proclaimed (20th March). After the departure of the Greek troops the Cretan leaders, who had hitherto demanded annexation to Greece, readily acquiesced in the decision of the Powers, and the insurgent Assembly, under its president Dr Sphakianakis, a man of good sense and moderation, co-operated with the international commanders in the maintenance of order. The pacification of the island, however, was delayed by the presence of the Turkish troops and the inability of the Powers to agree in the choice of a new Governor-General. The prospect of a final settlement was improved by the withdrawal of Germany and Austria, which had favoured Turkish pretensions, from the European concert (April 1898); the remaining Powers divided the island into four departments which they severally undertook to adminster. An attack made by the Moslems of Candia on the British garrison of that town, with the connivance of the Turkish authorities, brought home to the Powers the necessity of removing the Ottoman troops, and the last Turkish soldiers quitted the island on 14th November 1898. On the 26th of that month the nomination of Prince George of Greece as high commissioner of the Powers in Crete for a period of three years (renewed in 1901) was formally announced, and on 21st December the prince landed at Suda and made his public entry into Canea amid enthusiastic demonstrations. After his arrival complete tranquillity has prevailed in the island. On 27th April 1899 the new autonomous constitution was voted by a constituent assembly, and in the following June the local administration was handed over to Cretan officials by the international authorities.

Among the more recent works on Crete are:—RAULIN. *Description physique de l'Ile de Crète*, 3 vols. and Atlas, Paris, 1869.—STILLMAN. *The Cretan Insurrection of 1866–68*. New York, 1874.—EDWARDES. *Letters from Crete*. London, 1887.—STAVRAKIS. Στατιστικὴ τοῦ πληθυσμοῦ τῆς Κρήτης. Athens, 1890.—J. H. FREESE, *A Short Popular History of Crete*. London, 1897.—BICKFORD-SMITH. *Cretan Sketches*. London, 1897.—LAROCHE. *La Crète ancienne et moderne*. Paris, 1898.—VICTOR BERARD. *Les Affaires de Crète*. Paris, 1898. See also MRS WALKER. *Eastern Life and Scenery*. London, 1886; and *Old Tracks and New Landmarks*. London, 1897.—H. F. TOZER. *The Islands of the Ægean*. Oxford, 1890.—J. D. BOURCHIER, "The Stronghold of the Sphakiotes," *Fortnightly Review*, August 1890.—E. J. DILLON. "Crete and the Cretans," *Fortnightly Review*, May 1897.—Blue-books, 1888–1891, 1895–99. For the antiquities see SVORONOS. *Numismatique de la Crète ancienne* (with a portfolio of plates). Maçon, 1890.—A. J. EVANS. *Cretan Pictographs and Phœnician Script*. London, 1895.

(J. D. B.)

**Cretinism.** See PATHOLOGY (metabolic diseases).

**Creuse,** a department in the central plateau of France, watered by the Creuse.

Area, 2164 square miles, distributed among 25 cantons and 266 communes. The population decreased from 284,942 in 1886 to 259,138 in 1901; births in 1899, 5176, of which 321 illegitimate; deaths, 4624; marriages, 2040. There were in 1896, 594 schools, with 43,000 pupils, and five per cent. of the population was illiterate. None of the towns has a large population. The returns for 1896 gave the total area under cultivation at 1,093,210 acres, of which 674,310 acres were plough-land and 316,160 acres grass land. In 1899 the wheat crop returned a value of £258,000, or less than half that of rye, £562,000. Potatoes yielded a crop valued at £490,000, and the natural pastures and grass lands £814,000. Hemp, which is largely cultivated, gave a return of the total value (in harl and in seed) of £400,000. Chestnut is also an important culture. The live stock of 1899 included 228,250 cattle, 645,690 sheep, 120,540 pigs, and 14,620 goats. 195,000 metric tons of coal were mined in 1898, but metallurgy is in a backward state.

**Creusot, Le,** or **Creuzot,** a town and railway centre of France, department of Saône-et-Loire, in the arrondissement of Autun, 34 miles in direct line north-west of Macon. The importance of its coal and iron mines, and vast engineering works of every description, has very much increased. The total number of persons employed in the coal mines exceeds 10,000, and about 9000 are engaged in the metallurgical departments. A network of railways with a total length of about 37 miles connects all branches of the works, which now occupy about 1000 acres. The output of the coal-field (Creusot and Blanzy) amounted in 1899 to 1,647,594 tons. Special attention is paid to the welfare of the workers, and excellent schools have been established. Population (1881), 15,740; (1896), 19,713, (comm.) 31,589; (1901), 30,175.

**Crevillente,** a town of Spain in the province of Alicante. Population in 1897, 9846. It is built on rising ground, its flat-roofed houses standing picturesquely amidst rock, nopals, cactus, dwarf palms, and orange trees. In its neighbourhood are two sources not far from each other, the waters of which differ 25° Fahr. in temperature, and are used for irrigation. The rugged territory around produces wine, olives, wheat, spart grass, and famed melons. The local industries are manufactures of warse stuffs, spart carpets, oils, and flour. There are a mediæval castle, two fine churches, and a town hall.

**Crewe,** a municipal borough (incorporated 1877, enlarged 1892) in the Crewe parliamentary division of Cheshire, England, 158 miles north-north-west of London, on the main line of the London and North-Western Railway. It is a railway junction where lines converge from Manchester, North Wales and Holyhead, Liverpool, North Stafford, and Hereford. It is inhabited principally by persons in the employment of the London and North-Western Railway Company. Crewe is not only one of the busiest railway stations in the world, but is the locomotive metropolis of the London and North-Western Railway Company, who have centred here enormous workshops for the manufacture of the material and plant used in their railways. In 1901 the 4000th locomotive was turned out of the works. Recently the station has been extended, both north and south, and a series of subterranean ways extending many miles have been constructed to enable merchandise traffic to pass through without interfering with passenger trains on the surface railways. The Railway Company have erected one of the finest electric stations in the world, and electrical apparatus for the working of train signals has been brought into operation. The station is fitted with an extensive suite of offices for the interchange of postal traffic, the chief mails to and from Ireland and Scotland being stopped here and arranged for various distributing centres. Its enormous railway facilities and its geographical situation as the junction of the great trunk lines running north and south, tapping also the Staffordshire potteries on the one side and the great mineral districts of Wales on the other, constitute it one of the most important links of railway and postal communication in the kingdom. The town owes its growth and importance to the London and North-Western Railway Company, who built its principal schools, provided it with a mechanics' institute, containing library, science and art classes, reading rooms, assembly rooms, &c., and also with baths. Victoria Park, also the gift of the Company, was opened in 1888. There are five Established churches, a Roman Catholic church, and many Nonconformist chapels. Two cattle-markets and a theatre have been erected. The corporation have just completed a technical institute and school of art. The area of the borough is 2193 acres. Population (1881), 24,385; (1891), 28,671; (1891) (on the area as afterwards extended), 32,783; (1901), 42,075.

# CRICKET.

THE era of the modern development of cricket may be definitely dated from the visit of the first Australian team to England in 1878. The previous twenty years had been devoted to the gradual improvement of the game throughout the country. But whilst the value of the work of the touring organizations had been enormous, interest in their encounters with local twenty-twos had steadily abated. The splendid prowess of the family of Grace set a new standard of ability, and the real value of county cricket began to be appreciated after the enactment that no cricketer could play for two counties in the same season. Many had previously played indiscriminately either for that of birth or residence, whilst one player, Southerton, represented four counties in the same season.

The development and modification of modern cricket have considerably altered the game. The improvement in the ground has caused the abolition of long-stop, once the most important place in the field, that position not having been filled in first-class cricket since 1877. Over-arm action in bowling is now universal, though occasionally lobs judiciously pitched and supported by unusually brilliant fielding have proved effective. The tendency of the modern attack is to bowl for catches rather than on the wicket; consequently the positions of the field have been much altered, three slips being quite common, and four having been at times required by very fast bowlers. Cover-point, whilst still an important post, is no longer so brilliant a situation as in the days when the Rev. V. K. Royle became famous; and leg hitting has so entirely departed—the last great exponent having been William Oscroft—that for some bowlers not a single man is placed on the on-side. At the same time the conviction must grow upon every careful observer that, whilst the increased precision of modern batting continually augments the disadvantages under which the bowler labours, this is not only due to the admirable condition of the turf, but also to a deterioration in fielding. Whether first-class cricketers participate in more matches than they are physically capable of playing at the top of their skill in all departments, or whether this additional handicap to the bowler is due to lack of unison between members of a side, the fact remains that the evil of giant scoring can be best remedied by improvement in fielding, which is largely a matter of personal effort, and without which the multiplication of matches is spoiling the perfection of the game.

The accessories of cricket are now very different from those in former days. Large pavilions with admirable accommodation for refreshment and dressing have replaced the old tents or "booths," whilst the general public now finds spacious covered stands and thousands of free seats on every county ground. The improved telegraph boards, giving the runs as scored and the numbers opposite the names of both batsmen and bowlers on the printed card, are even now inferior to those employed in Australia, where the entire score and bowling analysis is often displayed. The increasing amount of space devoted to the game in every daily paper, and the publication of the averages weekly during the season, indicate the enormous attention given by the press to the game, whilst signed articles by the most noted amateurs have become prominent in many popular journals, and the latest scores are a feature of each edition of the evening papers. The legislative power over the game is still vested in the Committee of Marylebone Cricket Club, consisting of sixteen members, four retiring annually. Their places are filled by general vote at the annual meeting of the club, when all the suggestions for legislation have to be ratified by a majority of those present. The new president of the club is annually nominated by the outgoing president at the dinner held on the same evening; but as this is badly patronized, it is now usual to mention the successor when responding to the customary vote of thanks at the meeting.

The line of demarcation between the professional and the *pseudo-amateur* has often given rise to much bitterness. It is of course the rule that any amateur, who desires it, may receive the money for which he is out of pocket in hotel and travelling expenses. But it has been asserted that a number of prominent amateurs derived large incomes under the guise of expenses. Until Dr W. G. Grace retired from Gloucestershire to take the direction of the London County Cricket Club at the Crystal Palace for five years at a salary of a thousand a year, the question of his expenses was continually cropping up. Lord Alverstone as chairman of the Surrey County Cricket Club, also stated, on the retirement of Mr. W. W. Read, that his case had been peculiar and would never become a precedent. Prowess at cricket has undoubtedly helped amateurs to get comfortable billets not only as schoolmasters, but in breweries, offices, and on the executive of county cricket clubs.

***Pay.***

A professional in first-class cricket obtains five pounds for each county match he plays, and his hotel bill and third-class railway fares in out-matches. It is the custom of many committees to give a sovereign to every professional who scores fifty runs, and money to those who perform the hat trick (*i.e.*, take three wickets with consecutive balls) or make a "century." Yorkshire, however, leaves the donation of "talent money" to the captain, whilst the M.C.C. give a bat to every amateur or professional who scores a century for them. Professionals have always received ten pounds when playing for Players *v.* Gentlemen at Lords, and a like sum was invariably paid in "test matches" (*i.e.*, between representative elevens of England and Australia) up to August 1896, when the five professionals selected demanded twenty pounds for their services. The affair created a great sensation, and eventually three of the five, having withdrawn their request, were included on the side. In all the test matches of 1899 twenty pounds was given to each professional employed. Every county professional of proved ability has the prospect of a benefit towards the end of his career, and the proceeds of the Whit Monday match at Lord's is annually devoted to the recompense of one of the professionals on the ground staff of the Marylebone Cricket Club. In December 1899, on Lord Hawke's instigation, it was resolved at a meeting of the county secretaries that "the counties should reserve direct control over the investment and disposal of all cricket moneys." The largest amounts have been recorded at Peel's benefit at Sheffield and Mold's at Manchester, when the subscription lists and the gate money in each case exceeded £2500. Many counties now give winter pay to their professionals at about fifty shillings a week, Yorkshire having been the first to set the example. Professionals in advanced years also derive benefit from the Cricketers' Fund, and obtain billets as coaches and groundmen. Umpires receive a pound a day, and each gets a cricket ball as a perquisite. The list of county umpires was first submitted by the counties to the Committee of M.C.C. in December 1882 to prevent any one standing when his own county was playing. Latterly the county captains have selected twenty umpires to act in the county matches of the following year.

The present rules differ in many respects from those in use in the middle of the last century. The trend of cricket legislation has been in three directions: (1) to put county qualification on a more equitable basis; (2) to enforce fair bowling; and (3) to increase the chances of bringing matches definitely to a conclusion.

*Laws.*

(1) The question of county qualification has been a matter of constant friction. The importations of Mr J. J. Ferris to Gloucestershire, and of Albert Trott and Roche to Middlesex, are examples of men qualifying from Australia. Mr F. R. Spofforth, of New South Wales, has played for Derbyshire, for which county the West Indian Mr C. A. Olivierre has qualified, whilst Mr G. C. B. Llewellyn and Mr C. O. H. Sewell, of the Cape, have played respectively for Hants and Gloucestershire. Some wealthy counties practically purchased skilled professionals born outside their boundaries, and county teams have been seen in which only two members on the side were actually qualified by birth. The rules had, however, stood unchanged since 1873, except for the addition in 1888 that a man can play for his old county during the two years that he is qualifying for another, until the new code came into operation in 1900. (2) Unfair bowling has been prevented so far as possible, but the umpires have often failed to agree in penalizing bowlers who were widely accused of throwing. The chief discussion arose over the delivery of Crossland, and after Lord Harris had openly made himself the spokesman of the malcontents an unfortunate difference arose between Notts and Lancashire. Just as the question of Crossland's action threatened to cause a serious schism, it was discovered that he had lost his residential qualification, so the matter terminated through a side issue, and Crossland was never no-balled by any umpire. There are six prominent instances of no-balling for throwing in first-class matches, the most sensational being those of Mr E. Jones in Australia, Mr C. B. Fry, Mold, and Tyler, the umpire in each case being James Phillips; in the two last-named cases even when the bowler was not at his end and he was standing at square-leg. Hopkins of Warwickshire was no-balled by Titchmarsh in 1898, and Captain Bradford of Hampshire by three umpires in 1899. The delivery of several great bowlers has been impeached, and Mr F. R. Spofforth in a letter to a sporting paper in January 1897 stigmatized both Mr T. R. M'Kibbin and Peel. The action of Mr M. A. Noble in the Australian team of 1899, of Mr W. C. Hedley, Mr W. F. Forbes, and Watson, all aroused marked difference of opinion. (3) The alteration of the follow-on rule and the legislation of the right of declaring an innings closed were made in consequence of two remarkable exhibitions in the university matches of 1893 and 1895, whilst in other cases batsmen had obviously knocked down their wickets. The result in minor matches has not been conducive to the popularity of the game, for instances have often been given of cricketers not getting an innings in several successive games; but in first-class fixtures Dr W. G. Grace is the only captain who has yet applied the closure and lost the game. The enormously increasing percentage of drawn games, now annually over 63 per cent., is attributed to the excellence of cricket pitches; and suggestions for heightening and broadening the wicket, reducing the size of the bat, deciding unfinished fixtures on the first innings, and giving the losers of the toss the option to bat first in the return match, have been widely discussed and thus far negatived. The Committee of M.C.C., in May 1900, tried the experiment of the abolition of boundaries by the erection of a netting round the ground. Several alterations were effected in the complicated system of scoring thus introduced, but the entire attempt was pronounced a complete failure and soon abandoned. The law of leg-before-wicket has also been much discussed, owing to the general objection to the growing habit of deliberately putting the body or legs in front of a breaking ball instead of playing it with the bat. To Gunn and Shrewsbury belongs the reputation of first regularly practising and perfecting a form of legitimate cricket absolutely at variance with the spirit of the game, and their example has been widely followed, to the detriment of the attractiveness of batting. In 1884 Lord Harris proposed that the side losing the toss in the first match should have the option of choice of innings in the return engagement; but this was never tried. In the previous year he had commented on the prevalence of illegal-sized bats, and in 1884 nearly all the prominent cricketers appeared with bats which had been shaven down to the proper width.

Lord Harris, 7th December 1886, proposed the establishment of a cricket council, which was organized 12th June 1887, a date practically coinciding with the centenary of the M.C.C. It was expressly stated that the new body should have no power over the laws of the game, but be competent to amend the rules of county cricket qualification, whilst at the meeting in December 1887 a discussion was raised on the leg-before-wicket question and on the reduction of scoring. In December 1889 Lord Cobham became chairman, on the appointment of Lord Harris to be governor of Bombay. On 11th August 1890, at the Oval, with Mr J. Shuter in the chair, the council received the report of the committee appointed to draw up a classification of counties. The scheme advocated that the shires should be divided into three sections, with the suggestion that the lowest county in the first and the highest in the second should, in the following season, play home-and-home matches, the winner to be qualified for inclusion in the premier body. On 25th October the representatives of the second-class counties held a meeting protesting against the proposed new legislation, Dr Russell Bencraft being in the chair. At the meeting of the cricket council on 8th December 1890, with Mr M. J. Ellison presiding, on the motion that the whole question of classification be discussed, Mr A. J. Webbe proposed as an amendment that the meeting be suspended *sine die*, which was carried by the chairman's casting vote, thus putting an abrupt and unexpected termination to the existence of this abortive assembly.

*Cricket council.*

The classification of counties was introduced by Mr Ellison at the meeting of the county secretaries December 1893, for the express purpose "of doing away with that very invidious distinction which had existed for some years and abolishing that hated word 'championship,' which the whole cricket world would be glad to get rid of." This opinion was proved to be erroneous. A special meeting was called for 1st May 1894, when an amendment was carried requesting the Committee of M.C.C. to consider and advise on the whole subject. The captains of the then first-class counties—Lord Hawke (Yorkshire), Dr W. G. Grace (Gloucestershire), Messrs J. Shuter (Surrey), S. M. J. Woods (Somersetshire), J. A. Dixon (Notts), F. Marchant (Kent), A. J. Webbe (Middlesex), W. L. Murdoch (Sussex), and A. N. Hornby (Lancashire)—sent in a resolution that the fixtures of Derbyshire, Essex, Leicestershire, and Warwickshire be regarded as first-class. This was ratified by the Committee of the M.C.C., who also included Hampshire in the following year. The consolidation of county cricket has since caused the line of demarcation to be very marked, but Worcestershire was elevated in 1899. The earliest mention of a county championship had been in 1870. For a long time con-

*County championship.*

servative folk and many prominent cricketers vigorously opposed what was to a great extent a creation of the sporting press. Popular opinion could not, however, be withstood, and it became presently evident that the interest of the public was most keenly aroused over the championship, although the notion of a trophy in commemoration of the annual achievement was universally scouted. Finally the recognition of the county championship was forced upon the Committee of the M.C.C., who laid down the rule that "one point shall be reckoned for each win; one deducted for each loss. Unfinished games shall not be reckoned. The county which, during the season, shall have, *in finished matches*, obtained the greatest proportionate number of points shall be reckoned the champion county." The old way, prior to this enactment, had been simply to regard the county which lost fewest matches as champions, taking no account of proportion. The actual result has been to concentrate not only popular attention but the best efforts of the foremost cricketers on county fixtures. Therefore, the interest in the first-class fixtures of the M.C.C. as well as other scratch teams has enormously diminished. Indeed, so important had county cricket become that it was thought necessary at the meeting of the secretaries in December 1895 to propose a motion pledging the first-class counties to give up any players required to represent England in the test matches.

The list of champion counties is :—

| | | Played. | Won. | Lost. | Drawn. |
|---|---|---|---|---|---|
| 1873 | Notts | 7 | 5 | 1 | 1 |
| | Gloucestershire | 6 | 4 | 0 | 2 |
| 1874 | Derbyshire | 4 | 3 | 0 | 1 |
| 1875 | Notts | 10 | 6 | 1 | 3 |
| 1876 | Gloucestershire | 8 | 5 | 0 | 3 |
| 1877 | Gloucestershire | 8 | 7 | 0 | 1 |
| 1878 | Middlesex | 6 | 3 | 0 | 3 |
| 1879 | Notts | 12 | 5 | 1 | 6 |
| | Lancashire | 10 | 5 | 1 | 4 |
| 1880 | Notts | 10 | 6 | 1 | 3 |
| 1881 | Notts | 13 | 10 | 0 | 3 |
| 1882 | Notts | 12 | 8 | 1 | 3 |
| | Lancashire | 14 | 10 | 1 | 3 |
| 1883 | Notts | 12 | 4 | 1 | 7 |
| 1884 | Notts | 10 | 9 | 0 | 1 |
| 1885 | Notts | 12 | 6 | 1 | 5 |
| 1886 | Notts | 14 | 7 | 0 | 7 |
| 1887 | Surrey | 16 | 12 | 2 | 2 |
| 1888 | Surrey | 14 | 12 | 1 | 1 |
| 1889 | Surrey | 14 | 10 | 3 | 1 |
| | Lancashire | 14 | 10 | 3 | 1 |
| | Notts | 14 | 9 | 2 | 3 |
| 1890 | Surrey | 14 | 9 | 3 | 2 |
| 1891 | Surrey | 16 | 12 | 2 | 2 |
| 1892 | Surrey | 16 | 13 | 2 | 1 |
| 1893 | Yorkshire | 16 | 12 | 3 | 1 |
| 1894 | Surrey | 16 | 13 | 2 | A tie |
| 1895 | Surrey | 26 | 17 | 4 | 5 |
| 1896 | Yorkshire | 26 | 16 | 3 | 7 |
| 1897 | Lancashire | 26 | 16 | 3 | 7 |
| 1898 | Yorkshire | 26 | 16 | 3 | 7 |
| 1899 | Surrey | 26 | 10 | 2 | 14 |
| 1900 | Yorkshire | 28 | 16 | 0 | 12 |
| 1901 | Yorkshire | 27 | 20 | 1 | 6 |

***County cricket.***

We now come to the performance of the counties. Notts has a great record. Daft and Oscroft with the bat, and Shaw and Morley, perhaps unrivalled as a pair of bowlers, left traditions well supported by Gunn and Shrewsbury, two exceptionally able batsmen. With them was associated Scotton, most patient of "stonewallers," whilst Barnes, Flowers, and Attewell did splendid service (the last-named being a remarkably steady bowler, keeping a good length, which gave him an abnormal number of "maidens"), and Sherwin was an excellent successor to Plumb and Wild at the wicket. Latterly Mr J. A. Dixon, for many years a vigilant captain, has seen a considerable decline in the fortunes of the county, the slow play of the home side alienating popular support at Trent Bridge until the advent of a dashing batsman in Mr A. O. Jones. With Shrewsbury, the latter scored 391 *v.* Gloucestershire in 1899, that being a "record" for first wicket. From 1873 to 1902 Notts won 155 matches, lost 90, and drew 109.

Gloucestershire, founded in 1871, and so long known as the county of the Graces, at the outset played an entirely amateur team. Apart from the prowess of the three famous brothers—E. M., W. G., and G. F. Grace—many fine cricketers have appeared on the side, such as in the earlier days Messrs F. Townsend, W. R. Gilbert, and J. A. Bush, a notable stumper; in the middle period, Midwinter, Mr J. Cranston, Mr O. G. Radcliffe, and Woof; more recently the colonial importations, Messrs J. J. Ferris and C. O. H. Sewell, and latterly that tremendous "slogger," Mr G. L. Jessop, and Mr C. L. Townsend, a remarkable left-handed batsman. From 1871 to 1902 Gloucestershire won 115 matches, lost 164, and drew 114. This county can boast the only cricketers who have scored 2000 runs and taken 100 wickets in the same season, namely, Dr W. G. Grace (1873), Mr C. L. Townsend (1899), and Mr G. L. Jessop (1900).

Lancashire, founded in 1864, has been directed by one of the hardest of hitters and best of captains, Mr A. N. Hornby. With his name will always be associated that of the patient Barlow. The bowling of Crossland, Nash, and Watson aroused discussion and evoked legislation on the nature of a fair delivery. The four brothers Steel did noble service when able to play, Mr A. G. Steel especially uniting marvellous skill with consummate theoretical knowledge. Briggs proved a clever left-handed bat, who gradually became one of the principal bowlers in England. Sugg, who migrated from Yorkshire and Derbyshire, was a very aggressive bat, and Pilling was the finest English wicket-keeper. A great professional bat of the defensive type is Albert Ward, and the present captain is the famous Harrovian, Mr A. C. MacLaren, who played in such magnificent form as to be chosen to occupy that post for England in the four last test matches with the Australians in 1899. He made the highest individual score in a first-class match, 424 against Somerset at Taunton in 1895. The success of Mold as a fast bowler, the excellent cricket of Cuttell, and the batting of Baker and Tyldesley, have alike proved invaluable. From 1873 to 1902 Lancashire won 228 matches, lost 106, and drew 105.

Yorkshire, whose county club was founded in 1861, was at one time a team of professionals, but of late years Lord Hawke has been the captain. Its team, always good, has played the best and most attractive cricket, culminating in the highest honours in 1900, when the side went through a programme of twenty-eight fixtures without sustaining a reverse. In the earlier period Ulyett, Hall, and Lockwood were the most notable bats, Bates and Emmett valuable all-round men, with Freeman and Hill as straight fast bowlers. As wicket-keeper, Pinder was succeeded in turn by the capable brothers Hunter. In recent cricket Brown and Tunnicliffe have become famous for their partnerships. In 1898 *v.* Derbyshire, at Chesterfield, their stand of 554 runs is a world record, whilst *v.* Surrey in 1897 they scored 328 for the first wicket. Tunnicliffe has also caught out more batsmen than any other fieldsman. Hirst and Wainwright have been efficient all-round men, of value to any side; Haigh is an excellent fast bowler, and Mr Ernest Smith a useful bat. Wilfrid Rhodes has also made a great name with the ball very early in his career, and in 1900, in county matches alone, he took 206 wickets for 12 runs apiece. The admirable all-round cricket of Mr F. S. Jackson has been of immense value, and Denton has done creditable work both with the bat and in the field. In earlier times Mr Sellars, Lee, and Preston were all successful, and Edmund Peate in his prime was never surpassed as a bowler. The county record to 1902 was 257 victories against 114 defeats and 131 draws.

Middlesex was founded in 1868 on the initiative of the renowned family of the Walkers, seven brothers, the record of whose prowess has been latterly written by Mr W. A. Bettesworth. The county team was subsequently controlled by Mr A. J. Webbe, a notable old Oxonian. Pre-eminent in a team relying much on amateur talent was Mr A. E. Stoddart, one of the grandest bats of any period and a shrewd judge of the game, whose retirement from county matches was universally lamented. Sir Timothy O'Brien in his prime was also very sound, and his performance with Mr G. F. Vernon against Yorkshire in 1895 will live in the annals of the game. The triumvirate of Studds—Messrs J. E. K., G. B., and C. T.—did fine work in the 'eighties, and a number of other university cricketers have assisted the metropolitan county: Messrs J. G. Walker, P. F. Warner, M. R. Jardine, E. A. Nepean, E. H. Buckland, F. J. N. Thesiger, B. J. T. Bosanquet, F. H. E. Cunliffe, F. G. J. Ford, W. J. Ford, A. F. J. Ford, J. Douglas, E. Lyttelton, R. N. Douglas, C. M. Wells, P. J. de Paravicini, P. J. T. Henery, C. I. Thornton, W. H. Hadow, and A. W. Ridley, may all be cited. Nor must the work of Messrs T. S. Pearson, S. W. Scott, E. M. Hadow, and J. Robertson be forgotten, and the lengthy services of Mr A. J. Webbe will be memorable in county annals. After the retirement of Mr Alfred Lyttelton, no stumper of ability could be found until the appearance of Mr Gregor MacGregor, the finest amateur wicket-keeper and a good captain. The attack—led by J. T. Hearne, most willing of good-length bowlers, and the spirited Australian, A. E. Trott, with such useful changes as Rawlin and Roche—is formidable. Trott both in 1899 and 1900 performed the hitherto unprecedented feat of scoring over

1000 runs and taking 200 wickets. From 1873 to 1902 Middlesex won 131 matches, losing 117, with 96 unfinished.

Surrey, one of the oldest counties, passed through vicissitudes when Jupp, Pooley, Southerton, and Humphrey grew old. Under the energetic direction of Mr J. Shuter they again came to the front, and for several years the excitement over the Bank Holiday match with Notts was intense, 63,763 people witnessing the game in 1892. So remarkable a cricketer as George Lohmann would alone have made a side famous, and he received admirable support from Beaumont and Bowley. In those days Mr W. W. Read was performing marvels with the bat, and Abel showed extraordinary ability, being the finest cricketer of his inches in the world. His biggest score was 357 not out *v.* Somerset in 1899. Maurice Read, a dashing hitter, Mr W. E. Roller, and the late Mr M. P. Bowden also did yeoman service. Mr K. J. Key then became captain; and Brockwell, a valuable and hard-working all-round player, sprang into prominence. With Abel he scored 379 *v.* Hants, 1897, the largest of many notable stands. Sharpe had a brief and sensational success with the ball, and Lockwood became almost as deadly as Lohmann. Yet more famous has been Tom Richardson, who from 1893 to 1898 was absolutely a terror to all Surrey's opponents, taking 1340 wickets for 20,000 runs. Hayward, nephew of the famous Cambridgeshire professional, gained fame as a wonderfully judicious bat; and his superb play in the test matches of 1899, when he averaged 65, may be considered the highest standard attained by any salaried cricketer. Mr D. L. A. Jephson, advancing on his university reputation, developed dogged defence combined with great punishing power, and became the only modern lob bowler of calibre. Surrey up to 1902 had won 212 victories against 138 defeats and 109 drawn games.

Sussex has always been hampered by lack of effective bowling and by the run-getting capability of the county ground at Brighton. In the 'eighties the performances were of the feeblest, but better days came when the Australian, Mr W. L. Murdoch, qualified. Of more value was the inclusion of Kumar Shri Ranjitsinhji, the Indian cricketer, whose dexterity and grace as a batsman have never been surpassed. He actually scored 2780 runs in 1896, averaging 57, while in county matches in 1899 he amassed 2555, averaging 75, and in 1900 his average of 83 was obtained for an aggregate of 2563 runs. Mr C. B. Fry is a brilliant bat; Mr P. H. Latham has scored largely; and Mr W. Newham, with Mr G. Brann, bore the brunt of the batting for fifteen years. The bowling, in spite of the brothers Hide, has always been weak, though the lobs of Walter Humphreys were sometimes puzzling, and Alfred Shaw emerged successfully from his retirement in 1894. Sussex from 1873 to 1902 could claim only 80 victories against 195 defeats, with 104 undecided fixtures.

Kent (the modern county club, dating from 1870) has varied considerably, and has played more cricketers in its team in the past twenty-five years than any other county. The incalculable value of Lord Harris as batsman and captain was terminated by his appointment as governor of Madras. In the earlier period Messrs Frank Penn and Ivo Bligh were the greatest batters, with Mr E. F. S. Tylecote as wicket-keeper. Then came Mr W. H. Patterson, a remarkably sound bat, and Rev. W. Rashleigh, with Mr M. C. Kemp behind the stumps, Mr Stanley Christopherson as bowler, and that hard hitter Mr F. Marchant. In 1898 the latter handed over the reins of office to the Wykehamist, Mr J. R. Mason, an admirable all-round cricketer, who has been assisted by the fast bowler Mr W. M. Bradley and by Mr C. J. Burnup, an obstinate bat difficult to dislodge. The family of the Hearnes have done admirable service for Kent, and the bowling of Martin and Wright has proved effective, whilst Blythe is useful with left-handed deliveries. From 1873 to 1902 Kent won 119 matches, lost 165, and drew 95.

Derbyshire, founded in 1870, fared so poorly after the decline of their two fast bowlers, Hay and Mycroft, that conspicuous failures in 1886 and 1887 caused the county to be dropped from first-class fixtures until 1895. The re-inclusion was due to the excellent all-round play of Davidson, the steady batting of Chatterton, and the fine cricket of Storer, a great wicket-keeper, who could bat and on occasion bowl. Hulme bowled well when health permitted. The achievements of the county, whilst reckoned first-class, up to 1902 were only 36 successes against 123 defeats, with 53 unfinished fixtures.

Somersetshire only came into the first rank in 1891, and has since played an attractive though not always a successful game. The retirement of the captain, Mr H. T. Hewett, a brilliant left-handed hitter, was an incalculable loss, though his successor, Mr S. M. J. Woods, has worked with untiring courage and ability. Mr L. C. H. Palairet, the best bat in the county, with Mr H. T. Hewett, scored 346 in partnership *v.* Yorkshire 1892. Messrs R. C. N. Palairet, V. T. Hill, and W. N. Roe, have been valued batsmen, Rev. A. P. Wickham and Mr A. E. Newton excellent stumpers, and Tyler a successful slow bowler. Up to 1902, 36 victories were scored against 89 defeats, with 39 unconcluded games.

Essex, a comparatively new county, owes its elevation in 1895 originally to the exertions of Mr C. E. Green. The eleven possesses a quartette of bowlers with notably diversified styles: Messrs C. J. Kortright, F. G. Bull, Mead, and Young. The batting of Messrs P. Perrin, C. M'Gahey, and A. J. Turner, with Carpenter, has been wonderfully good. No small part of the success is due to the presence of that fine player, Mr A. P. Lucas, who took part in the first test match in 1880, and twenty years later still averaged over 27. To 1902 the county had 41 gains to 36 losses and 50 undecided fixtures.

Warwickshire has played steady but unattractive cricket. Mr H. W. Bainbridge has proved valuable as captain and bat, the brothers Quaife have scored heavily though slowly, Diver has often made long innings, and Lilley has been pre-eminently the modern English wicket-keeper. The achievement from 1895 to 1902 was 28 victories against 35 defeats and 62 draws.

Leicestershire has been least successful of all. Apart from Pougher, Mr C. E. de Trafford has had no player of rank under his captaincy, though Woodcock is a straight fast bowler. From 1895 to 1902 only 16 wins, 67 losses, and 36 draws make a poor chronicle, and the batting collapses have been frequent.

Worcestershire, only promoted in 1899, owes its advance mainly to the capital cricket of the Foster family.

Largely relying on military assistance the form of Hampshire has been uncertain. The batting of Major Poore in 1899 has never been approached. In two months he scored 1399, with an average of 116. Grand batting capacity has also been displayed by Captain Wynyard. These two scored 411 *v.* Somerset in 1899 before they were separated. From 1895 to 1902, 24 wins, 62 losses, and 39 drawn games form the record of what is the oldest cricket county in England.

In December 1894 Mr P. H. Foley announced that the majority of the eighteen counties outside the important shires had agreed to the institution of a championship among the second-class counties. This met with complete success, though it was unfortunate at the outset that Cheshire, who had not lost a game in 1894, could not enter the competition. In 1895 Worcestershire was bracketed champion with Norfolk and Durham, though third according to the ruling of M.C.C. In 1896 Worcestershire came out easily first, with only one defeat inflicted by Northamptonshire, whilst in 1897 and 1898 they possessed an unbeaten record, which caused their elevation to the front rank. In 1899 Northamptonshire and Bucks obtained the highest percentage of points, though the record of Glamorganshire, who only lost one game to the Surrey Second Eleven, was infinitely superior. In 1900 Glamorganshire and Northamptonshire alike came through their list of fixtures without sustaining any defeat. It must be pointed out that the level of play in minor county cricket is of a standard distinctly lower than that of even the less successful first-class counties. In 1899 and 1900 the following minor counties played eight games apiece:—Northamptonshire (Mr T. Horton, captain), Bucks (Mr P. J. de Paravicini), Glamorganshire (Mr J. H. Brain), Norfolk (Mr L. C. V. Bathurst), Hertfordshire, Durham (Mr J. F. Whitwell), Northumberland (Mr F. G. Clayton), Wiltshire (Mr A. M. Miller), Berkshire (Mr A. C. M. Croome), and Cambridgeshire. Oxfordshire (Mr C. C. Bradford), Bedfordshire (Mr L. C. R. Thring), Devonshire, Cornwall, Monmouthshire, Rutlandshire, Cumberland, and Lincolnshire have also put elevens of varying ability in the field within the last few seasons. The popularity of cricket does not seem to progress much in either Scotland or Ireland, though the Dublin University crack, Mr Lucius Gwynne, twice played for Gentlemen *v.* Players, and proved himself a steady left-handed bat.

***Non-county cricket.***

The Marylebone Cricket Club has always remained the dominating authority on the game. Apart from its legislative powers, it has played an unparalleled number of matches. Between 1878 and 1899 no less than 3151 fixtures have taken place, of which the premier club won 1730, losing 607, with two ties and the remainder drawn. First-class fixtures between 1878 and 1902 numbered 289, of which 135 were successful, 105 ended in defeat, and 50 were unfinished. With increased interest in county fixtures, the engagements of M.C.C. with counties have latterly deteriorated into trial matches for promising colts, the best amateurs of the county often declining to encounter the weak and unsatisfactory elevens put into the field by the club even at headquarters. As an example of the increase in county fixtures, it may be mentioned that the match-list for the following season was first published in Lillywhite's *Annual* for 1882, and occupied two pages, whilst in the issue for 1899 the forthcoming matches filled nine pages. Mr Henry Perkins, as secretary to M.C.C., was in 1898 succeeded by Mr F. E. Lacey, who used to play for Hants, and represented Cambridge in 1882. The M.C.C. celebrated its centenary in 1887 by a banquet at which the president for the year, Mr E. Chandos Leigh, took the chair, the matches for the commemorative week being England *v.* M.C.C., and Ground and Gentlemen of M.C.C. *v.* Eighteen Veterans. In 1895 I Zingari celebrated their jubilee by playing the Gentlemen of England at Lord's. The historic wandering club is still paramount at the Canterbury Week, though county fixtures are now

the rule. Scarborough and Hastings also have important cricket festivals at the conclusion of each season.

The University match yearly sustains its importance and interest. Up to 1901, 66 matches had been played, of which Cambridge have won 32, Oxford 30, and 5 have been left drawn; 503 by Oxford in 1900, 388 by Cambridge in 1872 and 1892, and 365 by Oxford in 1892 are the highest totals. Mr R. E. Foster's 171 in 1900, Mr K. J. Key's 143 in 1886, and Mr M. R. Jardine's 140 in 1892, are the largest individual scores, whilst Mr K. J. Key and Mr C. E. M. Wilson have the best batting averages for the match. Eton has played Harrow 75 times, losing 32 and winning 28. The chief scores are Mr E. Bayley's 152 in 1841, and Mr T. G. O. Cole's 142 in 1897, the highest total being Harrow's 388 in 1900. Cricket is enthusiastically played at all the public schools.

Gentlemen *v.* Players at Lord's always forms the crowning tussle of the year. In addition to the companion but less representative fixture at the Oval, matches under this title have been played at Prince's, Scarborough, Brighton, and Hastings. Dr W. G. Grace has made fifteen three-figure innings—217 at Brighton, 215 at Oval, 174 at Scarborough, 169 at Lord's—all these being at the time records in the match on the ground. At Hastings he has scored 131, and at Prince's 110; but Gunn scored 169 at Hastings, and G. F. Grace 134 at Prince's. Abel made 247 at the Oval, whilst Mr R. E. Foster made 102 not out, and 136 in the same match at Lord's, Barnes 130, Brown 163. Altogether there have been 144 encounters, of which the amateurs have secured 51, and the professionals 70 matches, 22 being unfinished and 1 resulting in a tie. In 14 of these the aggregate exceeded 1000; in 1899, 1258 was scored at the Oval for 30 wickets, and in 1900, 1274 for 38 wickets, the Players going in to make 508 on fourth hands and winning by 2 wickets. North *v.* South has lapsed from its former position of importance, and M.C.C. *v.* England and Over Thirty *v.* Under Thirty have been dropped. Gentlemen no longer play I Zingari at Scarborough, nor does East oppose West. Smokers *v.* Non-Smokers proved interesting at Lord's in 1884, Notts played England in 1886, Surrey opposed England in 1895 (the testimonial match to Mr W. W. Read), Surrey and Sussex confronted England in 1898 and 1900, and the Home Counties played the Rest of England in 1899. Lord Sheffield's team, Daft's team, and both Mr A. E. Stoddart's teams played the Rest of England on their return from Australian tours, the last two defeating formidable opponents.

The visits of the Australian teams to England have aroused unparalleled interest and acted as an immense incentive to the game. The greatest sensation was caused when the first team on 27th May 1878 defeated a powerful M.C.C. eleven in a single day, disposing of them for 33 and 19, Mr Spofforth taking 6 wickets for 4 runs, and Mr Boyle 5 for 3, whilst the Australians fielded superbly. Their prowess was well maintained when, in September 1880, Australia for the first time met the whole strength of England, for though the Old Country won by 5 wickets the honours were fairly divided, especially as Mr Spofforth could not play. Dr W. G. Grace with a magnificent score of 152 headed the total of 420, but even finer was Mr W. L. Murdoch's imperturbable display, when he carried his bat for a superb 153. From 1882 onwards the Colonials, with two exceptions, at Blackpool and Skegness, only played eleven-a-side matches. Such bowlers as Messrs Spofforth, Boyle, Palmer, Garrett, and Giffen became household names. Nor was the batting less admirable, for Mr Murdoch was supported by Messrs Massie, M'Donnell, Bannerman, Horan, Bonnor, and Jones, whilst the wicket-keeper was the unrivalled Mr M'Carthy Blackham. This visiting side in 1882 was the greatest team of all; 23 matches were won, only 4 lost, and England was defeated at the Oval by 7 runs. In 1884 English cricket had improved, and the visiting record was hardly so good. The stupendous match against England at the Oval will never be forgotten. The Colonials scored 551 (Mr Murdoch 211, Mr M'Donnell 103, Mr Scott 102), and England responded with 346, Scotton and Mr W. W. Read adding 151 for the ninth wicket. Mr Scott's team in 1886 proved less successful, for all three test matches were lost, and eight defeats had to be set against nine victories, but Giffen covered himself with distinction. This was the first tour under the auspices of the Melbourne Club. M'Donnell's team in 1888 was rendered remarkable by the appearance of Messrs Turner and Ferris. The former took 314 wickets for 11 runs each, and the latter 220 for 14 apiece. To all appearance they redeemed a poor tour, 19 matches being won and 14 lost. The 1890 tour, though Mr Murdoch reappeared, proved disappointing, both the test matches being lost and defeats for the first time exceeding victories, though the two bowlers again performed marvellously well. After an interval of three years, Mr Blackham captained the seventh team, which was moderately fortunate. Messrs Graham and Gregory batted admirably, and the magnificent 149 of Mr J. J. Lyons, *v.* M.C.C., electrified spectators, and was perhaps the finest display of punishing cricket ever recorded. In 1896, though they did not win the rubber of test matches, the Colonials were most successful, 19 matches being victories and only 6 lost. Messrs Gregory, Darling, Iredale, Giffen, Hill, and G. H. S. Trott were the best bats, and the last-named made an admirable skipper. Mr H. Trumble kept an excellent length, and whilst the wickets lasted Mr E. Jones was deadly. Finally, the Australian representatives in 1899 demonstrated that they were the best since 1882, 16 successes and only 3 defeats (*v.* Essex, Surrey, and Kent) being emphasized by a victory over England at Lord's by the handsome margin of 10 wickets, the only one of the five test matches brought to a conclusion. The steady batting proved untiring, Messrs Noble and Trumper, both new-comers, being superb. The latter, *v.* Sussex, made 300, the largest individual score ever made by an Australian in England, the previous best having been 286 by Mr Murdoch in the corresponding match in 1882. Mr H. Trumble scored 1183 runs and took 142 wickets for 18 runs apiece, and Mr Darling not only made a judicious captain, but scored the biggest aggregate, 1941, ever obtained by any batsman touring with a Colonial eleven in England. On the home side, Hayward did sound service as a batter, and his stand with Mr F. S. Jackson in the fifth test match yielded 185 runs for the first wicket. In England the ten Australian teams have played 320 eleven-a-side matches, winning 149, losing 74, and leaving 97 unfinished. Their highest innings was 843 *v.* Past and Present of Oxford and Cambridge at Portsmouth 1893, and the highest against them 576 for England at Oval 1899. Their lowest was 18, *v.* M.C.C. in 1896, when Pougher took 5 wickets in 15 balls for no runs, and the lowest against them 19 by M.C.C. in 1878. Of the 24 test matches England has won 12 and the Australians 8.

***Australian matches.***

The first team to visit Australia was organized in 1862. George Parr took out the next in 1864, Dr E. M. Grace being the only amateur. In 1873 the Melbourne Club invited Dr W. G. Grace to take out an eleven, and three years later James Lillywhite conducted a band of professionals. On this tour for the first time Colonials contended on equal terms, one match *v.* Australia being won by 4 wickets and the other lost by 45 runs. Lord Harris in the autumn of 1878 took a team of amateurs assisted by Ulyett and Emmett, winning 2 and losing 3 eleven-a-side encounters, Emmett's 137 wickets averaging 8 runs each. Shaw, Shrewsbury, and Lillywhite jointly organized the expedition of 1881, when Australia won the second test match by 5 wickets. Mr Ivo Bligh in 1882 took a fine team, which was crippled owing to the injury sustained by Morley that eventually proved fatal. Four victories could be set against three defeats; Australia winning the only test match, owing to the batting of Mr Blackham. Shaw's second tour in 1884 showed Barnes heading both batting and bowling averages, while six victories counterbalanced two defeats. In the third tour Shrewsbury became captain, but the English for the first time encountered the bowling of Mr C. T. B. Turner, who took 27 wickets for 113 runs in two matches. Australia was twice defeated, the English captain batting in fine form. On this tour was played the Smokers *v.* Non-Smokers, when the latter scored 803 for 9 wickets (Shrewsbury 236, Mr W. Bruce 131, Gunn 150), against the bowling of Briggs, Boyle, Lohmann, Mr Palmer, and Flowers. The winter of 1887 saw two English teams in Australia, one under Lord Hawke and Mr G. F. Vernon, the other under Shrewsbury and Lillywhite. Both teams played well, the batting being headed by Mr W. W. Read with an average of 65, and Shrewsbury with 58. The ill-success of Lord Sheffield's team in two out of three test matches did not disprove the great merits of his eleven. Dr W. G. Grace headed the averages with 44, and received the best support from Abel and Mr A. E. Stoddart, whilst Attewell, Briggs, and Lohmann all possessed fine bowling figures. Mr A. E. Stoddart's first team (in 1894) achieved immense success and was the best of all. In the first test match they went in against 586 runs and ultimately won by 10 runs, Ward making 75 and 117. Mr Stoddart himself averaged 51, scoring 173 in the second test match, and Mr A. C. MacLaren, who made 228 *v.* Victoria, Brown, and Ward all averaged over 40. The last tour conducted by Mr A. E. Stoddart proved less satisfactory, four of the five test matches being lost, and some friction being caused by various incidents. K. S. Ranjitsinhji, who averaged 60 and made 175 in a test match and 189 *v.* South Australia, and Mr A. C. MacLaren, who scored five hundreds and averaged 54, were prominent, Hayward also doing good work; but the bowling broke down badly. Altogether, in Australia, the English teams have played 87 eleven-a-side matches, winning 52 and losing 27. Of the 26 test matches, 12 have been won and 13 lost.

***Other foreign visits.***

With regard to cricket in other parts of the world, many pleasant tours have been organized. The Philadelphians visited England in 1884, 1889, and 1897, when they won 2 and lost 9 games. Messrs G. S. Patterson, F. H. Bohlen, J. A. Lester, J. B. King, and R. S. Newhall have been the best amateurs. Teams of Canadian Gentlemen came in 1880 and 1887, whilst Haverford College enjoyed an instructive tour in 1897. Parsees arrived in 1884 and 1888, and one member of the side, M. E. Pavri, once played for Middlesex. Gentlemen of Holland made a modest pilgrimage in 1894. The

Cape team of 1894 won 12 matches and lost 7, Mr C. O. H. Sewell, who subsequently played for Gloucestershire, heading the batting, and Mr Rowe proving an excellent bowler, who captured 136 wickets for 12 runs apiece. A representative side from the West Indies were comparatively unsuccessful in 1900, though two coloured bowlers, Woods and Mignon, had fair averages, and Mr Olivierre, who headed the batting, remained to qualify for Derbyshire. Many visits have been paid to the United States. Irish amateurs toured in 1878 and 1892; and English teams were taken by Mr E. J. Sanders in 1885 and 1886, Lord Hawke in 1891 and 1895, Mr F. Mitchell in 1896, Mr P. F. Warner in 1897 and 1898, and K. S. Ranjitsinhji in 1899. Mr R. S. Lucas took a team to the West Indies in 1896, and both Lord Hawke and Mr A. Priestley had elevens touring in the islands in 1898. Mr A. E. Stoddart scored 1079, with an average of 53, making six hundreds, and capturing 104 wickets for 7 runs each. Mr P. F. Warner scored 984, with an average of 51, making four centuries. In April 1898 an English eleven visited Oporto under Mr Westray. India was visited by Mr G. F. Vernon's team in 1889 and by Lord Hawke's in 1892. All the above were strictly amateur combinations. Four tours have been made in South Africa—under Mr C. A. Smith in 1888, Mr W. W. Read in 1891 (when Mr Ferris took 235 wickets for 5 runs each), under Lord Hawke in 1896 (when Lohmann captured 157 wickets for 6 runs apiece), and in 1899 (when Haigh took 107 for 8 runs, and Trott 168 for 9 runs each). A very large proportion of the engagements of all these sides resulted in English victories, and the lavish hospitality left the pleasantest memories.

*Records* other than those already cited may be added for reference:—A schoolboy named A. E. J. Collins, at Clifton College, 1899, excited some interest by scoring 628 not out in a boys' match, being about seven hours at the wicket. Mr A. E. Stoddart made 485 for Hampstead *v.* Stoics in 1886. Melbourne University scored 1094 against Essendon in March 1898, this being the highest authenticated total on record. M.C.C. and Ground made 735 *v.* Wiltshire in 1888, the highest total at Lord's. In the match between Mr A. E. Stoddart's team and New South Wales at Sydney 1898, 1739 runs were scored, an aggregate unparalleled in first-class cricket. The lowest total in a first-class match is 12 by Oxford University *v.* M.C.C. and Ground at Oxford in 1877. The record for first wicket is 472 by Messrs S. Colman and P. Coles at Eastbourne in 1892. The longest partnership is 623 by Captain Oates and Fitzgerald at the Curragh in 1895. The best stand for the last wicket in a first-class match is 230 by Mr R. W. Nicholls and Roche for Middlesex *v.* Kent at Lord's in 1899.

The best *averages* for both batting and bowling in different seasons are appended:—

BATTING.

| | | Inns. | Times not out. | Runs. | Most in an Inns. | Average. |
|---|---|---|---|---|---|---|
| 1878 | Dr W. G. Grace . | 40 | 2 | 1115 | 116 | 29·13 |
| ,, | Ulyett . . . | 49 | 3 | 1347 | 109 | 29·13 |
| 1879 | Dr W. G. Grace . | 28 | 3 | 880 | 123 | 35·5 |
| 1880 | Dr W. G. Grace . | 27 | 3 | 951 | 152 | 39·15 |
| 1881 | Mr A. N. Hornby | 37 | 0 | 1531 | 188 | 41·14 |
| 1882 | Mr C. T. Studd . | 43 | 5 | 1249 | 126 | 32·33 |
| ,, | Lord Harris . . | 24 | 0 | 987 | 176 | 32·19 |
| 1883 | Mr W. W. Read . | 39 | 6 | 1573 | 168 | 47·22 |
| ,, | Mr C. T. Studd . | 36 | 5 | 1193 | 175 | 41·4 |
| 1884 | Mr A. G. Steel . | 28 | 3 | 967 | 148 | 38·17 |
| ,, | Lord Harris . . | 47 | 5 | 1417 | 112 | 33·31 |
| 1885 | Mr W. W. Read . | 42 | 0 | 1880 | 163 | 44·32 |
| ,, | Shrewsbury . . | 24 | 4 | 1130 | 224 | 56·10 |
| 1886 | Mr W. W. Read . | 46 | 3 | 1825 | 120 | 42·19 |
| ,, | Shrewsbury . . | 38 | 5 | 1404 | 227 | 42·18 |
| 1887 | Shrewsbury . . | 23 | 2 | 1653 | 267 | 78·15 |
| ,, | Dr W. G. Grace . | 46 | 8 | 2062 | 183 | 54·10 |
| 1888 | Mr W. W. Read . | 41 | 2 | 1414 | 338 | 36·10 |
| ,, | Dr W. G. Grace . | 59 | 1 | 1886 | 215 | 32·30 |
| 1889 | Gunn . . . | 38 | 4 | 1299 | 118 | 38·7 |
| 1890 | Shrewsbury . . | 43 | 5 | 1568 | 267 | 41·26 |
| ,, | Gunn . . . | 53 | 6 | 1621 | 228 | 34·48 |
| 1891 | Shrewsbury . . | 25 | 3 | 1071 | 178 | 48·68 |
| 1892 | Shrewsbury . . | 34 | 4 | 1260 | 212 | 42 |
| 1893 | Gunn . . . | 51 | 3 | 2057 | 156 | 42·85 |
| ,, | Mr A. E. Stoddart | 50 | 1 | 2072 | 195 | 42·28 |
| 1894 | Brockwell . . | 45 | 6 | 1491 | 128 | 38·09 |
| 1895 | Dr W. G. Grace . | 48 | 2 | 2346 | 238 | 51 |
| ,, | A. C. MacLaren . | 24 | 0 | 1229 | 424 | 51·20 |
| 1896 | K. S. Ranjitsinhji | 55 | 7 | 2780 | 171 | 57·44 |
| 1897 | K. S. Ranjitsinhji | 48 | 5 | 1940 | 260 | 45·5 |
| ,, | Abel . . . | 50 | 3 | 2099 | 250 | 44·31 |
| 1898 | W. G. Quaife . | 28 | 8 | 1219 | 157 | 60·95 |
| ,, | Abel . . . | 45 | 3 | 2053 | 219 | 48·88 |
| ,, | Mr C. B. Fry . | 37 | 4 | 1788 | 179 | 54·18 |
| 1899 | Major R. M. Poore | 21 | 4 | 1551 | 304 | 91·23 |

BATTING—*Continued.*

| | | Inns. | Times not out. | Runs. | Most in an Inns. | Average. |
|---|---|---|---|---|---|---|
| 1899 | K. S. Ranjitsinhji | 58 | 8 | 3159 | 197 | 63·18 |
| ,, | Hayward . . | 49 | 4 | 2647 | 273 | 58·82 |
| ,, | Abel . . . | 53 | 3 | 2685 | 357 | 53·70 |
| 1900 | K. S. Ranjitsinhji | 40 | 5 | 3065 | 275 | 87·57 |
| ,, | Mr C. B. Fry . | 41 | 3 | 2325 | 229 | 61·18 |
| ,, | Abel . . . | 49 | 3 | 2592 | 221 | 56·34 |
| ,, | Hayward . . | 57 | 7 | 2693 | 193 | 53·86 |
| 1901 | Mr C. B. Fry . | 43 | 3 | 3147 | 244 | 78·67 |
| ,, | K. S. Ranjitsinhji | 40 | 5 | 2468 | 285 | 70·51 |

BOWLING.

| | | Overs. | Maidens. | Runs. | Wkts. | Average. |
|---|---|---|---|---|---|---|
| 1878 | Mr A. G. Steel . | 1223 | 447 | 1542 | 161 | 9·66 |
| 1879 | Shaw . . . | 1575 | 924 | 1259 | 134 | 9·53 |
| 1880 | Shaw . . . | 1994 | 1231 | 1525 | 177 | 8·109 |
| 1881 | Peate . . . | 1638 | 731 | 2088 | 162 | 12·144 |
| 1882 | Peate . . . | 1853 | 868 | 2466 | 214 | 11·112 |
| 1883 | Harrison . . | 786 | 328 | 1326 | 100 | 13·26 |
| 1884 | Emmett . . | 1031 | 557 | 1250 | 107 | 11·73 |
| 1885 | Lohmann . . | 1264 | 592 | 2030 | 142 | 14·42 |
| 1886 | Emmett . . | 1339 | 677 | 1675 | 132 | 12·91 |
| 1887 | Lohmann . . | 1634 | 737 | 2404 | 154 | 15·94 |
| 1888 | Lohmann . . | 1649 | 783 | 2280 | 209 | 10·190 |
| ,, | Briggs . . | 1450 | 763 | 1679 | 160 | 10·79 |
| ,, | Peel . . . | 1648 | 830 | 2091 | 171 | 12·39 |
| 1889 | Attewell . . | 1314 | 654 | 1555 | 140 | 11·15 |
| ,, | Briggs . . | 1040 | 447 | 1646 | 140 | 11·106 |
| ,, | Lohmann . . | 1614 | 646 | 2714 | 202 | 13·88 |
| 1890 | Briggs . . | 1113 | 456 | 1950 | 158 | 12·34 |
| ,, | Attewell . . | 1581 | 820 | 1874 | 151 | 12·41 |
| ,, | Lohmann . . | 1759 | 737 | 2998 | 220 | 13·62 |
| 1891 | J. T. Hearne . | 791 | 301 | 1449 | 129 | 11·23 |
| ,, | Lohmann . . | 1189 | 445 | 2065 | 177 | 11·66 |
| 1892 | Lockwood . . | 890 | 292 | 2052 | 151 | 13·58 |
| 1893 | Peel . . . | 1060 | 431 | 1622 | 121 | 14·23 |
| 1894 | Richardson . | 936 | 293 | 2024 | 196 | 10·64 |
| 1895 | Richardson . | 1690 | 463 | 4170 | 290 | 14·37 |
| 1896 | J. T. Hearne . | 2003 | 818 | 3670 | 257 | 14·72 |
| ,, | Richardson . | 1656 | 526 | 4015 | 246 | 16·79 |
| 1897 | Richardson . | 1603 | 495 | 3945 | 273 | 14·123 |
| 1898 | J. T. Hearne . | 1802 | 781 | 3120 | 222 | 14·05 |
| ,, | Rhodes . . | 1240 | 482 | 2249 | 154 | 14·61 |
| 1899 | A. E. Trott . | 1772 | 587 | 4080 | 239 | 17·09 |
| ,, | Rhodes . . | 1518 | 543 | 3062 | 179 | 17·10 |
| 1900 | Rhodes . . | 1553 | 455 | 3606 | 261 | 13·81 |
| ,, | Haigh . . | 958 | 269 | 2416 | 163 | 14·82 |

The following figures give a summary of some of the greatest performances with bat and ball during the entire career of each cricketer up to the conclusion of the season of 1901:—

BATTING.

| | Inns. | Times not out. | Runs. | Most in an Inns. | Average. |
|---|---|---|---|---|---|
| K. S. Ranjitsinhji . | 347 | 42 | 17,170 | 285 | 56·90 |
| C. B. Fry. . . | 307 | 14 | 12,932 | 244 | 44·40 |
| F. S. Jackson . . | 376 | 26 | 11,594 | 160 | 42 |
| Hayward . . . | 420 | 44 | 15,509 | 315 | 41·93 |
| Dr W. G. Grace . | 1362 | 98 | 51,406 | 344 | 40·846 |
| Abel . . . . | 848 | 60 | 29,358 | 357 | 37·202 |
| Shrewsbury . . | 752 | 81 | 24,569 | 267 | 36·413 |
| A. C. MacLaren . | 346 | 21 | 11,511 | 424 | 35·136 |
| Gunn . . . . | 761 | 64 | 23,347 | 273 | 33·346 |
| A. E. Stoddart . | 513 | 16 | 16,081 | 221 | 32·177 |
| W. W. Read . . | 739 | 53 | 22,919 | 328 | 32·167 |

BOWLING.

| | Overs. | Maidens. | Runs. | Wkts. | Average. |
|---|---|---|---|---|---|
| Shaw . . . . | 22,830 | 12,803 | 21,887 | 1916 | 11·811 |
| Mr F. R. Spofforth . | 5,342 | 2,168 | 8,773 | 682 | 12·509 |
| Mr C. T. B. Turner . | 5,388 | 2,396 | 8,419 | 649 | 12·631 |
| Rhodes . . . . | 5,871 | 1,985 | 11,808 | 845 | 13·823 |
| Emmett . . . . | 14,672 | 6,870 | 20,811 | 1523 | 13·1012 |
| Lohmann . . . | 15,196 | 6,508 | 23,958 | 1734 | 13·1416 |
| Morley . . . | 12,610 | 6,239 | 15,938 | 1213 | 13·169 |
| Peate . . . . | 11,669 | 5,593 | 14,299 | 1061 | 13·506 |
| Attewell . . . | 22,461 | 11,408 | 28,671 | 1874 | 15·561 |
| Briggs . . . . | 20,300 | 8,275 | 34,411 | 2161 | 15·1996 |
| Richardson . . | 12,531 | 3,456 | 32,341 | 1847 | 17·942 |
| Dr W. G. Grace . | 27,745 | 10,680 | 48,201 | 2653 | 18·447 |

No exhaustive summary on cricket could be complete without a tribute to the grand cricket of the Graces. Dr E. M. Grace has altogether taken 10,006 wickets, scored 72,482 runs and been the most daring field at point ever seen. Far greater has been the record of Dr W. G. Grace, who has made over a hundred centuries in first-class matches and has in four seasons scored three successive centuries. In 1871 his aggregate was 2739, and in 1895 he reached his thousand runs in May; he has always been a very crafty bowler, whose leg ball has dismissed scores of unwary colts. K. S. Ranjitsinhji, who in 1899 scored 3159 runs, and in 1900, 3065 runs, has even surpassed Dr W. G. Grace's performances with the bat. The feat of three consecutive hundreds has been scored, in addition to these two great batsmen, by Messrs C. B. Fry (who in 1901 made six in succession, besides scoring over 3000 runs altogether), E. G. Wynyard, A. C. MacLaren, W. L. Foster, R. E. Foster, Major Poore, Tyldesley, Abel, Hayward, Hirst, and Storer. But it must always be remembered that the batsmen of recent years have a great advantage in the improved grounds, as compared with Dr W. G. Grace's achievements twenty years before. To ensure some estimate of the comparative ability of the finest cricketers, an eminent judge selected, for the present article, the following as forming the three best modern elevens, it being calculated that each man is chosen on his form when in the prime of his career:—First World Eleven: Dr W. G. Grace, Dr E. M. Grace, K. S. Ranjitsinhji, Messrs A. E. Stoddart, A. G. Steel, J. M'C. Blackham, C. T. B. Turner, F. R. Spofforth, with Shrewsbury, Lohmann, and Peate. Second World Eleven: Messrs W. W. Read, G. Giffen, W. L. Murdoch, with Abel, Hayward, Gunn, Shaw, Peel, Pilling, Richardson, and A. E. Trott. Third World Eleven: Messrs P. S. M'Donnell, H. F. Boyle, F. S. Jackson, A. C. MacLaren, C. B. Fry, with Barnes, Briggs, Rhodes, Ulyett, Lockwood and Lilley or Mr G. E. M'Gregor. Messrs S. M. J. Woods, G. E. Palmer, C. T. Studd, and J. T. Hearne would be the reserves. (H. S. C. M. G.)

**Crieff,** a police burgh of Perthshire, Scotland, 18 miles west of Perth by rail. New Established and Free churches were erected in 1881, and a new United Presbyterian church in 1891. The academy was remodelled in 1878. The town grows in favour as a summer resort. Population of the police burgh (1881), 4469; (1891), 4902; (1901), 5706.

**Crimea.** See TAURIDA.

# CRIMINAL LAW.

THE article on Criminal Law in the ninth edition of the *Encyclopædia Britannica* deals with general principles, and it is not necessary to reproduce them save in the briefest fashion. A crime is an act which, by violating the law, affects injuriously not only the civil rights belonging to an individual but also the public rights and duties due to the whole community. The sovereign is taken to be the person injured by the crime, as he represents the whole community, and he is nominally the prosecutor of crime. Criminal law includes the rules as to the prevention of crime, the investigation of crime, the prosecution of crime, the punishment of crime. It lays down what constitutes a criminal offence, what proof is necessary to establish the fact of a criminal offence and the culpability of the offender, what excuse or justification for the act can be legally admitted, what procedure should be followed in a criminal court, what degrees and kinds of punishment should be imposed on the various offences which come up for trial. Finally, it regulates the constitution of the tribunals established for the trial of offences according to the gravity of the infraction of law, and deals with the organization of the police and the proper management of prisons, and maintenance of prison discipline. (See EVIDENCE, PRISON DISCIPLINE, and POLICE.)

***Definition of crime.***

Criminal and civil law, however, overlap, and in all offences where an individual has suffered loss, he can claim damages in a civil court from the wrong-doer. Again, there are many minor offences established by statute which cannot be said to have a strictly criminal character, although the case is tried by a magistrate with criminal powers, and the result of the case is in a sense penal because it consists solely in a fine or penalty, or sometimes a short term of imprisonment is also imposed. Any statutory nuisance, such as improper emission of smoke from a chimney, or the failure to repair a highway, or the carrying on of certain trades in close proximity to inhabited houses, are all tried as criminal offences, although they cannot be described as crimes. Crimes—the word is here intended to include all breaches of the criminal law—may be divided into (*a*) crimes which affect public order, abuses and obstructions of public authority, offences which are injurious to the public at large; (*b*) offences against the person, offences against parental and conjugal rights; (*c*) offences against property, by way either of force or fraud.

There are three classes of crimes—treason, felony, and misdemeanour—in addition to a large number of petty infractions of law known as summary offences. The distinction between felony and misdemeanour, though still maintained in the English system, has no longer any logical basis. Formerly all felonies, including treason, involved forfeiture of goods and property, whilst misdemeanours were not treated as felonies and did not involve forfeiture. Forfeiture is no longer a legal punishment, and whenever English criminal law is codified the distinction will no doubt disappear and a new classification be introduced.

***Treason, felony, and misdemeanour.***

*Treason* in England is a crime of a special character. The offence of treason is the attempt by overt acts either to upset the Government of the country or to kill or personally injure the sovereign or his family. The offence at common law was never concisely defined, and depended too much on the discretion of the king and his judges. It was limited by legislation so long ago as 1352 by what is called the Statute of Treason. The punishment for treason was beheading, with other brutal accompaniments. The barbarous features of the punishment were abolished in 1799. The severity of the punishment, *i.e.*, death, led in 1848 to the constitution of Treason Felonies, which are, like treason proper, of a special character, but are now tried as ordinary felonies. Whilst the compassing of the death of the sovereign or his deposition, or levying war upon him, remain punishable with death, lesser treasonable acts are punishable with penal servitude. The procedure for treason was formerly of a very oppressive character, and was made more reasonable in 1695. The offence is now tried on indictment and by a jury at the Court of Assize in the same manner as ordinary felonies. Persons indicted for treason (1) can have a copy of indictment five days before trial; (2) can have counsel; (3) can produce witnesses, who will be heard on oath. On charges of treason, bail may not be granted except by order of the Secretary of State or of the High Court.

The distinctions between felonies, misdemeanours, and summary offences are of considerable importance. Thus a person guilty of felony can be arrested by any person without a warrant; a person guilty of misdemeanour cannot, unless by a constable in special circumstances, be arrested without a warrant. Further, a person charged with a misdemeanour or summary offence is entitled to be released on bail, *i.e.*, on the obtaining of sureties, who are bound under the penalty of paying a sum of money to produce the prisoner charged for his trial on the day and at a place named. The sureties must be sufficient in the opinion of the court, and as a rule only householders are accepted. Bail is obligatory in all misdemeanours, with the exception of misdemeanours where the costs of the prosecution are payable out of the county or borough rate or fund. It is obligatory in all summary cases. But a person charged with felony is not entitled as of right to be released on bail, but may be so released at the discretion

of the judge or justice dealing with the case. In the procedure for the trial of felonies and misdemeanours there are several differences as regards: (*a*) the right of challenge, that is to say, the right of either party to challenge jurors, which is equivalent to an exception for one or more of the jurors, who have appeared individually, and who in consequence of the challenge are set aside. In the case of felonies the defendant may challenge peremptorily twenty jurymen; in the case of misdemeanour he has no right to peremptory challenge, but has to show justification for his challenge.

(*b*) The withdrawal of the jury from communicating with the outside world during the pendency of the case.

(*c*) The obligatory presence of the person charged. In the case of misdemeanour the court may permit his absence. Formerly, on conviction of the offence of felony, forfeiture of lands and goods ensued. But forfeiture resulting on a conviction of felony was abolished in 1870, and the distinction of felony and misdemeanour with regard to forfeiture, as already stated, now only exists in the unusual case of outlawry.

Whether a crime is a felony, misdemeanour, or a summary offence depends chiefly on the heinousness of the offence. But a few misdemeanours, created by statutes of Victoria's reign for punishing frauds of modern origin, are punishable more severely than some felonies. However, as a rule all the more serious offences are felonies, and the most trivial offences are summary offences, whilst misdemeanours come between the two categories. Many summary offences are what some writers call *mala prohibita*, as distinguished from *mala in se*; that is to say, they do not involve any breach of ordinary morality, except such breach as is involved in any violation of positive law.

The chief common law *felonies* are: homicide, rape, larceny, *i.e.*, in ordinary language, theft, robbery, *i.e.*, theft with violence, burglary, and kindred offences; counterfeiting the coin has been made a felony instead of being treason; and forgery of most documents has been made felony instead of being, as it was at common law, a misdemeanour.

Among the chief *misdemeanours* the following may be mentioned:—

1. Assaults on the Sovereign.
2. Unlawful assemblies.
3. Riots and seditious offences.
4. Forcible entries.
5. Perjury.
6. Blasphemy.
7. Extortion.
8. Bribery.
9. Minor bodily injuries.
10. Assaults.
11. Common nuisances.
12. Libel.
13. Conspiracy to defraud, &c.

Perjury was, until the year 1563, punished solely by the ecclesiastical courts, but since that year it has been punished, like any other misdemeanour, by a civil court.

Examples of *summary offences* are as follows:—

1. Offences by children (under twelve years).
2. Offences by young persons (twelve to sixteen years).
3. Offences by adults (above sixteen years), in cases of larceny and embezzlement.
4. Common assaults.
5. Certain larcenies not indictate.
6. Small wilful injuries to property.
7. Offences relating to game.

**Trial of a peer.**

The criminal law applies in England to all persons alike, with the sole exception of a peer or peeress charged with felony, who has the right to be tried by the House of Lords. An Earl Marshal is appointed. He presides over the House of Lords to try the indictment. When the trial is over, the staff, which is the sign of his office, is broken, and the Earl Marshal ceases to exist as the president of this special court.

**Special tribunals.**

There are in England no courts of a special character, such as exist in some foreign countries, for the determination of disputes between the governing classes themselves or with the governed classes, whether of a civil or criminal character. Special tribunals do indeed exist for trying naval or military offences committed by members of the navy and army, but those members are not exempt from being tried by the ordinary tribunals for civil offences, as though they were civilians.

**Benefit of clergy.**

The *punishment* for crimes by English law was formerly most brutal, but this brutality was tempered partly by the law of Benefit of Clergy, partly by the rigid adherence to singular technicalities, as, for instance, acquitting a criminal because the person whom he was charged with killing had two Christian names, whereas one only was mentioned in the indictment, or because the name of the person killed was wrongly spelt in the indictment. Benefit of clergy began with the claim of the ecclesiastical authorities that they alone should punish a clerk. The term clerk always included a large number of persons in what were called minor orders, and after a time the test of being a clerk was ability to read, and thus everybody who could read obtained exemption from punishment for his crime, as the ecclesiastical authorities practically enacted no punishment. This practice led to Parliament declaring certain offences to be felonies without benefit of clergy, in order to ensure punishment in all cases of offence against life or property.

Bentham pointed out at the beginning of the 19th century that certainty of punishment was more effective than severity, that severe punishments induced juries to acquit criminals, and thus the certainty of punishment was diminished. But his arguments and the eloquence of Sir Samuel Romilly produced no effect until after the reform of Parliament in 1832, shortly after which Acts were passed abolishing the death sentence for all felonies where benefit of clergy existed. Benefit of clergy was finally abolished in 1827 (7 & 8 Geo. IV. c. 28). At present no offences are capital except treason, murder, piracy accompanied by violence, setting fire to the royal dockyards, and inciting to mutiny. The severity of the capital sentences had already been modified by the pardoning power of the Crown, which directed the convict to be transported to convict settlements in the Colonies instead of being hanged. For some years this was only done by the consent of the convict, who agreed to be transported if his death sentence was remitted, but in 1824, when a convict refused to give this consent, Parliament authorized the Crown to substitute transportation for a death sentence.

**Punishment.**

About the middle of the 19th century the Colonies objected to receive any more convicts. Transportation was prohibited in 1857, and penal servitude within the United Kingdom was substituted for transportation; whilst for many felonies imprisonment with hard labour for a term not exceeding two years may now be substituted for penal servitude. By the Penal Servitude Act, 1864, the shortest period of penal servitude for an offence committed after the passing of the Act is five years, and where any previous Act had fixed a maximum of less than five years, the period of five years is to be substituted for such shorter term. The distinction between penal servitude and imprisonment with hard labour is rather one of prison management and discipline than one of any principle. The punishment for misdemeanour at common law has always been fine or imprisonment, or both, at the discretion of the court before which the prisoner was convicted. To this simple imprisonment hard labour has been added by statute for various offences, but the term for imprisonment with hard

labour is limited to two years. The punishment for summary offences is imprisonment with or without hard labour, or a fine, or both, subject to limitations which as a rule do not allow imprisonment exceeding six months. When the punishment may exceed three months' imprisonment, the accused has a right to demand that the offence shall be tried by a jury as a misdemeanour and not summarily.

In the case of treason and murder the court has no discretion as to the punishment awarded, and in most other cases some limitation is imposed by statute on the length of penal servitude or imprisonment with hard labour which may be imposed. But the maximum in every case is so high that, save in treason and murder, the court has a very large discretion as to the punishment to be imposed, and is not as a general rule limited, outside the offences of treason and murder, in its discretion as regards the minimum of punishment which it can award. Together with the mitigation of punishment since 1832, laws have been passed for getting rid of the technicalities which formerly led to the improper acquittal of criminals. Indeed the looseness of pleading in criminal cases is carried almost too far; for while there is no danger in such looseness when times are quiet and when law is administered by the judges of the High Court in England. Yet when crimes of a certain character are committed in times of great political excitement and the law is administered by an inferior judiciary, there may be some danger of injustice if the strictness of pleading and procedure is too much relaxed.

The punishments which may be imposed summarily are as follows:—

(a) In the case of adults pleading guilty to offences involving property worth over 40s., imprisonment not exceeding 6 months, without the option of a fine.

(b) In the case of adults where the offence affects property not worth over 40s., imprisonment not over 3 months, or fine not exceeding £20.

(c) In the case of young persons, imprisonment not over 3 months, or fine not exceeding £10.

(d) In the case of children, imprisonment not over 1 month, or fine not exceeding 40s.

If the offence is trifling, the accused may be discharged without punishment, and under the First Offenders Act (1887) the justices have a discretionary power to forego punishment. The justices have also the power, under the Reformatory Schools Act and the Industrial Schools Act, to commit youthful offenders to one or other of these institutions,—in the case of a previous conviction, the Industrial School; in the case of a first offence, the Reformatory (see INDUSTRIAL SCHOOLS).

Crime is in England treated locally; the responsibility for the suppression of it is local. Formerly each township was responsible for the suppression of crime within its own boundaries. The "view of frank pledge" which gave effect to this has long since disappeared, but the system of each township having a headborough or constable still survives in a few places. In each county the sheriff was, and in law still is, responsible for the peace of the county, and he had control of the county jail, in which he lodged the prisoners he arrested as suspected of crime. In ancient times the freeholders of the county sat, with the sheriff presiding, to inquire into and punish the crime in the county. The Sheriff's Criminal Court, being superseded by the Assizes and Quarter Sessions, was long ago abolished, but the tribunal at the Assizes for the trial of crimes is still furnished by the freeholders of the county, acting as jurymen under the direction of the judge. The jury must come from the vicinage or neighbourhood. The judges, who used to be

*"View of frank pledge."*

sent on a commission of jail delivery and "*oyer* and *terminer*" from Westminster, are now from the Royal Courts of Justice, and not from Westminster. In olden days, and even now in theory, the Grand Jury inquire of their own knowledge, by the oath of good and lawful men of the neighbourhood, into the crime of the county, but in practice the charges against the accused persons are always submitted to an officer known as the Clerk of the Crown. The Grand Jury is first instructed as to their inquisition by a charge from the judge, as regards the indictment concerning which they are called upon to examine, whether there is a *primâ facie* case to send for trial to the ordinary jury. The Grand Jury must consist of not less than twelve, not more than twenty-three, good and lawful men of the county. But any person who prefers an indictment is entitled to put it forward, provided he submits to be bound over to prosecute and to be liable to costs in case his prosecution fails. Such cases are very rare. As a rule, in the big towns a solicitor is specially appointed to direct criminal prosecutions; in the rural districts it may be the person injured, it may be the magistrates' clerk, it may be a policeman who is bound over to prosecute.

*The Grand Jury.*

The Clerk of the Crown puts the charges into proper shape, and lays them before the Grand Jury. The charges are then called Bills, and if the Grand Jury considers that there is no *primâ facie* case, the foreman endorses the Bill with the words "no true case," and then presents it to the judge. The jury are then said to have ignored the Bill, and if the person charged is in custody he is released, yet liable to be tried on better evidence.

When an indictment is found by the Grand Jury (twelve at least must concur), the person charged is brought before the court, the indictment is read to him, he is asked whether he is guilty or not guilty; if he pleads guilty, he is then sentenced by the court; if he pleads not guilty, a petty jury of twelve is formed out of the number of jurors who have been summoned by the sheriff to attend the court. He is tried by these jurors in open court; he can, if he choose, have counsel to defend him, by cross-examining the witnesses, by calling witnesses of his own, and by addressing the jury. The judge then sums up the case to the jury, and they acquit or convict him. If he is acquitted, he is discharged from custody; if convicted, the judge awards the sentence. From such acquittal or conviction, properly speaking there is no appeal in criminal trials. The verdict of the jury is final. Any considerable defect or informality in the procedure may be taken before the King's Bench by Writ of Error, but such cases are not now of frequent occurrence. And if any question of law arises at the trial, the judge may reserve it for the opinion of the court for the consideration of Crown Cases Reserved, by whom the conviction may be either quashed or confirmed.

*Procedure before petty jury.*

The question of criminal appeal has been, and still is, a matter of great controversy. On the Continent of Europe, and even in India, appeal is allowed in criminal cases on the facts as well as on the law of the case. In England an appeal on questions of law arising at the trial is allowed, as stated above, but the procedure is intricate and technical, whilst no provision whatever is made for questioning the decision of the jury on matters of fact. The verdict of a jury, however unsatisfactory, cannot be reversed, and the only remedy is founded on the prerogative of pardon inherent in the Crown, which is exercised, as a matter of fact, by the Home Secretary. Various proposals have been made, the most practical being that a new trial shall be granted (1) when the verdict is obviously against the evidence, (2) when new

*Criminal appeal.*

facts have arisen after the trial, proving the verdict conclusively wrong. The exercise of the power of pardon in the prerogative of the Crown does not satisfy the justice of the case—it only accords mercy where there may be no criminal guilt. Moreover, as it is given on the advice of the Secretary of State, and his inquiry must necessarily be informal and without publicity, cases might arise where a pardon would not satisfy public opinion. At the same time, celerity of punishment is absolutely necessary for the repression of crime, and so far no system of criminal appeal has duly satisfied that requirement. The Court of Crown Cases Reserved consists of a number of judges of the High Court—not less than five—and from their decision there is no appeal.

The indictment must say that it is found by a jury of a particular county, and the offence charged must appear to have been committed in that county; this is known as the *venue*, and in former days, at any rate, was a great protection against the oppression of the subject on the part of the Crown. It prevented the Crown in the days of its great power from removing a person whom it wished to get rid of from among his neighbours, and placing him on trial in a strange place where the influence of the Crown was greater. This is still true to a certain extent, as great injustice may be caused to a man by removing him from his neighbours and trying him at a distance from his friends and from the witnesses whom he might call for his defence. In Ireland, for instance, the greatest injustice might be done by removing an Orangeman from Belfast and trying him in a Roman Catholic county. But it has its evils where the area from which the jurors are drawn is a small one, such as a town of a few thousand inhabitants. In that case a man charged, say, with fraud, may be protected by his friends from being properly punished for that fraud. In 1856 power was given for the first time to remove a prisoner for trial from any part of England to the Central Criminal Court. This was originally done in favour of a prisoner against whom there was great local animosity, but so long as the law is administered in quiet times by judges of the High Court there is no danger of injustice to any accused person.

***The venue.***

It has been mentioned above that in theory an indictment is the spontaneous act of the Grand Jury, but that in practice a Bill for that indictment is always presented by some individual to the Grand Jury. In theory the prosecution is on the part of the Crown; and this is so far true in fact that the Attorney-General, on behalf of the Crown, can in any case intervene, and either take the conduct of the prosecution out of the hands of the private person or enter what is called a *nolle prosequi*, which has the effect of stopping any further prosecution; but in practice such a course is never taken.

It is obviously necessary that criminals should be arrested as soon as possible after the crime is committed, and that the arrest should not wait until an indictment has been found. Hence a practice has grown up, which has been largely extended of recent years, of having a preliminary inquiry of the crime before justices, the effect being that if there is no *primâ facie* case a man is at once discharged, instead of being kept in custody until the Assizes are held, and the Grand Jury can inquire into the case. This procedure before justices was regulated by an Act of 1848, known as Jarvis's Act, and is now almost universal. This procedure before justices is entirely different from the procedure for summary offences. It may be, though usually it is not, held in private; it is an inquiry and not a trial; the justices have to consider not whether the man is guilty, but whether there is such a *primâ facie* case against him that he ought to be tried. If they think that there is, they commit him to prison to wait his trial, or require him to give security, with sureties, to the amount named by them for appearing to take his trial.

***Preliminary inquiry.***

If a coroner's jury, on inquiring into any sudden death, finds that murder or manslaughter has been committed, that finding has the same effect as an indictment by a grand jury, and the man charged may be tried by the petty jury accordingly. The law and procedure of the Coroner's Courts are now regulated by the Coroners Act, 1887 (50 & 51 Vict. c. 71). When there is a dead body of a person lying within the area of his jurisdiction, and there is reasonable cause to suspect that such person died a violent or unnatural death, or a sudden death of which the cause is unknown, or has died in prison, the coroner's decision to hold an inquisition cannot be challenged. The verdict of guilty is followed by trial in the ordinary manner.

***Coroner's courts.***

For many years the costs of the prosecution of felonies, and also of many misdemeanours, were paid out of the public funds, raised in each county. After 1852 an annual sum was voted by Parliament for the reimbursement of half, and then of all, these costs to the counties, or rather localities, which paid them, and thus the cost of these prosecutions fell upon the Imperial Exchequer. In 1888 the proceeds of certain taxes were handed over to the local authorities, and they again became liable to pay these costs.

With the organization of the police forces, which began about the year 1827 in London, and in 1834 in the United Kingdom generally, the police became the prosecutors in many cases. In 1879 an Act was passed (42 & 43 Vict. c. 22, amended by 47 & 48 Vict. c. 58) providing for the payment of a director of public prosecutions, who was to act under the Attorney-General in such cases and under such conditions as might be settled by rules laid before Parliament, and in 1884 a further Act developed the system of the Act of 1884. The office of director is now held by the officer who, for the time being, is solicitor to the Treasury. He is subject to the direction of the Attorney-General; and in the cases provided for by the rules, which may be roughly taken to be the cases of the most serious crimes, or of crimes which require long and careful investigation, undertakes, always with the approbation of the Attorney-General, the prosecution in place of the private individual.

***Director of public prosecutions.***

The Attorney-General has always represented the Crown in criminal matters, and in State prosecutions appears in person on behalf of the Crown, and when he so appears has certain privileges as respects the reply to the prisoner's defence and the mode of trial. The Attorney-General has a right on behalf of the Crown to institute in the High Court, by information, a prosecution for any misdemeanour, but he cannot so institute a prosecution for felony; any such information is tried by a jury in like manner as if it were an indictment. Preliminary jurisdiction in criminal cases is possessed by the Justices of the Peace, who may also under special Acts convict in a summary manner for offences of minor importance. The procedure for punishing summary offences is before two justices, or in the case of a stipendiary magistrate, one justice. This proceeding must not be confused with the preliminary procedure already mentioned before justices for an indictable offence, nor with the procedure before justices in relation to civil matters, such as the recovery of small sums of money. The proceeding begins either by the issue of a warrant for the arrest of the person charged, in which case a sworn information must be filed, or by a summons directing the person charged to appear on a certain day to answer the complaint made by the prosecutor. The jus-

tices hear the case in open court; the person charged can make his defence either in person or by his solicitor or counsel, he can cross-examine the witnesses, for the prosecution, call his own witnesses, and address the justices in his defence. The justices, after hearing the case, either acquit or convict him, and in case of conviction award the sentence. If the sentence is a fine and the fine is not paid, the person convicted is liable to be imprisoned for the term fixed by the justices, not exceeding a scale fixed by an Act of 1879, the maximum of which is one month. The imprisonment may be with or without hard labour.

*Procedure for summary offences.*

Of late years this summary jurisdiction of the justices has received very large extensions, and many offences which were formerly prosecuted as serious offences by an indictment before the Court of Assize or Quarter Sessions have, where the offence was a trivial one, been made punishable, on summary proceedings before justices, by a small fine or a short term of imprisonment.

The extension of the jurisdiction of the justices is open to the observation that it deprives a person charged of the protection of a jury, and also that it throws upon him, if convicted, and upon the prosecution if there is no conviction, the cost of the proceedings. The former objection is much mitigated by the enactment made in 1879, that a person if liable on conviction to be sentenced to imprisonment for more than three months, or to a fine exceeding £100, can claim to be tried by a jury. But the objection as to the costs remains, and the payment of costs is often a very serious addition to the trivial fine; and it is anomalous that a person convicted of a trifling offence should bear the cost of the prosecution, while if he is convicted before a superior tribunal of the most serious offence he does not pay the cost.

The Criminal Evidence Act, 1898, is explained in the article on EVIDENCE; but as it goes to the root of the English system of criminal trials, this article requires a brief reference to it. Bentham wrote that amongst the singularities of the English common law the most remarkable is the rule that does not allow any questions to be put to the accused which might lead to the proof of his guilt. Sir James Stephen rather defended the rule, because it stimulated independent inquiry. Other writers maintained that any interrogation of the prisoner would be contrary to the principle "nemo tenetur se ipsum accusare." On the Continent of Europe the prisoner can be interrogated; and the Criminal Evidence Act, 1898, now enables every person, and the wife or husband of such person, to be a competent but not compellable witness for the defence at every stage of the procedure. No comment is allowed by the prosecution on the abstention of the accused or the accused's wife or husband from giving evidence. Cross-examination is allowed, but previous convictions and bad antecedents are not allowed to influence the court, which is bound to judge according to the facts presented to it. The Indian procedure does not go so far as this English reform. The court is empowered to ask the accused questions generally on the case after the witnesses for the prosecution have been examined and before he is called for his defence. His answers are taken into consideration, and the court and the jury may draw such inference from the answers as appears just. The accused does not render himself liable to punishment by refusing to answer or by giving false answers. Theoretical objections often do not stand the test of practice, and the Criminal Evidence Act, 1898, has given satisfaction. In England, as already pointed out, although the prosecution is in the name of the Crown, and although a public prosecutor has been appointed, still criminal charges are conducted, with few exceptions, by the person injured, with the assistance of the police. In the Prosecution of Offences Acts of 1879 and 1884 there is to be found the nucleus of the system of the public action such as obtains in other countries in case of crime. Under these Acts the Solicitor to the Treasury acts as Director of Public Prosecutions under the Attorney-General. But both these high officials have many other duties, and the outcome of the present system, worked as it is now, is small. The annual average of cases by jury on indictment for the five years ending 1897 was 11,633; if the indictable cases disposed of summarily were included, the annual average would be 55,174. Yet in 1897 only 414 cases were prosecuted by the Public Prosecutor. In Ireland the system is nominally the same as in England, but in practice almost all prosecutions are instituted and conducted under the direction of the Attorney-General for Ireland, who is a member of the Government of the day, and so responsible to Parliament, as in the case of the Lord Advocate. In Ireland, owing to the police being a centralized force, under the management of Commissioners residing in Dublin, any prosecution which in England might be conducted by the local police, would in Ireland be conducted under the direction of the chief of the police in Dublin, who is neccessarily in close communication with the Attorney-General.

*Evidence.*

In *Ireland* the law relating to crimes is nearly the same as in England, but in *Scotland* hardly any crimes are constituted by statute law, the common law being to the effect that if a judge will direct any act to be a crime, and a jury will convict, that act is a crime. This great elasticity of the common law to include every sort of new crime which may arise is obviously one very dangerous to political liberty, as it greatly enlarges the power of the Crown to oppress political opponents, but in modern days it has its convenience in facilitating the punishment of persons committing crimes for the punishment of which in England a new Act of Parliament may be necessary. The localization in England of crime, and the procedure for punishing it, differ largely from the view taken in France and most European countries. The French theory is that a Frenchman owes allegiance to the French State, and commits a breach of that allegiance whenever he commits a crime against French law, even although he is not at the time within French territory. And in modern days this theory has been extended so as to allow the French courts to punish Frenchmen for crimes committed in foreign countries.

The principle of the French law, though not expressly recognized in England, must be invoked to justify two departures from the English principle (1) as regards offences on the high seas, and (2) as regards certain limited offences committed outside the United Kingdom. In early days offences committed by Englishmen on the high seas were punished by the Lord High Admiral, and he encroached so much on the ordinary courts as to render it necessary to pass an Act in Richard II.'s reign (15 Rich. II. st. 2, c. 3) to restrain him.

*Offences on the high seas.*

In the time of Henry VIII. (28 Hen. VIII. c. 15) an Act was passed stating that as the admiral tried persons according to the course of the civil law, they could not be convicted unless either they confessed or they or the witnesses were submitted to torture, and that therefore it was expedient to try the offences according to the course of the common law. Under that Act a special commission of Oyer and Terminer was issued to try these offences at the Old Bailey, and English law was satisfied by permitting the indictment to state that the offence was committed on board a ship on the high seas, to wit in the county of Middlesex. Since 1861 these special commissions have

been rendered unnecessary by the provision that all offences committed on the high seas may be tried as if they had been committed in England. As regards offences on land, it was found necessary as early as the reign of Henry VIII. to provide for the trial in England of treasons and murders committed on land outside England; this was largely due to the constant presence in France of the king and many of his nobles and knights. The latest legislation on the subject was in 1861 (24 & 25 Vict. c. 100, s. 9), and any murder or manslaughter committed on land out of the United Kingdom, whether within the King's dominions or without, and whether the person killed were a subject of His Majesty or not, may be dealt with in all respects as if it were committed in England. The jurisdiction has been extended to a few other cases such as slave trade, bigamy, perjury committed with reference to an English court, and offences connected with explosives. But these offences must be committed on land and not on board a foreign ship, because if a man takes service on board a foreign ship he is treated for the time as being a member of the foreign State to which that ship belongs. The principle has been also extended to misdemeanours (but not felonies) committed by public officers in colonies and elsewhere, whether within or without the British dominions. Thus a Governor or an Inferior Officer of a colony, if appointed by the British Government, may be prosecuted for any misdemeanour committed by him by virtue of his office in the colony; and cases have happened where governors have been so prosecuted, such, for instance, as the case of General Picton at the beginning of the 19th century, and of Governor Eyre of Jamaica in 1865.

**Offences committed on land outside England.**

**Misdemeanours committed by public officers in colonies.**

There are a few exceptional courts with criminal jurisdiction. The Court of Chivalry, which used to punish offences committed within military lines outside the kingdom, has long disappeared. The Military Courts for trying members of the navy and army for offences committed against naval and military law have been already referred to. The naval courts can only try members in actual service on board a ship. The military courts can only try persons who are actually members of the army at the time, and their authority is annually renewed by Parliament, in consequence of the jealousy still felt against the trial of any man except by the ordinary courts of law. These courts can try in any part of the world, and whenever the forces are in active service can try followers of the camp as if they were actual members of the forces. (See articles on MILITARY LAW and MARTIAL LAW.)

**Ecclesiastical Courts.**

The Ecclesiastical Courts, which were formerly very powerful in England, and punished persons for various offences, such as perjury, swearing, and sexual offences, have now almost fallen into desuetude. Their authority over Protestant dissenters from the Established Church was taken away by statute; their authority over lay members of the Church of England has disappeared by disuse. Occasionally suits are instituted in them against the clergy for offences either against morality or against doctrine or ritual. In these cases their sentences are enforced by penalties, such as suspended deprivation of their benefice, or by imprisonment, which has replaced the old punishment of excommunication.

Reference has been made in various places to the criminal law which prevails on the Continent. The English system prevails in most of the States which form the United States of America. It prevails also, with a few exceptions, in the Colonies of the British Empire; but the manner in which it has been adapted to the requirements of a backward country is best exemplified in the system of law which obtains in India, the greatest dependency of the Empire. In the first place both the substantive and the adjective criminal law have been codified. The Indian Penal Code came into force in 1860, and the Indian Code of Criminal Procedure, enacted in 1882, has been somewhat modified by an amending Act of 1898. As regards all criminal law as administered throughout British India, they have taken the place of an older criminal system, which was based partly on Mahommedan law, partly on usage and custom, partly on principles imported from England. Great delays and considerable injustice were formerly caused by the want of unity in judicial organization. Now, one set of courts has been established throughout the country, composed of well-paid, well-educated judges, most of the higher judicial appointments being held by Englishmen; all those who hold subordinate judicial posts at the same time are subjected to a combined system of appeal and revision. The arrangement of the Indian Penal Code is natural as well as logical; its basis is the law of England freed from technicalities, whilst certain modifications are introduced to meet the exigencies of a country such as British India. It opens with a chapter of general explanations, and interpretations of the terms used throughout the Code. It then describes the various punishments to which offenders are liable; follows with a list of the exceptions regarding criminal responsibility under which a person who otherwise would be liable to punishment is exempted from the penal consequences of his act, such as offences committed by children, by accident or misfortune without any criminal intention, offences committed by lunatics, offences committed in the exercise of the right of private defence. It may be worth while to add, as an innovation on English law, that an act which results in harm so slight that no person of ordinary sense and temper would complain of such harm is not considered an offence under the Code. Then follows a chapter on Abetment, in other words, the instigation of a person to do a wrongful act. The next chapters deal with offences against the public, including the State, the army and navy, public tranquillity, public servants, contempts of the lawful authority of public servants, perjury; offences relating to coin and Government stamps, to weights and measures; offences affecting the public health, safety, convenience, decency, and morals; offences relating to religion; and offences relating to the human body, from murder down to the infliction of any hurt. The Code then passes on to offences against property; offences relating to forgery, including trade marks, criminal breach of contracts for service; offences relating to marriage, defamation, criminal intimidation, insult, and annoyance. Under this last head is included an attempt to cause a person to do anything which that person is not legally bound to do, by inducing him to believe that he would otherwise become subject to Divine displeasure. The last chapter deals with attempts to commit offences punishable by the Code with transportation or imprisonment, and the punishment is limited to one-half of the longest term provided for the offence had it been carried out.

**Indian Penal Code.**

One peculiarity of the Penal Code which has proved eminently successful and been imitated by other Codes, lies in the system of illustration of the offence declared in every section by a brief statement of some concrete case. For instance, as illustration of the offence of an attempt to commit an offence the following examples are given:—

I. "A. makes an attempt to steal some jewels by breaking open a box, and finds on opening the box there is no jewel in it. He has done an act towards the commission of theft, and therefore is guilty under this section.

II. "A. makes an attempt to pick the pocket of Z. by thrusting his hand into Z.'s pocket. A. fails in the attempt in consequence

of Z. having nothing in his pocket. A. is guilty under this section."

Passing on to the system of criminal procedure which is set forth in detail in the Code of Criminal Procedure as amended in 1898, it is no doubt modelled on the English system, but with considerable modifications. The principal steps are—(1) arrest by the police and inquiries by the police; (2) the issue of summons or warrant by the magistrate; (3) the mode of procedure before the magistrate, who may either try the accused himself or commit him to the Sessions or the High Court, according to the importance of the case; (4) procedure before the Court of Session; (5) appeals, reference and revision by the High Court.

***Indian Code of Criminal Procedure.***

Elaborate provision is made for the prevention of offences, as regards security for keeping the peace and for good behaviour, the dispersion of unlawful assemblies, the suppression of nuisances, disputes as to immovable property, which in all Oriental countries constitute one of the most frequent causes of a breach of the peace.

Ample provision is thus made for the prevention of offences, and the Code next deals with the mode of prosecution of offences actually committed.

As a general rule, every offence is inquired into and tried by the court within the local limits of whose jurisdiction it was committed. Differing from the practice of Continental countries, all offences, even attempts, may be prosecuted after any lapse of time. As in England, there is no statutory limitation to a criminal offence.

A simple procedure is provided for what are called summons cases, as distinguished from warrant cases—the first being offences for which a police officer may arrest without warrant, the second being offences where he must have a warrant, or, in other words, minor offences and important offences. In summons cases no formal charge need be framed. The magistrate tells the accused the particulars of the offence charged: if he admits his guilt, he is convicted; if he does not, evidence is taken, and a finding is given in accordance with the facts as proved. When the complaint is frivolous or vexatious, the magistrate has the power to fine the complainant. The Code gives power of criminal appeal which goes much farther than the system in England.

In cases tried by a jury, no appeal lies as to matters of fact, but it is allowed as to matters of law; in other cases, criminal appeal is admitted on matters of law and fact.

In addition to the system of appeal, the superior courts are entrusted with a power of revision, which is maintained automatically by the periodical transmission to the High Courts of calendars and statements of all cases tried by the inferior courts; and at the same time, whenever the High Court thinks fit, it can call for the record of any trial and pass such orders as it deems right. All sentences of death must be confirmed by the High Court. No appeal lies against an acquittal in any criminal case. This system of appeal, superintendence, and revision would be totally inapplicable to England, but it has proved eminently successful as applied to the present social condition of the inhabitants of India. The appeals keep the judges up to their work, revision corrects all grave mistakes, superintendence is necessary as a kind of discipline over the conduct of judges, who are not subjected, as in England, to the criticism of enlightened public opinion.

The French Penal Code and Code of Criminal Procedure are still substantially the model of all systems of Continental criminal law. They were promulgated in 1811 by Napoleon I., and although he called in the aid of the greatest French jurists, he guided, and occasionally even revised, their labours. The French Codes have been amended by later Continental Codes, and more especially the Italian Penal Codes. All Codes have an opening chapter where the general principles of criminal law in its practical application are enunciated, such as, for instance, the rules that—(1) no person is liable to punishment for any act not expressly declared to be an offence; (2) no person can be punished for an act which by virtue of a subsequent law is declared not to be an offence; (3) whoever commits an offence within the kingdom is tried and punished according to the criminal law of the kingdom, and by the tribunals created for the administration of justice, to the exclusion of special tribunals created for temporary purposes. This rule really lays down that no citizen can be deprived of his own judges when he is accused of a criminal offence. (4) A citizen, although he may have been tried in a foreign country for an offence committed within the kingdom, can be retried according to the law of the kingdom; (5) extradition only applies to foreigners, not to citizens. The preliminary chapter is followed by the classification of offences according to the importance of the punishments the law assigns to them. The lowest degree of offence is denominated "contravention." It applies mainly to the pettiest offences, or to infractions of police regulations, and can be punished by fine or by imprisonment under a week, or by both fine and imprisonment, limited to a week. Next comes the "*délit*," which includes all offences punished by imprisonment over a week and under five years. Then, finally, we arrive at the "crime," the highest form of offence in French Criminal Law. It includes all offences subject to a more severe sentence than the punishment assigned to a *délit*. All cases are held to be crimes where death, life-imprisonment with or without hard labour, deportation out of the kingdom, detention or seclusion in a fortress or other expressly assigned place, are the punishments mentioned by the law. A certain number of explanatory definitions follow, of which the most important concern *attempts* to commit offences, and in "crimes" they are punishable if the execution of the attempt was only prevented by circumstances beyond the will of the offender, whilst in "*délits*" an attempt is not punishable as an offence unless the law specially provides that it should be punished. As regards "contraventions," attempts not carried out are not held to be offences at all. Accomplices are generally subject to the same punishment as the principal. Old offenders (*récidivistes*) are subject to severer punishments. The usual exceptions as regards responsibility for crime, such as madness and extreme youth and *force majeure*, are to be found in all Codes. The excuse of youth extends to all offenders under the age of sixteen, when the tribunal decides whether the offender has acted without "discernment," and acquits where the discernment is not found, whilst one-half of the usual punishment is inflicted where discernment is found. Foreign Codes differ from the English law in allowing the injured party to claim damages in the criminal suit, appearing as *partie civile*. On another question there is a wide divergence on the Continent from English law. According to the law of England there is no prescription in criminal law. An offender is always liable to punishment whatever time may have elapsed since the committal of the offence. On the Continent the limitation of a judgment and sentence for a crime is twenty years; five years for a *délit*, and for a contravention two years. No proceedings can be taken as regards a crime after a lapse of ten years, whilst as regards a *délit* the limit is three years, and two years for a contravention. There are three main differences between English criminal procedure and Continental criminal procedure.

***Non-British criminal procedure.***

1. A criminal prosecution directed on Continental

criminal procedure at once passes into the hands of the State as an infringement of law which must be repressed, on the ground that the whole community bases its security on obedience to law. In England the repression of all minor crime is left to the injured party.

2. In England every criminal proceeding from beginning to end is, and has always been, public, whilst on the Continent, with rare exceptions, all preliminary proceedings in a criminal charge are secret. The public system is called accusatory, the secret system is called inquisitorial.

Outside English-speaking countries this secret investigation continues more or less. But of the two systems, accusatory or inquisitorial—the first meaning the right of the accused to defend himself, the second meaning the right of the State to examine any legal offence in private in order to ensure the safety of society,—the accusatory is gaining ground in every country. In English-speaking countries it is an established law that an accused person should have the right of publicity of the proceedings and the right to defend himself by counsel and by witnesses. On the Continent the inquisitorial system is gradually being abandoned. Perhaps the best Code of Criminal Procedure in Europe is that promulgated in Austria in 1873. It followed a fundamental law of the Empire which laid down *inter alia* that all legal proceedings, civil or criminal, should be oral and public, and that the accusatory system in criminal cases should be adopted. Germany followed this example. Italy, Holland, Switzerland, and Spain have followed Austria and Germany as regards the preliminary investigation; Italy and Belgium have surrounded the accused with guarantees against arbitrary confinement before trial; Holland has conferred upon the accused the right of seeing the adverse testimony and of being confronted with the witnesses, and, further, has formally insisted that no insidious questions, such as questions assuming a fact as true which is not known to be true, should be allowed. Other countries still remain on the old lines. But everywhere, whether reform has actually been accomplished or not, there is a demand for even-handed justice, and a growing conviction that the accused should have all his rights, now that society is no longer in danger from undiscovered criminals and unpunished crime. Even in France, the champion of the inquisitorial system, a change is rapidly being made. Up to 1897 secrecy was imposed invariably in the preliminary investigation of crime, and was held necessary for the discovery and punishment of the offender. The "Loi de l'Instruction Contradictoire," December 8, 1897, however, was a long step towards complete justice in the treatment of the accused in the preliminary inquiry. The main reform is that the accused, after he had once appeared before the judge and a formal charge has been made against him, is entitled to the assistance of counsel, either chosen by himself or assigned to him if he is poor. If he is in prison, he is allowed to communicate freely with his counsel, who is entitled to see all the proceedings, and in every appearance before the judge his counsel accompanies him. There are, however, certain limitations. The counsel cannot address the judge without leave, which may be refused, nor can he insist on any proceeding he thinks necessary in his client's interest. He can only solicit. He has no right to be present at the examination of witnesses, who continue to be interrogated by the judge alone and not in the presence of the accused; but he must receive twenty-four hours' notice of every appearance of the accused, and he is entitled to be present whenever his client, after the first formal appearance, comes before the judge. In England, as already pointed out, although the prosecution is in the name of the Crown, and although a public prosecutor has been appointed, still as a rule it is conducted by the person injured as the person injured, or by the police.

3. In England the single-judge system is universal, save in appeal; on the Continent plurality of judges is insisted upon, save in the most trivial cases, where the punishment is insignificant. The Public Prosecutor's Department is yet in embryo in England, whilst in most countries of the Continent the whole machinery for the prevention, investigation, and punishment of crime, is conducted by what is called the *Parquet*, which represents society as a collective unit and not the individual injured. The head of the whole Parquet in France is the *Procureur-Général*, who holds equal rank with the members of the Supreme Court. Under him there are Procureurs-Généraux attached to each of the Courts of Appeal, of which in France there are twenty-six, and under each of these subordinate Procureurs there are Procureurs (prosecutors) of a lesser degree. The next stage to the Parquet is the Juge d'Instruction, who corresponds to the English magistrate, and is the most formidable personage in the whole system of French criminal law. He can detain and accuse a person in prison, can send for him at any time and ask him such questions as he pleases.

After the first examination the prisoner is entitled, in most Continental countries, to the assistance of counsel, but the powers of counsel are so limited that the Juge d'Instruction has a complete discretionary power regarding the investigation of the case. The natural consequence of this procedure is that the preliminary investigation really decides the ultimate result, and the final trial becomes more or less a solemn form.

The single-judge system, applied to important matters, prevails only in English-speaking countries, or where English influence is dominant. On the Continent a plurality of judges is deemed essential to the administration of sound justice. This rule was probably made at a time when judges could never be allowed to sit alone for fear of the influence of the rich and powerful, the possibility of corruption, and the danger that a judge sitting alone would decide questions sometimes according to his convenience. Experience has shown in England and in all Greater Britain that the concentration of responsibility, which is the basis of the single-judge system, is preferable to a multiplicity of judges, none of whom feel the same duty to the case before them. Financial considerations also come into the question. It is of paramount importance that a judge should be sufficiently well paid to ensure his absolute independence from every point of view. The following comparative tables of judicial salaries in England and France speak for themselves:—

*England*—

| | | |
|---|---|---|
| | Lord Chancellor | £10,000 |
| | Lord Chief Justice of England | 8,000 |
| (4) | Lords of Appeal, each | 6,000 |
| | Master of the Rolls | 6,000 |
| (5) | Lord Justices, each | 5,000 |
| (23) | Judges of the High Court, each | 5,000 |
| | Recorder of London | 4,000 |
| | Common Serjeant | 3,000 |
| | Assistant Judges, each | 1,500 |
| | Judge (City of London Court) | 2,400 |
| (56) | County Court Judges, each | 1,500 |
| (11) | Metropolitan County Court Judges, each | 1,500 |
| | Other Metropolitan Police Magistrates, each | 1,500 |
| | Bow Street Police Magistrate | 1,800 |

*France*—

| | | |
|---|---|---|
| | President of the Court of Cassation | 1,200 |
| (3) | Presidents of Chambers of the Court of Cassation, each | 1,000 |

| | |
|---|---|
| (45) Judges of the Court of Cassation, each | £720 |
| (1) President (at Paris) of the Court of Appeal | 1,000 |
| (25) Presidents of other Courts of Appeal, each | 720 |
| (59) Presidents of Chambers of Courts of Appeal— | |
| (9) at Paris, each | 550 |
| (50) in Provinces, each | 400 |
| (359) Presidents of Tribunals of 1st Instance— | |
| (1) at Paris | 800 |
| (15) 1st Class, each | 400 |
| (76) 2nd Class " | 280 |
| (267) 3rd Class " | 200 |
| (633) Judges— | |
| (48) Paris, each | 320 |
| (77) 1st Class, each | 240 |
| (175) 2nd Class " | 160 |
| (335) 3rd Class " | 120 |

*Tribunals of the Juge de Paix.*

| | |
|---|---|
| Judges number 2872— | |
| 20 receive, each | 320 |
| 43 " " | 200 |
| 754 " " salaries varying from | 140 to 84 |
| 2055 " " | 72 |

*Ministère Publique* (*Public Prosecutor's Department*).

| | |
|---|---|
| Chief Public Prosecutor | 1,200 |
| His Advocate-General in Cour de Cassation | 720 |
| (26) Public Prosecutors in Court of Appeal— | |
| (1) Paris | 1,000 |
| (25) In Provinces, each | 720 |

AUTHORITIES.—STEPHEN. *History of Criminal Law.*—ESMEIN. *Histoire de la Procédure Criminelle en France; Codes Français et les Codes des autres pays d'Europe.*—LIVINGSTON. *On the Criminal Legislation of Louisiana.*—WHITLEY STOKES. *The Anglo-Indian Codes.* (H. JE.; JNO. S.)

**Crimmitschau,** a town of Germany, on the Pleisse, 8 miles north-north-west of the town and in the circle of Zwickau, kingdom of Saxony; on the Leipzig-Hof Railway. There are *real*, commercial, and technical schools, and over 100 spinning mills and woollen cloth factories, employing between 5000 and 6000 workmen. Population (1890), 23,068; (1900), 22,840.

**Cripple Creek,** a mining city of El Paso county, Colorado, U.S.A., situated near the centre of the state, in 38° 45′ N. lat. and 105° 11′ W. long., in the mountains west of Pike's Peak, at an altitude of 9500 feet. It has two railways, the Florence and Cripple Creek, making connexion with Pueblo, and the Midland Terminal, a branch of the Colorado Midland, connecting with Colorado Springs. It is the richest gold mining camp in the United States. Gold was first discovered in 1891, and in 1897 the production exceeded $10,000,000. The sources of the gold are placers, veins, and the country rock. The ores consist of free gold, not only in placers but in veins and country rock, and tellurides and auriferous iron pyrites. They differ greatly in value, ranging from $20 up to several thousand dollars per ton. Population (1900), 10,147.

**Crispi, Francesco** (1819–1901), Italian statesman, was born at Ribéra in Sicily, October 4, 1819. In 1846 he established himself as advocate at Naples. On the outbreak of the Sicilian Revolution at Palermo (January 12, 1848) he hastened to the island and took an active part in guiding the insurrection. Upon the restoration of the Bourbon Government (May 15, 1849) he was excluded from the amnesty and compelled to flee to Piedmont. Here he unsuccessfully applied for a situation as communal secretary of Verolengo, and eked out a penurious existence by journalism. Implicated in the Mazzinian conspiracy at Milan (February 6, 1853), he was expelled from Piedmont, and obliged to take refuge at Malta, whence he fled to Paris. Expelled from France, he joined Mazzini in London, and continued to conspire for the redemption of Italy. On June 15, 1859, he returned to Italy after publishing a letter repudiating the aggrandizement of Piedmont, and proclaiming himself a Republican and a partisan of national unity. Twice in that year he went the round of the Sicilian cities in disguise, and prepared the insurrectionary movement of 1860. Upon his return to Genoa he organized, with Bertani, Bixio, Medici, and Garibaldi, the expedition of the Thousand, and overcoming by a stratagem the hesitation of Garibaldi, secured the departure of the expedition on May 5, 1860. Disembarking at Marsala on the 11th, Crispi on the 13th, at Salemi, drew up the proclamation whereby Garibaldi assumed the Dictatorship of Sicily, with the programme: "Italy and Victor Emmanuel." After the fall of Palermo, Crispi was appointed Minister of the Interior and of Finance in the Sicilian provisional government, but was shortly afterwards obliged to resign on account of the struggle between Garibaldi and the emissaries of Cavour with regard to the question of immediate annexation. Appointed secretary to Garibaldi, Crispi secured the resignation of Depretis, whom Garibaldi had appointed Pro-Dictator, and would have continued his fierce opposition to Cavour at Naples, where he had been placed by Garibaldi in the Foreign Office, had not the advent of the Italian regular troops and the annexation of the Two Sicilies to Italy brought about Garibaldi's withdrawal to Caprera, and Crispi's own resignation. Entering Parliament in 1861 as deputy of the Extreme Left for Castelvetrano, Crispi acquired the reputation of being the most aggressive and most impetuous member of the Republican party. In 1864, however, he made at the Chamber a Monarchical profession of faith, in the famous phrase afterwards repeated in his letter to Mazzini: "The Monarchy unites us; the Republic would divide us." In 1866 he refused to enter the Ricasoli Cabinet; in 1867 he worked to impede the Garibaldian invasion of the Papal States, foreseeing the French occupation of Rome and the disaster of Mentana. By methods of the same character as those subsequently employed against himself by Cavallotti, he carried on the violent agitation known as the Lobbia affair, in which sundry Conservative deputies were, on insufficient grounds, accused of corruption. On the outbreak of the Franco-German War he worked energetically to impede the projected alliance with France, and to drive the Lanza Cabinet to Rome. The death of Ratazzi in 1873 induced Crispi's friends to put forward his candidature to the leadership of the Left; but Crispi, anxious to reassure the Crown, secured the election of Depretis. After the advent of the Left he was elected (November 1876) President of the Chamber. During the autumn of 1877 he went to London, Paris, and Berlin on a confidential mission, establishing cordial personal relationships with Gladstone, Granville, and other English statesmen, and with Bismarck.

In December 1877 he replaced Nicotera as Minister of the Interior in the Depretis Cabinet, his short term of office (70 days) being signalized by a series of important events. On January 9, 1878, the death of Victor Emmanuel and the accession of King Humbert enabled Crispi to secure the formal establishment of a unitary Monarchy, the new monarch taking the title of Humbert I., instead of Humbert IV. of Savoy. The remains of Victor Emmanuel were interred in the Pantheon, instead of being transported to the Savoy Mausoleum at Superga. On February 9, 1879, the death of Pius IX. necessitated the first Conclave held after the unification of Italy. Crispi, helped by Mancini

and Cardinal Pecci (afterwards Leo XIII.), persuaded the Sacred College to hold the Conclave in Rome, and prorogued the Chamber lest any untoward manifestation should mar the solemnity of the event. The statesmanlike qualities displayed on this occasion were unavailing to avert the storm of indignation conjured up by Crispi's opponents in connexion with a charge of bigamy incapable of legal proof. Crispi was compelled to resign office, although the judicial authorities upheld the invalidity of his early marriage, contracted at Malta in 1853, and ratified his subsequent union with Signora Barbagallo. For nine years Crispi remained politically under a cloud, but in 1887 returned to office as Minister of the Interior in the Depretis Cabinet, succeeding to the Premiership upon the death of Depretis (July 29, 1887).

One of his first acts as Premier was a visit to Bismarck, whom he desired to consult upon the working of the Triple Alliance. Basing his foreign policy upon the alliance, as supplemented by the naval *entente* with Great Britain negotiated by his predecessor, Count Robilant, Crispi assumed a resolute attitude towards France, breaking off the prolonged and unfruitful negotiations for a new Franco-Italian commercial treaty, and refusing the French invitation to organize an Italian section at the Paris Exhibition of 1889. At home Crispi secured the adoption of the Sanitary and Commercial Codes, and reformed the administration of justice. Forsaken by his Radical friends, Crispi governed with the help of the Right, until, on January 31, 1891, an intemperate allusion to the former policy of the Conservative party led to his overthrow. In December 1893 the impotence of the Giolitti Cabinet to restore public order, then menaced by disturbances in Sicily and in Lunigiana, gave rise to a general demand that Crispi should return to power. Upon resuming office he vigorously suppressed the disorders, and lent sturdy support to the energetic remedies adopted by Sonnino, Minister of Finance, to save Italian credit, which had been severely shaken by the bank and financial crises of 1892–1893. Crispi's uncompromising suppression of disorder, and his refusal to abandon either the Triple Alliance or the Eritrean Colony, or to forsake his colleague Sonnino, caused a breach between him and the Radical leader Cavallotti. Cavallotti then began against him a pitiless campaign of defamation. An unsuccessful attempt upon Crispi's life by the anarchist Lega brought a momentary truce, but Cavallotti's attacks were soon renewed more fiercely than ever. They produced so little effect that the general election of 1895 gave Crispi a huge majority, but, a year later, the defeat of the Italian army at Adowa in Abyssinia brought about his resignation. The ensuing Rudini Cabinet lent itself to Cavallotti's campaign, and at the end of 1897 the judicial authorities applied to the Chamber for permission to prosecute Crispi for embezzlement. A parliamentary Commission, appointed to inquire into the charges against him, discovered only that Crispi, on assuming office in 1893, had found the Secret Service coffers empty, and had borrowed from a State bank the sum of £12,000 for Secret Service, repaying it with the monthly instalments granted in regular course by the Treasury. The Commission, considering this proceeding irregular, proposed, and the Chamber adopted, a vote of censure, but refused to authorize a prosecution. Crispi resigned his seat in Parliament, but was re-elected by an overwhelming majority in April 1898 by his Palermo constituents. For some time he took little part in active politics, chiefly on account of his growing blindness. A successful operation for cataract restored his eyesight in June 1900, and notwithstanding his 81 years he resumed to some extent his former political activity. Soon afterwards, however, his health began to give way permanently, and he died at Naples on the 12th of August 1901.

FRANCESCO CRISPI.
*(From a Photograph by Giacomo Brogi, Florence.)*

The importance of Crispi in Italian public life depended less upon the many reforms accomplished under his administrations than upon his intense patriotism, remarkable fibre, and capacity for administering to his fellow-countrymen the political tonic of which they stood in constant need. In regard to foreign politics he greatly contributed to raise Italian prestige and to dispel the reputation for untrustworthiness and vacillation acquired by many of his predecessors. (H. W. S.)

**Croatia - Slavonia** (Horvát - Szlavonország), an autonomous province (Borderland) of Hungary. Area, 16,417 square miles, with 2,416,304 inhabitants in 1900. At the head of the Government stands the Banus, appointed by the king, with counter-signature of the Hungarian Prime Minister. The provincial Diet (Croatia-Slavonian-Dalmatian National Assembly) consists (*a*) of elected deputies, (*b*) of personal. voters, whose number, however, cannot exceed half of that of the elected deputies. The National Assembly delegates out of its midst 40 deputies to the House of Commons and 3 deputies to the House of Magnates of the Hungarian Parliament, who participate in the discussion of the affairs which are common to Hungary and Croatia-Slavonia. The Croatian Minister, without portfolio, is a member of the Hungarian Government, who countersigns every act of importance of the provincial Government of Croatia-Slavonia. In the eastern part of the land, especially on the plain extending between the Danube, Dráva, and Száva, agriculture is largely carried on. The chief products of 1900 were 3·0 millions metric centners of wheat, 3·6 mill. metr. cent. of potatoes, and 4·7 mill. metr. cent. of maize. The mountainous portion of the country is wooded, and on the plains are extensive forests. Above one-third (1,511,779 hectares = 35·74 per cent.) of the cultivable territory is covered by forests, whereof the public treasury possesses 300·280 hectares, of a value of 58·9 million crowns. Of the grain produced, wheat, potatoes, and maize are

the most important. Excepting Zágráb (Agram), the rapidly rising capital of Croatia-Slavonia, and its surroundings, the greatest traffic is in the regions near the Danube and the frontier passes towards Bosnia.

**Croix,** or **Croix Wasequehal,** a town of France, in the department of Nord, arrondissement of Lille, 5 miles north-east of Lille and 2 miles south-west of Roubaix, with station on railway to Courtrai. The town is situated near the Marcq, an affluent of the Deule, and is practically a suburb of Roubaix. Port traffic (1899), 71,145 tons. Population (1881), 3260; (1896), 13,895; (1901), 15,933.

**Croll, James** (1821–1890), Scottish man of science, was born of a peasant family at Little Whitefield, in Perthshire, 2nd January 1821. He was regarded as an unpromising boy, but a trifling circumstance aroused a passion for reading, and he made great progress in self-education. Debarred by ill-health from manual labour, he became successively a shopkeeper and an insurance agent, and in 1859 was made keeper of the Andersonian Museum at Glasgow, a humble appointment, which, however, gave him what he most required. In 1857, being deeply impressed by the metaphysics of Jonathan Edwards, he had published an anonymous volume entitled *The Philosophy of Theism*; but his connexion with the Museum induced him to take up physical science, and in 1864 he wrote his celebrated essay "On the Physical Causes of the Changes of Climate during the Glacial Epoch." This led to his receiving an appointment on the Scottish Geological Survey in 1867. In 1875 he summed up his researches upon the ancient condition of the earth in his *Climate and Time*, in which he contends that terrestrial revolutions are due in a measure to cosmical causes. This theory excited warm controversy. Croll's replies to his opponents are collected in his *Climate and Cosmology* (1885). He had been compelled by ill-health to withdraw from the public service in 1881; yet, working under the greatest difficulties, and harassed by the miserable inadequacy of his retiring pension, he managed to produce *Stellar Evolution*, discussing, among other things, the age of the sun, in 1889; and *The Philosophical Basis of Evolution*, partly a critique of Herbert Spencer's philosophy, in 1890. He died on 15th December 1890. The soundness of Croll's theories remains a subject of controversy, but his character as a scientific worker under the greatest discouragements was nothing less than heroic. His life, prefaced by an unfinished autobiography, was written by Mr J. C. Irons in 1896. (R. G.)

**Cromarty.** See Ross.

**Cromer**, a parish and fashionable watering-place in the northern parliamentary division of Norfolk, England, 22 miles north of Norwich by rail. Standing on cliffs of considerable elevation, the town has repeatedly suffered from ravages of the sea. In 1894 a wall and esplanade were built at the bottom of the East Cliffs, and these are being extended to the west. A pier, 183 yards long, is to be constructed at a cost of £11,000. A water reservoir to hold 600,000 gallons was finished in 1896. There are a town-hall, a cottage hospital, and a lecture hall. On a site of three acres stands the Convalescent Home of the Norfolk and Norwich Hospital. There is an excellent golf course. There are herring, cod, lobster, and crab fisheries. Area of urban district, 938 acres. Population (1881), 1597; (1901), 3776.

**Cromer, Evelyn Baring,** 1st Earl (1841——), British statesman and diplomatist, was born on the 26th February 1841, the ninth son of Henry Baring, M.P., by Cecilia Anne, eldest daughter of Admiral Windham of Felbrigge Hall, Norfolk. Having joined the Royal Artillery in 1858, he was appointed in 1861 A.D.C. to Sir Henry Storks, High Commissioner of the Ionian Islands, and acted as secretary to the same chief during the inquiry into the Jamaica outbreak in 1865. Gazetted captain in 1870, he went in 1872 as private secretary to his cousin Lord Northbrook, Viceroy of India, where he remained until 1876, when he became major, received the C.S.I., and was appointed British Commissioner of the Egyptian Public Debt Office. Up to this period Major Baring had given no unusual signs of promise, and the appointment of a comparatively untried major of artillery as the British representative on a Financial Board composed of representatives of all the Great Powers was considered a bold one. Within a very short time it was recognized that the Englishman, though keeping himself carefully in the background, was unmistakably the predominant factor on the Board. He was mainly responsible for the searching report of the Commission of Inquiry that had been instituted into the financial methods of the Khedive Ismail; and when that able and unscrupulous Oriental had to submit to an enforced abdication, it was Major Baring who became the British Controller-General and practical director of the Dual Control. Had he remained in Egypt, the whole course of Egyptian history might have been altered, but his services were deemed more necessary in India, and under Lord Ripon he became Financial Member of Council in June 1880. He remained there till 1883, leaving an unmistakable mark on the Indian financial system, and then, having been rewarded by the K.C.S.I., he was appointed British Agent and Consul-General in Egypt and a Minister Plenipotentiary in the Diplomatic Service.

Sir Evelyn Baring was at that time only a man of forty-two, who had gained a reputation for considerable financial ability, combined with an abruptness of manner and a certain autocracy of demeanour which, it was feared, would impede his success in a position which required considerable tact and diplomacy. It was a friendly colleague who wrote—

> The virtues of Patience are known,
> But I think that, when put to the touch,
> The people of Egypt will own, with a groan,
> There's an Evil in Baring too much.

When he arrived in Cairo in 1883 he found the administration of the country almost non-existent. Ismail had ruled with all the vices, but also with all the advantages, of autocracy. Disorder in the finances, brutality towards the people, had been combined with public tranquillity and the outer semblance of civilization. Order, at least, reigned from the Equator to the Mediterranean, and such trivial military disturbances as had occurred had been of Ismail's own devising and for his own purposes. Tewfik, who had succeeded him, had neither the inclination nor character to be a despot. Within three years his government had been all but overthrown, and he was only Khedive by the grace of British bayonets. Government by bayonets was not in accord with the views of the House of Commons, yet Ismail's government by the kourbash could not be restored. The British Government, under Mr Gladstone, desired to establish in Egypt a sort of Constitutional Government; and as there existed no single element of a constitution, they had sent out Lord Dufferin to frame one. That gifted nobleman, in the delightful lucidity of his picturesque report, left nothing to be desired except the material necessary to convert the flowing periods into political entities. In the absence of that, the constitution was still-born, and Sir Evelyn Baring arrived to find, not indeed a clean slate, but a worn-out papyrus, disfigured by the efforts of centuries to describe in hieroglyph a method of rule for a docile people.

From that date the history of Sir Evelyn Baring, who became Baron Cromer in 1892, G.C.B. in 1895, Viscount in 1897, and Earl in 1901, is the history of Egypt, and requires the barest mention of its salient points here. From the outset he realized that the task he had to perform could only be effected piecemeal and in detail, and his very first measure was one which, though severely criticized at the time, has been justified by events, and which in any case showed that he shirked no responsibility and was capable of adopting heroic methods. He temporarily abandoned that portion of the territory over which Egypt held only a nominal sway, already challenged by the Mahdi, and set himself to work to reorganize the remainder. That portion, too, he attacked in detail. The very first essential was to regulate the financial situation; and in Egypt, where the entire revenue is based on the production of the soil, irrigation was of the first importance. With the assistance of Sir Colin Scott Moncrieff, in the Public Works Department, and Sir Edgar Vincent, as Financial Adviser, these two great departments were practically put in order before he gave more than superficial attention to the rest. The Ministry of Justice was the next department seriously taken in hand, with the assistance of Sir John Scott, while the army had been reformed under Sir Evelyn Wood, who was succeeded by Sir Francis Grenfell. Education, the Ministry of the Interior, and gradually every other department, came to be reorganized, or, more correctly speaking, formed, under Lord Cromer's carefully persistent direction, until it may be said to-day that the Egyptian administration can safely challenge comparison with that of any other state. In the meantime the rule of the Mahdi and his successor, Abdulla Khalifa, in the temporarily abandoned provinces of the Sudan, had been weakened by internal dissensions; the Italians from Massawa, the Belgians from the Congo State, and the French from their West African possessions, had gradually approached nearer to the valley of the Nile; and the moment had arrived at which Egypt must decide either to recover her position at Khartum or allow that important centre to fall into hands hostile to Great Britain and her position in Egypt. Lord Cromer was as quick to recognize the moment for action and to act as he had fifteen years earlier been prompt to recognize the necessity of abstention. In March–September 1896 the first advance was made to Dongola under the Sirdar, Sir H. (now Lord) Kitchener; between July 1897 and April 1898 the advance was pushed forward to the Atbara; and on September 2, 1898, the battle of Omdurman finally crushed the power of the Khalifa and restored the Sudan to the rule of Egypt and Great Britain. To have effected this in the face of the greatest difficulties,—political, national, and international,—and at the same time to have raised the credit of the country from a condition of bankruptcy to an equality with that of the first European Powers, entitles Lord Cromer to a very high place among the greatest administrators that the British Empire has produced. Lord Cromer married in 1876 Ethel Stanley, daughter of Sir Rowland Stanley Errington, eleventh baronet, but was left a widower with two sons in 1898; and in 1901 he married Lady Katherine Thynne, daughter of the fourth Marquess of Bath.

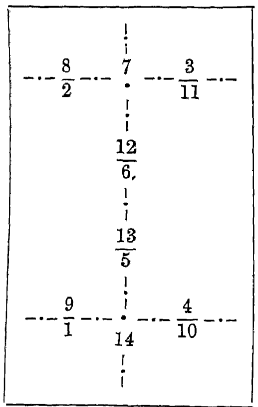
**Crompton,** a township in the Prestwich division of Lancashire, England, $2\frac{1}{2}$ miles north of Oldham. Since 1894 it has been governed by an urban district council. At Shaw, a large village included within it, is a station on the Lancashire and Yorkshire Railway. Population (1891), 12,901; (1901), 13,427.

**Crookes, Sir William,** (1832——), English chemist and physicist, was born in London on 17th June 1832, and studied chemistry under Hofmann at the Royal College of Chemistry. In 1861, while conducting a spectroscopic examination of the residue left in the manufacture of sulphuric acid, he observed a bright green line which had not been noticed previously, and by following up the indication thus given he succeeded in isolating a new metal, thallium, a specimen of which was shown in public for the first time at the Exhibition of 1861. During the next eight years he carried out a minute investigation of this substance and its properties. While determining its atomic weight, he thought it desirable, for the sake of accuracy, to weigh it in a vacuum, and even in these circumstances he found that the balance behaved in an anomalous manner, the metal appearing to be heavier when cold than when hot. This phenomenon he explained as a "repulsion from radiation," and he expressed his discovery in the statement that in a vessel exhausted of air a body tends to move away from another body hotter than itself. Utilizing this principle he constructed the radiometer (see *Ency. Brit.* vol. xix. p. 249 and *Supp.* RADIOMETER), which he was at first disposed to regard as a machine that directly transformed light into motion, but which was afterwards perceived to depend on thermal action. Thence he was led to his famous researches on the discharge of electricity through highly rarefied gases and on radiant matter, and to the development of his theory of a "fourth state of matter." In 1883 he began an inquiry into the nature and constitution of the rare earths. By repeated chemical fractionations he was able to divide yttrium into distinct portions which gave different spectra when exposed in a high vacuum to the spark from an induction coil. This result he considered to be due, not to any removal of impurities, but to an actual splitting-up of the yttrium molecule into its constituents, and he ventured to draw the provisional conclusion that the so-called simple bodies are in reality compound molecules, at the same time suggesting that all the elements have been produced by a process of evolution from one primordial stuff or "protyle." A later result of this method of investigation was the discovery of a new member of the rare earths, monium or victorium, the spectrum of which is characterized by an isolated group of lines, only to be detected photographically, high up in the ultra-violet end; the existence of this body was announced in his presidential address to the British Association at Bristol in 1898. In the same address he called attention to the conditions of the world's food supply, urging that with the low yield at present realized per acre wheat cannot long retain its position among the food-stuffs by which mankind is nourished, and that since nitrogenous manures are essential for an increase in the yield, the hope of averting starvation depends on the ability of the chemist to find an artificial method for fixing the nitrogen of the air. In addition to many other researches besides those here mentioned, Sir William Crookes has edited various books on chemistry and chemical technology, and has also given up a certain amount of time to the investigation of psychic phenomena, endeavouring to effect some measure of correlation between them and ordinary physical laws. He was knighted in 1897, and has received the Royal and Davy medals of the Royal Society, besides having filled the offices of President of the Chemical Society and of the Institution of Electrical Engineers.

**Crookston,** capital of Polk county, Minnesota, U.S.A., on the Red Lake River in the edge of Red River valley, on the Great Northern and the Northern Pacific Railways lines. Population (1890), 3457; (1900), 5359.

**Croos River.** See NIGERIA.

**Croquet.**—The line of demarcation between the old game and "New Croquet," as it is called, is not very difficult to draw, for croquet has had an experience quite unexampled in the history of games. The pastime eulogized by Lord Beaconsfield and illustrated by John Leech spread very rapidly. In some half dozen years after the appearance of the game, a croquet ground in a country house was deemed as important an adjunct as a conservatory. And then, almost in a night, the game disappeared. More than one reason has been assigned for this. It was pushed forward too quickly by experts and made too difficult; and then the croquet grounds were found admirably adapted for lawn tennis which in its early development could be played by man, woman, and child. The dimensions of the croquet ground have been altered since the days when Mr Henry Jones wrote his article in the ninth edition of the *Encyclopædia Britannica* (vol. vi.). A ground for match play must measure 35 yards in length by 28 yards in width, and the boundary must be marked with a white line. A little flag must be placed in each corner, and a spot of white near the flag, this spot being 3 feet from each boundary. Six hoops are used in the game, and two pegs. The hoop must be made of half-inch iron, and must stand up 12 inches above the ground. The hoop now used at all tournaments is the "Davidson," which develops into an inverted cone some 4 or 5 inches long under the soil, the broadest part at the top being a little broader than the iron above the surface. These hoops are very rigid, and if they get loose a tap with the mallet makes them tight again. The hoop must measure 4 inches across, inner measurement, and be square at the top. The pegs are of wood. They must be $1\frac{1}{2}$ inch in diameter and stand 2 feet out of the ground. One peg, the winning peg, is painted with four rings of colour, namely, blue, red, black, and yellow; the other peg is painted white. This distinction was made to indicate the top end and the bottom end of the ground, which was confusing sometimes at tournaments. Little cross bars should be on the top of the pegs to hold the clips. The balls are of boxwood, and weigh between $14\frac{1}{2}$ and $15\frac{1}{2}$ ozs. They are $3\frac{5}{8}$ inches in diameter. There must be a blue ball, a red ball, a black ball, and a yellow ball, and this sequence of the colours must be preserved. Thus if a player having the choice of balls and lead elects to play with yellow, blue must follow. Clips of the colour of the balls must be used. The clip indicates the next point in order of the player. The laws about mallets have changed since the old days of croquet when there was "no restriction as to the number, weight, size, shape, or material of the mallets." If you have indiarubber at one striking end you must not use it. Also your mallet must have the two striking ends perfectly vertical. The accompanying plan will show why a multiple of 5 and 4 has been selected for the dimensions of the ground. Up the central line the hoops are 7 yards apart, each peg 7 yards from the nearest outer hoop, 7 yards from each side hoop, 7 yards from the boundary. This is the setting, and the game consists in driving both balls through these hoops, in the order indicated by the numbers, up to the turning peg, and then returning to the winning peg, in a similar manner. At starting each player places his ball one foot away from hoop No. 1, placing it not slantingly, but in the exact centre. If he runs the hoop he plays again, and his turn can be prolonged by the following incidents:—1. Making a fresh point (hoop or peg) in order. 2. Hitting a ball that he has not hit since making a point. This hit is called a roquet, and after a roquet a player is compelled to *take croquet*. To take croquet you must place your ball in undeniable contact with the ball you have hit, and you may in your stroke glance away 20 yards (or other distance) after moving it half an inch, or you may roll it along with your own ball all that distance, or you may effect what is called a stop shot, and drive the croqueted ball a considerable distance while arresting the progress of your own ball almost completely. The *croquet* is an important stroke, and you must get from it all the advantage you can. But it is checked by certain minute regulations:—1. If the balls are not quite touching when you take croquet the adversary may have them put back and make you play the stroke over again. 2. If you fail to move both balls your turn ceases, and the adversary once more can have the balls put back. 3. If the croqueted ball reaches the boundary of the ground your turn ceases. 4. If your own ball reaches the boundary of the ground, unless intermediately it makes a roquet, your turn ceases. This, called the dead boundary law, was in existence when Mr Henry Jones wrote, but it has since been modified.




—·— indicates 7 yds.

The laws of croquet may here be briefly sketched. There are thirteen strokes called "foul." No point can be scored off any of them, the turn is lost, and the adversary, if he likes, can have the ball replaced after the stroke:—1. To strike the ball twice distinctly in playing it. 2. To push a ball without an audible knock. 3. To strike another ball besides one's own in playing, or taking aim. 4. To touch a rolling ball. 5. To allow a ball to rebound on the player's person or mallet. 6. To press a ball round a wire. 7. To play a ball after a roquet without taking croquet. 8. To fail to move the croqueted ball in the croquet stroke. 9. To take croquet from a ball without having first roqueted it. 10. To knock a hoop out of the ground with the mallet when making a stroke. 11. To use any part of the mallet, except the striking ends of the head, to propel a ball. 12. To use an indiarubber-tipped mallet. 13. To touch a ball improperly with hand, foot, or mallet. Besides these "foul strokes" there are six minor offences; it is a blemish in the laws that no defined penalties are attached to them, and players are advised to settle beforehand that the stroke must be played again if the adversary wishes it:—1. To play a stroke with a second mallet without having damaged the first. 2. To take croquet off a ball which you have sent not off but nearer than 3 feet to the boundary, without bringing it in three full feet before you play. 3. To lay down a mark to help your aim. 4. To play the first stroke at less than a foot from the first hoop, and not from a central spot. 5. To play with the wrong ball at starting. 6. To move a ball at rest accidentally. There are a few other laws. Only a rover can peg out a rover. A hoop is considered run when it cannot be touched with a straight edge from the playing side. On the other hand, a ball driven partly through a hoop from the non-playing side cannot run the hoop next stroke if it can be touched by a straight edge from the non-playing side. If the player play with a wrong ball, blue and black must be placed in one corner and red and yellow in the other corner, behind hoops 1 and 10, and the adversary may go on with either ball of his side.

A considerable advance has been made in the use of the mallet since 1877. Players are now divided into two groups, those who use *side-play* and those who use *front-play*. The distinction can be best understood if we imagine a player shooting at an object due north. The side player will face due east and strike with his mallet across the

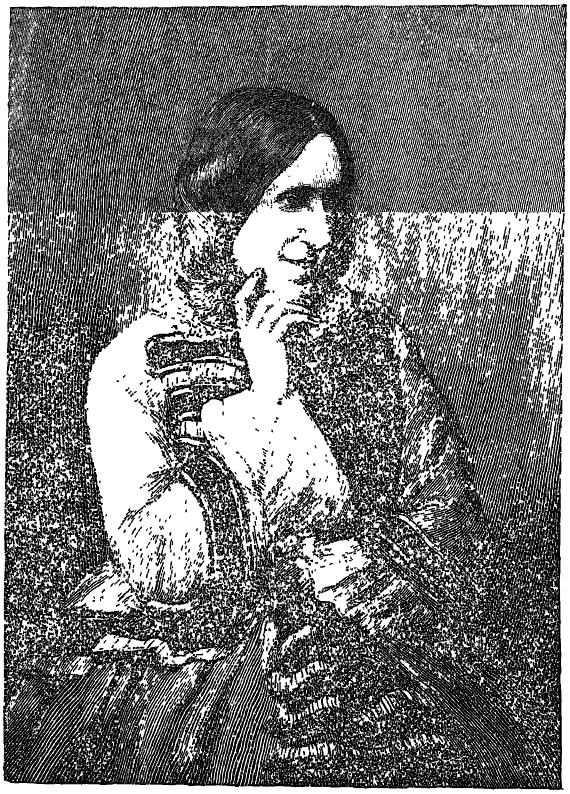
body, the front-player will face due north and look along the head of his mallet in taking aim. When Mr Henry Jones wrote his article side-play was the only play. Indeed a law in the code called "The Field" Laws absolutely forbids the use of front-play at all. The side-player usually stoops down and slopes his mallet, and delivers a stroke rather like a hockey stroke; he drives the ball, often very accurately, by a pure and unadulterated blow. But this stroke is uncertain. It depends entirely on eye and hand, and one bad stroke in a game may lose a match. The advantages of front-play are twofold. It allows the player to "look along the barrel," to use a phrase which fairly conveys the right idea. This is a great advantage, especially in strokes that require much accuracy, as with a hoop played at from a slanting direction. The second advantage of front-play is that the pendulum stroke can be used The player must have his mallet perfectly upright, his eye, his two hands, the line along the mallet head, the line through the centre of his ball, and the line through the centre of the ball aimed at must all be in the same vertical plane. His left hand will act as a pivot, the centre of the curve described by the mallet head in the stroke. The right hand will guide this mallet head, and it is essential to accuracy that it should be drawn up rather than back to preserve as much as possible the pendulum's curve. Much depends on the left hand, which clutches the mallet handle and acts as a pivot. The great difficulty of all is keeping this pivot during the stroke rigidly in the same vertical plane as the moving head.

The tactics of croquet have undergone a change since the days of Mr Henry Jones. The hoops for match play then were very difficult. They were of $\frac{1}{2}$-inch steel, and $3\frac{5}{8}$-inch span, and were fixed in a block of solid oak under the soil. This block was about the size and shape of a volume of the *Encyclopædia Britannica*. The diameter of a ball was only $\frac{1}{8}$th of an inch less than the span of the hoop, and when the ball touched the steel upright it was at once arrested. From this resulted very timid and cautious play. A tricky stroke was invented to put on what billiard players call "follow" in running a hoop. A player was afraid to attempt such a feat if any but a friendly ball was near. There was a great deal of what is called *finesse*, which means shooting into a corner to prevent your ball from helping the antagonist. Games were excessively long. Moderate players, and experts, who were not able to practise with the socketed hoops, soon gave up the game altogether. New croquet, by reverting to the 4-inch hoop and encouraging large handicaps, is giving to the scientific game a rapid and vast extension quite out of all precedent in the past. Excellent players are springing up everywhere, and with them a stronger and bolder game. A brief statement will show all that this means. Croquet is a unique game. If it is to be compared to any other it may be said that from the point of view of accurate striking and nice judgment of strength it approaches billiards, and from the intellectual side it approaches whist. Four balls, blue, red, black, and yellow, roll along the ground, and each of these balls affects the others at every stage of the game as much as the units of the little armies of spades and diamonds in whist. Red, we will say, hits blue. From that moment red dominates not only his own balls but those of his adversary, often for a considerable time. This is at once the weakness of croquet, and also its exceptional fascination. This command of the balls is called the *attack*, and the crucial strategy of the game is centred on two problems, namely, how to win when you have the attack, and how to get it when it is in the hands of the adversary. The object of the game being to pass both balls through the prescribed circuit of hoops, the player who possesses the attack will try to do this as fast as he can, passing not one hoop alone, but several, if practicable, in a turn. This sequence of hoops is called a *break*, and if it is effected with the aid of all the balls it is called a four-ball break, but if only three are available it is a three-ball break. The four-ball break is naturally the easiest. The principle of all breaks is to arrange to have a ball at your hoop the next in order as you come up to it, and another ball always at your next hoop but one in order. Thus if you are going up to hoop 5 (see plan) you should have a ball there to help you, and another at hoop 6. Let us say that with the aid of the first you run hoop 5; at once you send the ball that has assisted you on the turning peg itself, and you stop your ball in the croquet stroke close to the ball at hoop 6. The difficult feature of the setting is the four corner hoops, but these are run by the aid of what is called a centre ball, *i.e.*, you leave one of the balls in the centre of the ground as you run up to the stick. As you do so, you split the ball that has helped you to run hoop 6 away to hoop 8 and make the peg with the ball sent there to help you. Now comes in the work of the centre ball. You drive the ball that has helped you at the stick to the distant corner, hoop 9, and stop by the centre ball. You then hit it and take off to the ball left at hoop 8. In this way the centre ball will help you to do the four corner hoops 8, 9, 10, 11. Plainly the main object of the adversary must be to keep this fourth ball from you. His chief chance is coming in with a long shot, but he must send this as much as possible out of your game. (A. LI.)

**Cross, Mary Ann** (or, as she usually signed herself, Marian) (1819–1880), the famous English writer who is more generally known as **George Eliot,** was born at Arbury Farm, in Warwickshire, on 22nd November 1819. Her father, Robert Evans, was the agent of Mr Francis Newdigate, and the first twenty-one years of the great novelist's life were spent on the Arbury estate. She received an ordinary education at respectable schools till the age of seventeen, when her mother's death, and the marriage of her elder sister, called her home in the character of housekeeper. This, though it must have sharpened her sense, already too acute, of responsibility, was an immense advantage to her mind, and, later, to her career, for, delivered from the tiresome routine of lessons and class-work, she was able to work without pedantic interruptions at German, Italian, and music, and to follow her unusually good taste in reading. The life, inasmuch as she was a girl still in her teens, was no doubt monotonous, even unhappy. Just as Cardinal Newman felt, with such different results, the sadness and chain of evangelical influences from his boyhood till the end of his days, so Marian Evans was subdued all through her youth by a severe religious training which, while it pinched her mind and crushed her spirit, attracted her idealism by the very hardness of its perfect counsels. It is not surprising to find, therefore, that when Mr Evans moved to Coventry in 1841, and so enlarged the circle of their acquaintance, she became much interested in some new friends, Mr and Mrs Charles Bray and Mr Charles Hennell. Mr Bray had literary taste and wrote works on the *Education of the Feelings*, the *Philosophy of Necessity*, and the like. Mr Hennell had published *An Enquiry concerning the Origin of Christianity*. Miss Evans, then twenty-two, absorbed immediately these unexpected, and, at that time, daring habits of thought. So compelling was the atmosphere that it led to a complete change in her opinions. Kind in her affection, she was relentless in argument. She refused to go to church (for some time, at least), wrote painful letters to a former governess,—the pious Miss Lewis,—and barely avoided an irremediable quarrel with her father, a churchman of the old school. Here was rebellion indeed. But rebels come, for the most part, from the provinces where petty tyranny, exercised by small souls, show the scheme of the universe on the meanest possible scale. George Eliot was never orthodox again: she abandoned, with fierce determination, every creed, and although she passed, later, through various phases, she remained incessantly a rationalist in matters of faith and in all other matters. It is nevertheless true that she wrote admirably about religion and religious persons. She had learnt the evangelical point of view: she knew—none better—the strength of religious motives: vulgar doubts of this fact were as distasteful to her as they were to another eminent writer, to whom she refers in one of her letters (dated 1853) as "a Mr Huxley, who was the centre of interest" at some "agreeable evening." Her books abound in tributes to Christian virtue, and one of her own favourite characters was Dinah, the Quakeress, in *Adam Bede*.

She undertook, about the beginning of 1844, the translation of Strauss's *Leben Jesu*. This work, published in

1846, was considered scholarly, but it met, in the nature of things, with no popular success. On the death of Mr Evans in 1849, she went abroad for some time, and we hear of no more literary ventures till 1851, when she accepted the assistant-editorship of the *Westminster Review.* For a while she had lodgings at the offices of that publication in the Strand, London. She wrote several notable papers, and became acquainted with many distinguished authors of that period—among them Herbert Spencer, Carlyle, Harriet Martineau, Francis Newman, and George Henry Lewes. Her friendship with the last named led to a closer relationship, which she regarded as a marriage. Among the many criticisms passed upon this step (in view of the fact, among other considerations, that Lewes had a wife living at the time), no one has denied her courage in defying the law, or questioned the quality of her tact in a singularly false position. That she felt the deepest affection for Mr Lewes is evident; that we owe the development of her genius to his influence and constant sympathy is all but certain. Yet it is also sure that what she gained from his intimate companionship was heavily paid for in the unceasing consciousness that most people thought her guilty of a grave mistake, and found her written words, with their endorsement of traditional morality, wholly at variance with the circumstances of her private life. Doubts of her suffering in this respect will be at once dismissed after a study of her journal and letters. Stilted and unnatural as these are to a tragic degree, one can read well enough between the lines, and also in the elaborate dedication of each manuscript to "my husband" (in terms of the strongest love), that self-represssion, coupled with audacity, does not make for peace. Her sensitiveness to criticism was extreme: a flippant paragraph or an illiterate review with regard to her work actually affected her for days. The whole history of her union with Lewes is a complete illustration of the force of sheer will—in that case partly her own and not inconsiderably his—over a nature essentially unfitted for a bold stand against attacks. At first she and the man whom she had described "as a sort of miniature Mirabeau in appearance," went abroad, but they returned to England the same year and settled, after several moves, in lodgings at East Sheen.



GEORGE ELIOT.
*(From a Photo by the London Stereoscopic Co.)*

In 1854 she published *The Essence of Christianity*, a translation from Feuerbach, a philosopher to whom she had been introduced by Mr Bray. During 1855 she translated Spinoza's *Ethics*, wrote articles for the *Leader*, the *Westminster Review*, and the *Saturday Review*—then a new thing. It was not until the following year that she attempted the writing of fiction, and produced *The Sad Fortunes of the Reverend Amos Barton*—the first of the *Scenes of Clerical Life.* These, published in *Blackwood's Magazine*, were issued in two volumes in 1858. The Press in general extended a languid welcome to this work, and although the author received much encouragement from private sources, the few real critics were mostly noncommittal, and it was not until the publication of *Adam Bede* in 1859 that enthusiasm was attracted to the quality of the earlier production. *Adam Bede*, in many judgments George Eliot's masterpiece, met with a success (to use her own words) "triumphantly beyond anything she had dreamed of." In 1860 appeared *The Mill on the Floss.* After the sensational good fortune of *Adam Bede*, the criticism applied to the new novel seems to have been disappointing. We find Miss Evans telling her publisher that "she does not wish to see any newspaper articles." But the book made its way, and prepared an ever-growing army of readers for *Silas Marner* (1861), *Romola* (1862–63), and *Felix Holt* (1866). *The Spanish Gypsy* (1868), a drama in blank verse, received more public response than most compositions of the kind executed by those connected with the drama or with poetry only; and she published in 1874 another volume of verses, *The Legend of Jubal and other Poems.*

Any depression which the author may have felt with regard to the faults found with some of the last named books was completely cured by the praise bestowed on *Middlemarch* (1873). This profound study of certain types of English character was supreme at the time of its writing, and it remains supreme, of its school, in European literature. Thackeray is brilliant; Tolstoi is vivid to a point where life, not art, seems the question at issue; Balzac created a whole world; George Eliot did not create, but her exposition of the upper and middle class minds of her day is a masterpiece of scientific psychology. *Daniel Deronda* (1876), a production on the same lines, was less satisfactory. It exhibited the same human insight, the passionate earnestness, the insinuated special pleading for hard cases, the same intellectual strength, but the subject was unwieldy, almost forbidding, and, as a result, the novel, in spite of its distinction, has never been thoroughly liked. The death of Mr Lewes in 1878 was also the deathblow to her artistic vitality. She corrected the proofs of *Theophrastus Such* (a collection of essays), but she wrote no more. About two years later, however, she married Mr J. W. Cross, a gentleman whose friendship was especially congenial to a temperament so abnormally dependent on affectionate understanding as George Eliot's. But she never really recovered from her shock at the loss of George Lewes, and died at 4 Cheyne Walk, Chelsea, on the 22nd of December 1880.

No right estimate of her, whether as a woman, an artist, or a philosopher, can be formed without a steady recollection of her infinite capacity for mental suffering, and her need of human support. The statement that there is no sex in genius is, on the face of it, absurd. George Sand, certainly the most independent and dazzling of all women authors, neither felt, nor wrote, nor thought as a man. Saint Teresa, another great writer on a totally different

plane, was pre-eminently feminine in every word and idea. George Eliot, less reckless, less romantic than the Frenchwoman, less spiritual than the Spanish saint, was more masculine in style than either, but her outlook was not, for a moment, the man's outlook; her sincerity, with its odd reserves, was not quite the same as a man's sincerity, nor was her humour that genial, broad, unequivocal humour which is peculiarly virile. Hers approximated, curiously enough, to the satire of Jane Austen, both for its irony and its application to little everyday affairs. Men's humour, under all its headings, is on the heroic rather than the average scale. It is for the uncommon situations, not the daily tea-table. Again, George Eliot was a little scornful to those of both sexes who had neither special missions nor the consciousness of this deprivation. Men are seldom in favour of missions in any field. She demanded, too strenuously from the very beginning, an aim, more or less altruistic, from every individual, and as she advanced in life this claim became the more imperative, till at last it overpowered her art, and transformed a great delineator of humanity into an eloquent observer with far too many personal prejudices. But she was altogether free from cynicism, bitterness, or the least tendency to pride of intellect. She suffered from bodily weakness the greater part of her life, and but for an extraordinary mental health—inherited from the fine yeoman stock from which she sprang—it is impossible that she could have retained, at all times, so sane a view of human conduct, or been the least sentimental among women writers of the first rank—the one wholly without morbidity in any disguise. The accumulation of mere book knowledge, as opposed to the friction of a life spent among all sorts and conditions of men, drove George Eliot at last to write as a specialist for specialists: joy was lost in the consuming desire for strict accuracy: her genius became more and more speculative, less and less emotional. The highly trained brain suppressed the impulsive heart,—the heart described with such candour and pathos as Maggie Tulliver's in *The Mill on the Floss.* For this reason—chiefly because philosophy is popularly associated with inactive depression, whereas human nature is held to be eternally exhilarating — her later works have not received so much praise as her earlier productions. But one has only to compare *Romola* or *Daniel Deronda* with the compositions of any author except herself to realize the greatness of her designs, and the astonishing gifts brought to their final accomplishment.

*Life of George Eliot.* Edited by J. W. CROSS. 3 vols. 1885–87. (P. M. T. C.)

**Crossen,** a town of Prussia, at the influx of the Bober into the Oder, 31 miles south-east of Frankfurt by rail, capital of the circle of Crossen, Government district of Frankfurt. It has two Protestant and one Catholic church, a *real*, a mechanics', a horticultural, and other schools, and a brisk shipping trade. Population (1890), 6657; (1895), 7911; (1900), 7369.

**Crowe, Sir Joseph Archer** (1828–1896), English consular official and art critic, was born in London on 25th October 1828. At an early age he showed considerable aptitude for painting, and entered the studio of Paul Delaroche in Paris, where his father then resided as correspondent of the *Morning Chronicle*, but he never achieved any great distinction with the brush. During the Crimean War he was the correspondent of the *Illustrated London News*, and during the Austro-Italian War represented the *Times* in Vienna. He was British consul-general in Leipzig from 1860 to 1872, and in Düsseldorf from 1872 to 1880, when he was appointed commercial attaché in Berlin, being transferred in a like capacity to Paris in 1882. In 1883 he was secretary to the Danube Conference in London; in 1889 plenipotentiary at the Samoa Conference in Berlin; and in 1890 British envoy at the Telegraph Congress in Paris, in which year he was made K.C.M.G. During a sojourn in Italy, 1846–1847, he cemented a lifelong friendship with the Italian painter Cavalcaselle, and the two friends engaged in works of artistic research. Notable among these are *Early Flemish Painters* (London, 1857); *A New History of Painting in Italy from the Second to the Sixteenth Century* (London, 1864–66, 3 vols.). The latest work from his own pen was *Reminiscences of Thirty-Five Years of My Life.* He died at Schloss Gamburg in Bavaria on 6th September 1896.

**Crowther, Samuel Adjai** (18? –1891), African missionary-bishop, was born in Yoruba, and was sold into slavery in 1821. Next year he was rescued, with many other captives, by H.M. ship *Myrmidon*, and was landed at Sierra Leone. Educated there in one of the Church Missionary Society's schools, he was baptized on 11th December 1825. In the course of time he became a teacher at Fousah Bay, and afterwards an energetic missionary on the Niger. Summoned to England in 1842, he entered the Church Missionary College at Islington. On 11th June in the following year he was ordained by Bishop Blomfield. Returning to his native land, he laboured with great success amongst his own people, and afterwards at Abeokuta. Here he devoted himself to the preparation of school-books, and the translation of the Bible and Prayer-Book into Yoruba and other dialects. He also established a trade in cotton, and improved the native agriculture. In 1857 he commenced the third expedition up the Niger, and after labouring with varied success, and encountering great danger from a powerful native chieftain, returned to England and was consecrated, on St Peter's Day 1864, first Bishop of the Niger Territories, and was warmly welcomed in his native land. Before long a commencement was made of the missions to the Delta of the Niger, and between 1866 and 1884 congregations of Christians were formed at Bonny, Brass, and New Calabar, but the progress made was slow and subject to many impediments. In 1872, during a violent persecution, two converts suffered martyrdom. In 1888 the tide turned, and several chiefs embraced Christianity, and on Bishop Crowther's return from another visit to England, the large iron church known as "St Stephen's Cathedral" was opened, and all the objects of superstitious worship were given up. For three years more the bishop laboured, and then died of paralysis at the end of October 1891, having displayed as a missionary for many years untiring industry, great practical wisdom, and deep piety. (G. F. M*.)

**Croydon,** a parish and county borough, 10 miles south of London by rail, in the north-east of Surrey. It was once supposed to mark the site of the Roman station *Noviomagus*, but this opinion is now rejected, and Holwood Hill, Keston, is believed to be the true site of that station. It was formed into a municipal borough in 1883, a parliamentary borough in 1885, and a county borough in 1888. The population of the registration district was in 1881, 101,241; in 1891, 151,771; and in 1901, 194,425. The population of the county borough in 1891 was 102,695, and in 1901, 133,885. The parish church of St John the Baptist appears to have been built in the 14th and 15th centuries, but to have contained remains of an older building. The church was restored or rebuilt in the 16th century, and again restored by Sir Gilbert G. Scott in 1857–59. It was destroyed by fire, with the exception of the tower, on 5th January 1867, and

was at once rebuilt by Scott on the old lines. Addington Park, 3½ miles from Croydon, was purchased for the residence, in 1807, of the archbishop of Canterbury, but was sold in consequence of Archbishop Temple's decision to reside at the Palace, Canterbury. Whitgift's Hospital (1596) was restored in 1860, and the Whitgift Grammar School was built in 1871. Few towns have developed the modern spirit so thoroughly as Croydon has. It makes full use of electric lighting, and has one of the lowest death-rates in the United Kingdom.

**Crozet Islands,** an uninhabited insular group in the Indian Ocean, 46°–47° S. and 50° E. They are mountainous, with summits from 4000 to 5000 feet high, and are disposed in two divisions—Penguin or Inaccessible, Hog, Possession, East; and the Twelve Apostles. Like Kerguelen, Heard, Prince Edward, Marion, and the other clusters in these southern waters, they appear to be of igneous formation; but owing to the bleak climate and their inaccessible character they are seldom visited, and have never been explored since their discovery by Marion in 1771. Possession, the highest, has a snowy peak said to exceed 5000 feet. Hog takes its name from the animals which were here let loose by an English captain many years ago, but have since disappeared. Rabbits burrow in the heaps of scoria on the slopes of the mountains.

**Cruikshank, George** (1792–1878), English artist, caricaturist, and illustrator, was born in London on the 27th September 1792. By natural disposition and collateral circumstances he may be accepted as the type of the born humoristic artist predestined for this special form of art. His grandfather had taken up the arts, and his father, Isaac Cruikshank, followed the painter's profession. Amidst these surroundings the children were born and brought up, their first playthings the materials of the arts their father practised. George followed the family traditions with amazing facility, easily surpassing his compeers as an etcher. When the father died, about 1811, George, still in his "teens," was already a successful and popular artist. All his acquisitions were native gifts, and of home-growth; outside training, or the serious apprenticeship to art, were dispensed with, under the necessity of working for immediate profit. This lack of academic training the artist at times found cause to regret, and at some intervals he made exertions to cultivate the knowledge obtainable by studying from the antique and drawing from life at the schools. From boyhood he was accustomed to turn his artistic talents to ready account, disposing of designs and etchings to the printsellers, and helping his father in forwarding his plates. Before he was twenty his spirited style and talent had secured popular recognition; the contemporary of Gillray, Rowlandson, Alken, Heath, Dighton, and the established caricaturists of that generation, he developed great proficiency as an etcher. Gillray's matured and trained skill had some influence upon his executive powers, and when the older caricaturist passed away in 1815, George Cruikshank had already taken his place as a satirist. Prolific and dexterous beyond his competitors, for a generation he delineated Tories, Whigs, and Radicals with fine impartiality. Satirical capital came to him from every public event,—wars abroad, the enemies of England (for he was always fervidly patriotic), the camp, the Court, the Senate, the Church; low life, high life; the humours of the people, the follies of the great. In this wonderful gallery the student may grasp the popular side of most questions which for the time being engaged public attention.

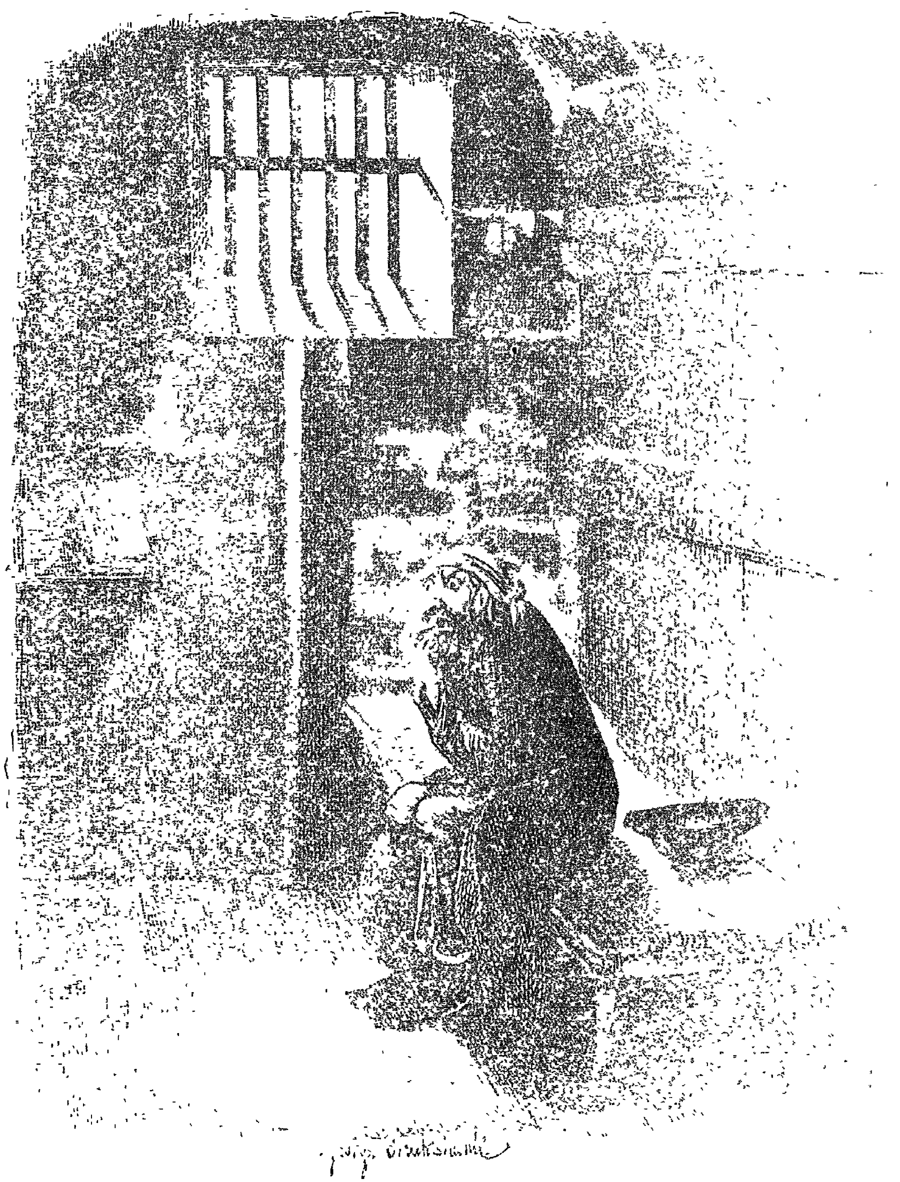
A vast number of Cruikshank's spirited cartoons were published as separate caricatures, all coloured by hand; others formed series, or were contributed to satirical magazines, the *Satirist, Town Talk, The Scourge* (1811–16), and the like ephemeral publications. In conjunction with William Hone's scathing tracts, G. Cruikshank produced political satires to illustrate the series of facetiæ and miscellanies, like *The Political House that Jack Built* (1819).

Of a more genially humoristic order are his well-known book illustrations, now so deservedly esteemed for their inimitable fun and frolic, among other qualities, such as the weird and terrible, in which he excelled. Early in this series came *The Humorist* (1819–21) and *Life in Paris* (1822). The well-known series of *Life in London*, conjointly produced by the brothers I. R. and G. Cruikshank, has enjoyed a prolonged reputation, and is still sought after by collectors. Grimm's *Collection of German Popular Stories* (1824–26), in two series, with 22 inimitable etchings, are in themselves sufficient to account for G. Cruikshank's reputation. To the first fourteen volumes (1837–43) of *Bentley's Miscellany*, Cruikshank contributed 126 of his best plates, etched on steel, including the famous illustrations to *Oliver Twist, Jack Sheppard, Guy Fawkes*, and *The Ingoldsby Legends*. For W. Harrison Ainsworth, Cruikshank illustrated *Rookwood* (1836), and *The Tower of London* (1840); the first six volumes of *Ainsworth's Magazine* (1842–44) were illustrated by him with several of his finest suites of etchings. For C. Lever's *Arthur O'Leary* he supplied 10 full-page etchings (1844), and 20 spirited graphic etchings for Maxwell's lurid *History of the Irish Rebellion in 1798* (1845). Of his own speculations, mention must be made of *George Cruikshank's Omnibus* (1841) and *George Cruikshank's Table Book* (1845), as well as his *Comic Almanack* (1835–1853). *The Life of Sir John Falstaff* contained 20 full-page etchings (1857–58). These are a few leading items amongst the thousands of illustrations emanating from that fertile imagination. As an enthusiastic teetotal advocate, G. Cruikshank produced a long series of pictures and illustrations, pictorial pamphlets, and tracts; the best known of these are *The Bottle*, 8 plates (1847), with its sequel, *The Drunkard's Children*, 8 plates (1848), with the ambitious work, *The Worship of Bacchus*, published by subscription after the artist's oil painting, now in the National Gallery, London, to which it was presented by his numerous admirers.

Regarding manual dexterity, George Cruikshank's technical and manipulative skill as an etcher was such that Ruskin and the best judges have placed his productions in the foremost rank; in this respect his works have been compared favourably with the masterpieces of etching. George Cruikshank died at 263 Hampstead Road on 1st February 1878, aged 86 years. His remains rest in St Paul's Cathedral. (J. GO*.)

**Crustacea.** Carcinology, as the science of crustacea is now called, begins with Aristotle, and, making no substantial advance in the days of Pliny, Aelian, Oppian, recommences in the 16th century with the writings of Rondelet, Belon, and Gesner. After several authors of various calibre, such as Friderich Martens, Ray, Swammerdam, Fritsch, had made more or less useful contributions to it, the science in the middle of the 18th century entered upon its modern phase under the auspices of Linnæus, though without much assistance from that great naturalist in person. His voluminous contemporaries Seba and Gronovius were still somewhat mediæval, while Pallas of the same date in time was a modern in spirit. But carcinology at large first took shape and definiteness in the last quarter of the 18th century through the writings of J. C. Fabricius, beginning with his *Systema Entomologiæ* in 1775. Important aid was rendered also by the works of O. F. Müller and J. F. Herbst. During the first quarter of the next century a great advance was made by the numerous writings of Latreille and Leach. From 1828 to 1855 the dominant writers were Henri Milne-Edwards, Henrik Krøyer, and J. D. Dana, the first producing his still valuable *Histoire naturelle des Crustacés*, the second his long series of important papers in the Danish *Naturhistorisk Tidsskrift*, and the third, after many preliminary essays, his vast report on the crustacea of the U.S. Exploring Expedition under Wilkes. During the same period other notable expeditions collected crustacea, and other eminent observers wrote about them, among well-known names being those of Guérin-Méneville, Vaughan Thompson, Lucas, Zaddach, Rathke, the two Costas, Harry Goodsir, Adam White, and Dr Baird. During the next ten or twelve years, with the older authors for the most part still writing, we find prominent the additional names of

"Oliver Twist asking for more."



"Fagin in his Cell."

ILLUSTRATIONS FOR *OLIVER TWIST.* By GEORGE CRUIKSHANK.

Leydig, Lilljeborg, Stimpson, Westwood, Bate, Kinahan, Thorell, and the incipient merit of Alphonse Milne-Edwards, C. Claus, and G. O. Sars. Thenceforward down to the present day the bibliography of crustacea exhibits a host of writers and a flood of records. From every zone, from water fresh, brackish, or saline, exposed or subterranean, from the surface of sea or lake down to almost every accessible depth, and from the surface of the land up to almost every accessible height, crustacea have been obtained, captured by new devices, examined by new methods, studied with a new zeal, and revealing new forms and relations in a previously unsuspected and still unceasing and increasing variety. From the axils of a plant to the nostrils of a fish or the intestines of an annelid, crustaceans can accommodate themselves to every kind of strange habitation, and the descriptions of them are often equally fugacious, since they may have to be tracked through an indefinite number of serials in nine or ten different languages. For an effective grasp of knowledge already acquired, and the adjustment of future acquisitions, it is clear that the mind of the naturalist is always yearning for classification;—in the crustacea the basis for this has been sought in many directions,—in the general shape, the eyes, the locomotive appendages, the mouth-organs, the breathing apparatus, the structure of the stomach, the genital organs, the circulatory and nervous systems, the development of the young, and the phylogeny. Unfortunately the last, which would be most decisive for a natural system, is likely always to remain the most speculative. On the other hand, parts of the organism which might seem least adapted for systematic purposes may be of service, since a high authority has stated that in the Copepoda the number and distribution of the hairs on the swimming-feet are capable of affording valuable characters for genera, or even for subfamilies.

As might be expected, in the great expansion of the class, with so much attention concentrated on its arrangement, numerous classificatory changes have been proposed, and many of them have been established on apparently satisfactory grounds, during recent years. But these alterations leave us at liberty to maintain the three leading divisions, the Malacostraca, Entomostraca, and Thyrostraca, while keeping apart the small group of the Leptostraca, established by Claus for the Nebaliidæ, as a connecting link between the first division and the second. Briefly, all the four may be distinguished as follows:

Malacostraca are those crustacea in which, apart from an ocular segment and telson, the assignable segments are nineteen in number. The first antennæ often have more than one branch.

Leptostraca have more than nineteen segments, and a second branch on their first antennæ.

In the rest of the crustacea the assignable segments are more or fewer than nineteen, and the first antennæ never have more than one branch. These form two divisions:—

Entomostraca, in which the antennæ of normal adults are unconcealed; and

Thyrostraca, more commonly called Cirripedia, in which the antennæ of adults are concealed.

Another division, named Gigantostraca, including the extinct Merostomata and Trilobita, and the still existing Xiphosura, represented by *Limulus*, the so-called king-crab, is by some eminent authorities altogether banished from the class of crustacea. By others the affinity of trilobitas and king-crabs with *Apus* and other phyllopod entomostracans is strictly maintained.

In regard to the Leptostraca it is worthy of note that G. H. Parker, in the *Mittheilungen aus der zoologischen Station zu Neapel* for 1895, endorses the opinion of Claus on the optic ganglia of the Nebaliidæ, both authors holding that these belong rather to the Malacostracan than to the Entomostracan type. On the other hand, the trunk limbs in this family are strikingly phyllopodan in character.

The unity of the whole crustacean class often receives unexpected illustrations, thus it is a notable characteristic of the Malacostraca that the seven pairs of limbs of the middle body are seven-jointed, although through subdivision or coalescence this peculiarity may be obscured in some of these limbs. But that the number of seven joints should be normal also for the maxillipeds, which immediately precede the median appendages above mentioned, is interesting less as a distinctive character of the Malacostraca, than for the opposite reason, as connecting them with the Entomostraca, inasmuch as the same number of joints is found to recur in what are now understood to be the homologous maxillipeds of the Copepoda.

An exposition of the present state of science in regard to each of the divisions above distinguished will be given under its own name, except that the linking Leptostraca, will, for convenience, be grouped with their allies (nearer or more remote), the Entomostracan Phyllopoda.

(T. R. R. S.)

**Csaba (Békés),** a market-town of Central Hungary, nearly 50 miles south-west of Grosswardein. There are many industrial establishments (including 8 steam mills), a Lutheran gymnasium, and a theatre. Population (1891), 34,243; (1900), 37,547.

**Csengery, Anton** (1822–1880), Hungarian publicist, and a historical writer of great influence on his time, was born at Nagyvárad on the 2nd of June 1822. He took, at an early date, a very active part in the literary and political movements immediately preceding the Hungarian Revolution of 1848. He and Baron Sigismund Kemény may be considered as the two founders of high-class Magyar journalism. After 1867 the greatest of modern Hungarian statesmen, Francis Deák, attached Csengery to his personal service, and many of the momentous state documents inspired or suggested by Deák were drawn up by Csengery. In that manner his influence, as represented by the text of many a statute regulating the relations between Austria and Hungary, is one of an abiding character. As an historical writer he excelled chiefly in brilliant and thoughtful essays on the leading political personalities of his time, such as Paul Nagy, Bertalan, Szemere, and others. He also commenced a translation of Macaulay's *History*. He died at Budapest on the 13th of July 1880.

**Csiky, Gregor** (1842–1891), one of the foremost dramatists of modern Hungary, was born on the 8th of December 1842 at Pankota, in the county of Arad. He studied Roman Catholic theology at Pest and Vienna, and was Professor in the Priests' College at Temesvar from 1870–78. In the latter year, however, he joined the Evangelical Church, and took up literature. Beginning with novels and works on ecclesiastical history, which met with some recognition, he ultimately devoted himself to writing for the stage. Here his career was one of almost instantaneous success. Already in his *Az ellenállhatatlan* ("L'Irresistible"), which obtained a prize from the Hungarian Academy, he showed the distinctive features of his talent—directness, freshness, realistic vigour, and highly individual style. In rapid succession he enriched Magyar literature with realistic *genre*-pictures, such as *A Proletárok* ("Proletariate"), *Buborékok* ("Bubbles"), *Két szerelem* ("Two Loves"), *A szégyenlős* ("The Bashful"),

*Athalia*, &c., in all of which he seized on one or another feature or type of modern life, dramatizing it with unusual intensity, qualified at the same time by chaste and well-balanced diction. Of the latter, his classical studies may, no doubt, be taken as the inspiration, and his translation of Sophocles and Plautus will long rank with the most successful of Magyar translations of the ancient classics. Among the best known of his novels are *Arnold*, *Az Atlasz család* ("The Atlas Family"). He died at Budapest on the 19th November 1891.

**Csongrád,** a large market-town of Hungary, at the confluence of the Tisza and Körös. It has a population (1900) of 22,619,—all Hungarians,—chiefly engaged in agriculture, for which the fine soil of the district (57,623 acres) is specially adapted.

**Csorba, Lake of,** a tourist centre in the county of Liptò, North Hungary, situated in the Tátra Mts., 4432 feet above sea-level. The lake, which is called the "Pearl of the Tátra," is of inconsiderable size, but its picturesque position at the foot of the highest snow-covered peaks, bordered by dense pine-forests, has given it a great vogue, and since 1895 it has been connected by a mountain railway with the chief line from Kassa to Oderberg.

**Ctenophora** were briefly described by Professor Huxley in 1875 (see ACTINOZOA, *Ency. Brit.* vol. i.) as united with what we now term Anthozoa to form the group Actinozoa; but little was known of the intimate structure of those remarkable and beautiful forms till the appearance in 1880 of Chun's Monograph of the Ctenophora occurring in the Bay of Naples. They may be defined as Cœlentera which exhibit both a radial and bilateral symmetry of organs; with a stomodæum; with a mesenchyma which is partly gelatinous but partly cellular; with eight meridianal rows of vibratile paddles formed of long fused or matted cilia; lacking nematocysts (except in one genus). An example common on the British coasts is furnished by Hormiphora. In outward form this is an egg-shaped ball of clear jelly, having a mouth at the pointed (oral) pole, and a sense-organ at the broader (aboral) pole. It possesses eight meridians (costæ) of iridescent paddles in constant vibration, which run from near one pole towards the other: it has also two pendent feathery tentacles of considerable length, which can be retracted into pouches. The mouth leads into an ectodermal stomodæum ("stomach"), and the latter into an endodermal funnel (infundibulum); these two are compressed in planes at right angles to one another, the sectional long axis of the stomodæum lying in the so-called sagittal (stomodæal or gastric) plane, that of the funnel in the transverse (tentacular or funnel) plane. From the funnel, canals are given off in three directions: (*a*) a pair of paragastric (stomachal, or stomodæal) canals run orally, parallel to the stomodæum, and end blindly near the mouth; (*b*) a pair of perradial canals run in the transverse plane towards the equator of the animal; each of these becomes divided into two short canals at the base of the tentacle sheath which they supply, but has previously given off a pair of short interradial canals, which again bifurcate into two adradial canals; all these branches lie in the equatorial plane of the animal, but the eight adradial canals then open into eight meridianal canals which run orally and aborally under the costæ; (*c*) a pair of aboral vessels which run towards the sense-organ, each of which bifurcates; of the four vessels thus formed, two only open at the sides of the sense-organ, forming the so-called excretory apertures. These three sets of structures, with the funnel from which they rise, make up the endodermal cœlenteron, or gastro-vascular system. The generative organs are endodermal by origin, borne at the sides of the meridianal canals as indicated by the signs ♂ ♀. There exists a subepithelial plexus with nerve cells and fibres, similar to that of jelly-fishes. The sense-organ of the aboral pole is complex, and lies under a dome of fused cilia shaped like an inverted bell-jar; it consists of an otolith, formed of numerous calcareous spheroids, which is supported on four plates of fused cilia termed balancers, but is otherwise free. The ciliated ectoderm below the organ is markedly thickened, and perhaps functionally represents a nerve-ganglion: from it eight ciliated furrows radiate outwards, two passing under each balancer as through an archway, and diverge each to the head of a meridianal costa. These ciliated furrows stain deeply with osmic acid, and nervous impulses are certainly transmitted along them. Locomotion is effected by strokes of the paddles in an aboral direction, driving the animal mouth forwards through the water: each paddle or comb (hence Ctenophora) consists of a plate of fused or matted cilia set transversely to the costa. The myoepithelial cells (= neuro-muscular cells of *Ency. Brit.* vol. xii. p. 549), characteristic of other Cœlentera, are not to be found in this group. On the other hand there are well-marked muscle fibres in definite layers, derived from special mesoblastic cells in the embryo, which are embedded in a jelly; these in their origin and arrangement are quite comparable to the mesoderm of Triploblastica, and, although the muscle-cells of some jelly-fish exhibit a

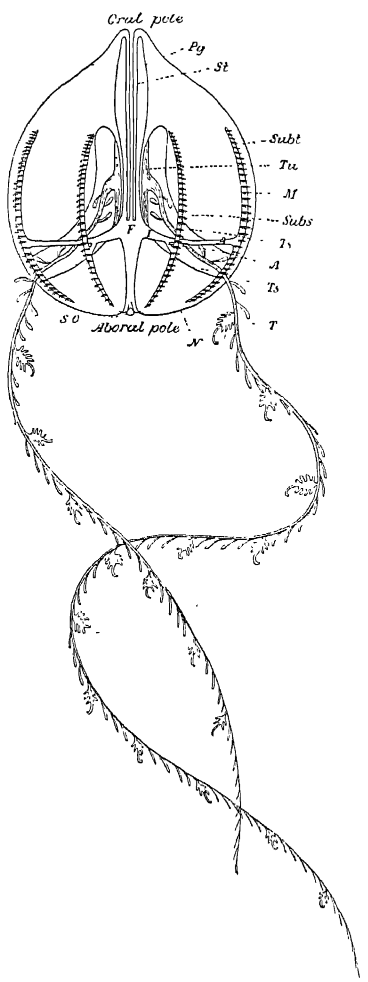



FIG. 1.—Schematic drawing of a cydippid from the side. (*After Chun.*) *A*, adradial canals; *F*, infundibulum; *I*, interradial canal: *M*, meridianal canal lying under a costa; *N*, ciliated furrow from sense pole to costa; *Pg*, paragastric canal; *SO*, sense-organ; *St*, stomodæum; *Subs*, sub-sagittal costa; [illegible]cular costa; *T*, tentacle; *Ts*, boundaries of tentacle-sheath.

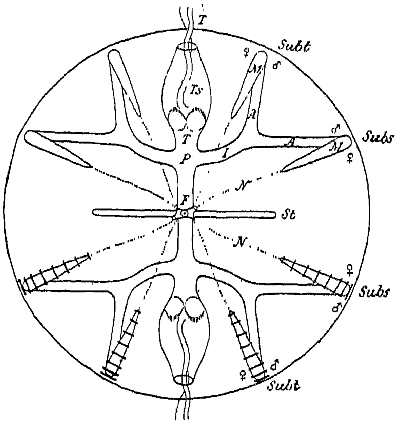



FIG. 2.—Schematic drawing of a cydippid from the aboral pole. (*After Chun.*) *T* (centrally), tentacular canal, and (distally) tentacle; ♂, position of testes; ♀, position of ovaries; other letters as in Fig. 1. The stomodæum lies in the sagittal plane, the funnel and tentacles in the transverse or tentacular plane.

somewhat similar condition, nothing so highly specialized as the mesenchyme of Ctenophora occurs in any other Cœlenterate. The nematocysts being nearly absent from their group, their chief function is carried out by adhesive lasso-cells.

The Ctenophora are classified as follows:—

| | | | |
|---|---|---|---|
| Subclass i. **Tentaculata**, | Order 1. Cydippidea, | *Hormiphora.* |
| | ,, 2. Lobata, | *Deiopea.* |
| | ,, 3. Cestoidea, | *Cestus.* |
| ,, ii. **Nuda**, | ,, | *Beroe.* |

The **Tentaculata**, as the name implies, may be recognized by the presence of tentacles of some sort. The Cydippidea are generally spherical or ovoid, with two long retrusible pinnate tentacles: the meridianal and paragastric canals end blindly. An example of these has already been briefly described. The Lobata are of the same general type as the first Order, except for the presence of four circumoral auricles (processes of the subtransverse costæ) and of a pair of sagittal outgrowths or lobes, on to which the subsagittal costæ are continued. Small accessory tentacles lie in grooves, but there is no tentacular pouch; the meridianal vessels anastomose in the lobes. In the Cestoidea the body is compressed in the transverse plane, elongated in the sagittal plane, so as to become riband-like: the subtransverse costæ are greatly reduced, the subsagittal

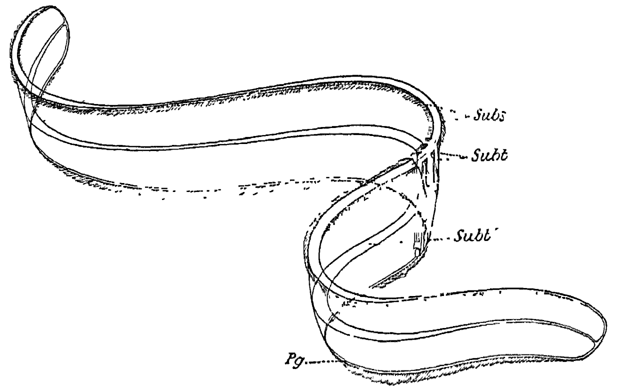



Fig. 3.—Schematic drawing of cestus. (*After Chun.*) *Subs*, subsagittal costæ; *Subt*, much reduced subtentacular costæ; *Subt*, branch of the subtentacular canal which runs along the centre of the riband; *Pg*, continuation of the paragastric canal at right angles to its original direction along the lower edge of the riband. At the right hand end the last two are seen to unite with the subsagittal canal.

costæ extend along the aboral edge of the riband. The subsagittal canals lie immediately below their costæ aborally, but continuations of the subtransverse canals round down the middle of the riband, and at its end unite, not only with the subsagittal, but also with the paragastric canals which run along the oral edge of the riband. The tentacular bases and pouches are present, but there is no main tentacle as in Cydippidea; fine accessory tentacles lie in four grooves along the oral edge. The subclass **Nuda** have no tentacles of any kind; they are conical or ovoid, with a capacious stomodæum like the cavity of a thimble. There is a cœlenteric network formed by anastomoses of the meridianal and paragastric canals all over the body.

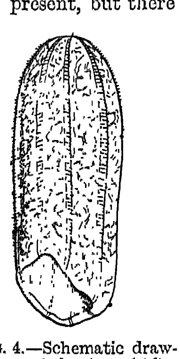


Fig. 4.—Schematic drawing of beröe. (*After Chun.*)

The embryology of Callianira has been worked out by Metschnikoff. Segmentation is complete and unequal, producing macromeres and micromeres marked by differences in the size and in yolk-contents. The micromeres give rise to the ectoderm; each of the sixteen macromeres, after budding off a small mesoblast cell, passes on as endoderm. A gastrula is established by a mixed process of embole and epibole. The mesoblast cells travel to the aboral pole of the embryo, and there form a cross-shaped mass, the arms of which lie in the sagittal and transverse planes (perradii).

There can be but little question of the propriety of including Ctenophora among the Cœlentera. The undivided cœlenteron (gastro-vascular system) which constitutes the sole cavity of the body, the largely radial symmetry, the presence of endodermal generative organs on the cœlenteric canals, the subepithelial nerve-plexus, the mesoglœa-like matrix of the body—all these features indicate affinity to other Cœlentera, but, as has been stated in the article under that title, the relation is by no means close. In the ninth edition of this work (see Hydrozoa) some stress was laid on Haeckel's discovery of Ctenaria as a possible link-form between Hydromedusæ and Ctenophora, but this view has now been generally abandoned. At what period the Ctenophora branched off from the line of descent, which culminated in the Hydromedusæ and Scyphozoa of to-day, is not clear, but it is practically certain that they did so before the point of divergence of these two groups from one another. The peculiar sense-organ, the specialization of the cilia into paddles with the corresponding modifications of the cœlenteron, the anatomy and position of the tentacles, and, above all, the character and mode of formation of the mesenchyme, separate them widely from other Cœlentera.

The last-named character, however, combined with the discovery of two remarkable organisms, Cœloplana and Ctenoplana, has suggested affinity to the flat-worms termed Turbellaria. Ctenoplana, the best known of these, has recently been redescribed by Willey (*Quart. Journ. Micr. Sci.* xxxix., 1896). It is flattened along the axis which unites sense-organ and mouth, so as to give it a dorsal (aboral) surface, and a ventral (oral) surface on which it frequently creeps. Its costæ are very short, and retrusible; its two tentacles are pinnate and are also retrusible. Two crescentic rows of ciliated papillæ lie in the transverse plane on each side of the sense-organ. The cœlenteron exhibits six lobes, two of which Willey identifies with the stomodæum of other Ctenophora; the other four give rise to a system of anastomosing canals such as are found in Beröe and Polyclad Turbellaria. An aboral vessel embraces the sense-organ, but has no external opening. Ctenoplana is obviously a Ctenophoran flattened, and of a creeping habit. Cœloplana is of similar form and habit, with two Ctenophoran tentacles: it has no costæ, but is uniformly ciliated. These two forms at least indicate a possible stepping-stone from Ctenophora to Turbellaria, that is to say, from Diploblastic to Triploblastic Metazoa. By themselves they would present no very weighty argument for this line of descent from two-layered to three-layered forms, but the coincidences which occur in the development of Ctenophora and Turbellaria,—the methods of segmentation and gastrulation, of the separation of the mesoblast cells, and of mesenchyme formation,—together with the marked similarity of the adult mesenchyme in the two groups, have led many to accept this pedigree. In his Monograph on the Polyclad Turbellaria of the Bay of Naples, Lang regards a Turbellarian, so to say, as a Ctenophora, in which the sensory pole has rotated forwards in the sagittal plane through 90° as regards the original oral-aboral axis, a rotation which actually occurs in the development of Thysanozoon (Müller's larva); and he sees, in the eight lappets of the preoral ciliated ring of such a larva, the rudiments of the costal plates. According to his view, a simple early Turbellarian larva, such as that of Stylochus, most nearly represents for us to-day that ancestor from which Ctenophora and Turbellaria are alike derived. For details of this brilliant theory, the reader is referred to the original monograph.

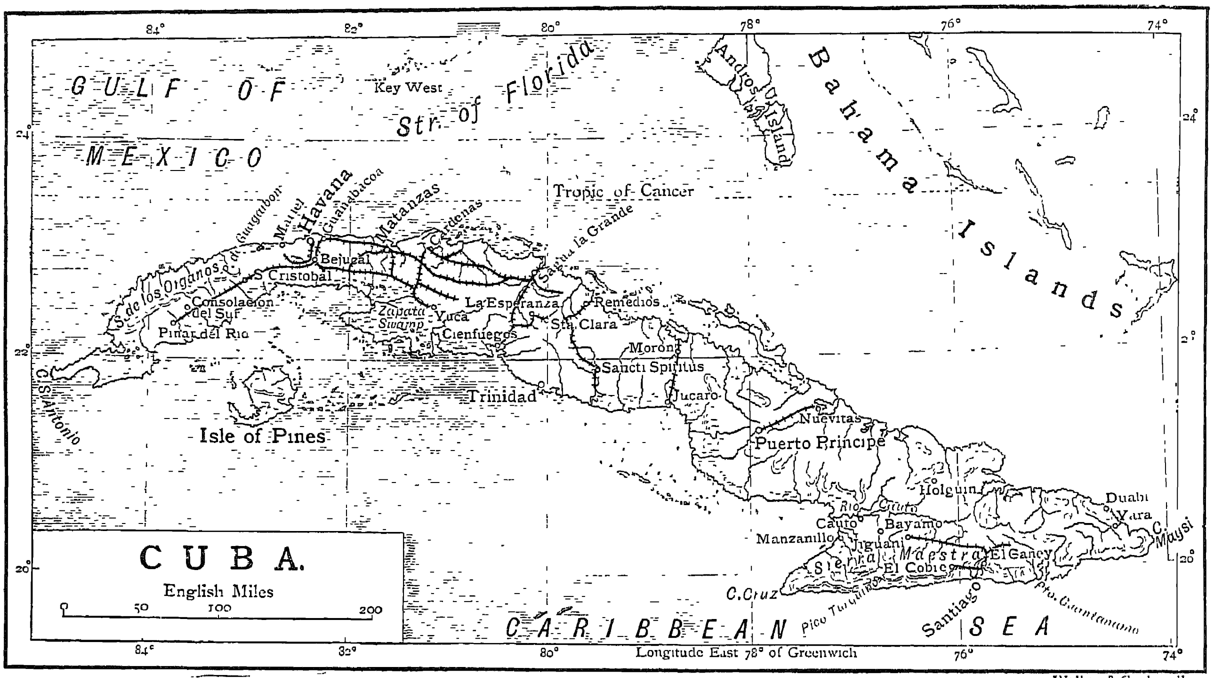
A list of the chief works relating to the group may be found at the end of Bourne's chapter on Ctenophora, in part ii. of Lankester's *Treatise on Zoology* (1900).

(G. H. Fo.)

# CUBA.

## I. Geography and Statistics.

CUBA is the largest and most populous of the West India islands. It lies directly south of Florida, the south-easternmost of the United States, being separated from it by the Strait of Florida, 100 miles in width. It is included between the meridians of 74° and 85° W. of Greenwich, and the parallels of 19° 40′ and 23° 33′ N. latitude. Its length from Cape Maisi on the east to Cape San Antonio on the west is 730 miles, while its breadth from north to south ranges from 25 miles in the neighbourhood of Havana to 100 miles in the eastern part of the island. Its area, including the Isle of Pines, which is under its jurisdiction, is 44,000 square miles. In its relief the island presents little appearance of unity of plan. West of Havana it is traversed, in a direction parallel to its length, by a mountain range, the Sierra de los Organos, whose summits rise to altitudes of 2000 to 2500 feet, culminating in Pan de Guagaibon, with the latter altitude. To the north and south of the crest of this range the land slopes to the coast, the southern slopes, known as Vuelta de Abajo, being the most celebrated tobacco lands of the island. The middle portion of the island consists mainly of low rolling plains, with shallow stream-valleys, rising in a few places into plateaux, which have been deeply dissected by erosion. The eastern portion of the island is mountainous, consisting in great part of a plateau, 2000 to 3000 feet high, deeply cut by streams, while closely bordering the southern coast from Santiago westward to Cape Cruz is Sierra Maestra, rising to an average altitude of 5000 feet, and culminating in Pico Turquino, said to be 8320 feet high. The rivers of Cuba are short, and except for the estuaries at their mouths, are not navigable. The only exception is the Rio Cauto, the largest river of the island, which drains a broad and fertile valley lying north of Sierra Maestra. This river has




Walker & Cockerell sc.

a length of 150 miles, one-third of which is navigable for light-draught vessels. Much of the south coast of the island is bordered by swamps, which in the longitude of Matanzas expand to a great breadth, 75 by 30 miles, forming the Zapata Swamp. Much of the north coast, especially along the middle part of the island, is fringed by low mangrove-covered islets, which are in the main uninhabited. The harbours are numerous and excellent. Most of them are pouch-shaped, with narrow, often sinuous, entrances, expanding in the interior into broad lakes, completely sheltered. Of this type are the harbours of Havana, Santiago, Cienfuegos, Guantanamo, and many others.

*Climate.*—The climate may be characterized as tropic and insular. At Havana, on the north coast, the mean annual temperature is 77° F., with a range of but 11° between the mean temperature of the warmest and the coldest months. Inland and upon the south coast the temperature is probably somewhat greater, the climate of the north coast being tempered by the north-east trades, the prevailing winds. The mean annual rainfall at Havana is 52 inches, while inland it is probably greater, and upon the south coast less. About two-thirds of this precipitation falls between May and October, in what is known as the rainy season. The mean relative humidity at Havana is 75 per cent.

*Minerals.*—The mineral resources, so far as developed, are not of great importance. Iron ore of excellent quality is mined at several points between Santiago and Guantanamo, at the south base of Sierra Maestra. The ore, though abundant, is apparently float ore, mainly hæmatite, containing about 62 per cent. of iron. Most of the product has been shipped to the United States. A copper deposit in the neighbourhood of El Cobre, said to be of enormous value, was formerly extensively worked, but since 1868 mining upon it has ceased. Asphaltum has been found in several localities, and has for some time been used in the production of illuminating gas for the city of Santa Clara. Gold and silver were mined on a small scale in past times, but none is produced at present. There is, however, every probability that thorough prospecting will discover great mineral wealth.

*Forests.*—The forests are extensive and comprise many valuable species, among which are mahogany, ebony, cedar, walnut, lignum-vitæ, oak, and many species of palm. The prevailing tree is the Cuban pine, which forms excellent lumber. It is estimated that half the area of the island is forested. Little use is at present made of the forest wealth, and its economic development awaits the construction of adequate means of transportation.

*Government.*—For administrative purposes Cuba is divided into six provinces, which, named from the west eastwards, are Pinar del Rio, Havana, Matanzas, Santa Clara, Puerto Principe, and Santiago. These are divided into municipal districts, or *terminos*, of which there were 132 at the time of the census of 1899. These, in turn, are subdivided into *barrios*, or wards, of which there were between 1100 and 1200. There are no chartered cities, and the population of cities here given has been obtained from that of the *barrios*, which are closely built. On May 20, 1902, the military occupation by the United States, which had been the form of government since the war with Spain, formally ceased, and a Cuban Republic was inaugurated under American protection; the local administration was already then in Cuban hands.

*Population.*—The population in 1899, according to the census, was 1,572,797. In 1887 it was 1,631,687, and in 1877, 1,509,291. In the twelve years preceding the latest census there was an actual diminution of population of 58,890, a result of the civil war which opened in 1895. This measures, however, only a part of the loss consequent upon the war, since the population doubtless increased up to 1895. Allowing for this increase, the loss was probably about 200,000. The average number of inhabitants to a square mile was 36. The following table gives the population and its density by provinces :—

| | Population. | Inhabitants per Square Mile. |
|---|---|---|
| Havana | 424,804 | 153 |
| Matanzas | 202,214 | 55 |
| Pinar del Rio | 173,064 | 35 |
| Puerto Principe | 88,234 | 8 |
| Santa Clara | 356,536 | 37 |
| Santiago | 327,715 | 26 |

The proportion of urban population was very high, when it is considered that nearly all the industries and products relate to agriculture. Including all places of 8000 inhabitants or more, the urban population numbered 507,831, or 32·3 per cent. of all the inhabitants, a proportion very close to that of the United States. The proportion of urban inhabitants of the several provinces differed greatly :—

| | Per cent. Urban. |
|---|---|
| Havana | 65·4 |
| Matanzas | 28·8 |
| Pinar del Rio | 5·1 |
| Puerto Principe | 28·4 |
| Santa Clara | 22·5 |
| Santiago | 17·5 |

The principal cities, with their population in 1899, are as follows:—Havana, the capital of Cuba and of Havana province, population 235,981; Santiago, on the south coast, the capital of Santiago province, population 43,090; Matanzas, on the north coast, the capital of Matanzas province, population 36,374; Cienfuegos, in Santa Clara province, on the south coast, population 30,038; Puerto Principe, situated in the interior, the capital of the province of the same name, population 25,102; Cardenas, on the north coast in Matanzas province, population 21,940; Manzanillo, on the south coast, in Santiago province, population 14,464; Guanabacoa, in Havana province, population, 13,965; Santa Clara, in the interior, the capital of Santa Clara province, population 13,763; Sagua la Grande, on the north coast, in Santa Clara province, population 12,728; Sancti Spiritus, in Santa Clara province, population 12,696; Regla, a suburb of Havana, population 11,363; and Trinidad, on the north coast in Santa Clara province, population 11,120. As to sex, the population was divided in the proportions of 51·8 per cent. males and 48·2 per cent. females, the disproportion being due to immigration.

As to race, the whites constituted nearly 68 per cent., or more than two-thirds, and the coloured, including negroes, persons of mixed blood, and Chinese, 32 per cent. The following table gives the proportions of the races in the several provinces :—

| | Per cent. White. | Per cent. Coloured. |
|---|---|---|
| Havana | 74 | 26 |
| Matanzas | 60 | 40 |
| Pinar del Rio | 73 | 27 |
| Puerto Principe | 80 | 20 |
| Santa Clara | 70 | 30 |
| Santiago | 55 | 45 |

The proportion of coloured has been diminishing since 1841, when it was 58·5 per cent. The proportion of persons of alien birth was 9 per cent. of the population, and three-fourths of these were from Spain, China and Africa contributing largely to the remainder. As in other countries, the foreign-born were proportionately more numerous in the cities than in the country, nearly one-third of this element being found in the city of Havana. During the last six months of 1900 there were 15,810 immigrants, of whom 12,676 came from Spain, 979 from the United States, and 923 from Mexico. The conjugal condition of the people was in certain respects peculiar. Of the total population in 1899 only 15·7 per cent. were lawfully married. Besides these, 8·4 per cent. of the population were living together by mutual consent, in more or less permanent unions. The proportion of married, even with the addition of those in these consensual unions, was much smaller than in Europe. Consensual unions were much more common among the coloured than among the whites.

Of the population over ten years of age, 57 per cent. were unable to read, the proportions of illiterates in the two races being, whites 49·2 per cent., and coloured 72 per cent. The public school system, which under Spanish régime existed mainly on paper, has been put into effective operation under American administration. In 1899 the census reported that only 15·7 per cent. of the children of school age attended school, the proportion of whites being somewhat greater than that of coloured. The number of schools was 1510, the number of public and private schools being about equal. The number of teachers was 2665. In 1901 there were 3567 public schools, 3608 teachers, and 172,273 enrolled scholars.

Of the population over ten years of age, 51·2 per cent. were engaged in gainful occupations. The wage-earners were distributed as follows among the great groups of occupations :—

| | Per cent. of all Wage-Earners. |
|---|---|
| Agriculture, fishing, and mining | 48·1 |
| Domestic and personal service | 22·8 |
| Manufactures | 14·9 |
| Trade and transportation | 12·8 |
| Professions | 1·4 |

Practically the only religious sect represented in Cuba is the Roman Catholic, of which nearly all the people are, nominally at least, adherents.

There are no statistics of manufactures available, but it is well known that, aside from sugar mills and cigar factories, this branch of industry is of little importance.

*Agriculture.*—In 1899 there were 60,711 farms and plantations, comprising an area of 8,761,600 acres. Of this, 901,100 acres were under cultivation, or only 3·2 per cent. of the area of Cuba. The average size of farm was 144 acres, a little larger than in the United States; and the average area cultivated per farm was 15 acres. Of the cultivated area 43·5 per cent. was owned by the occupants, and 56·5 per cent. rented or worked on shares. Again, 84·9 per cent. was occupied by whites, and only 15·1 per cent. by coloured, or in mixed occupancy of white and coloured.

The following table shows the proportion of the cultivated area which was planted in each of the principal crops, this being the only measure of products which the census furnishes:—

| | Per cent of Cultivated Area |
|---|---|
| Sugar cane | 47·3 |
| Sweet potatoes | 11·3 |
| Tobacco | 9·3 |
| Bananas | 8·6 |
| Indian corn | 7·3 |
| Malangas | 3·4 |
| Yucca | 3·2 |
| Coffee | 1·6 |
| Cocoanuts | 1·4 |
| Cocoa | 1·4 |

Sugar, which is by far the most important crop, was produced in all parts of the island, but chiefly in Santa Clara and Matanzas provinces. Tobacco also was widely distributed over the island, but nearly three-fourths of the area devoted to it was in Pinar del Rio.

Live stock on farms is summarized as follows:—

| | |
|---|---|
| Horses | 88,001 |
| Mules and asses | 20,316 |
| Cattle | 753,300 |
| Hogs | 358,868 |
| Sheep and goats | 28,546 |
| Fowls | 1,517,892 |

The sugar mills of Cuba numbered 207, with a total capacity of 8,754,192 arrobas of cane, and a daily output of 61,407 bags of 200 pounds each of sugar. In connexion with these mills were 85 stills, with a daily capacity of 161,751 gallons of rum.

*Rail and Road.*—Means of transportation are scanty. Outside of the three smallest western provinces and the neighbourhood of large cities there is not a good road in Cuba, and many of the good roads are impassable in wet weather. There are about 1100 miles of railway, most of which are in Havana, Matanzas, and the western part of Santa Clara provinces. These railways are for the most part poorly constructed and scantily equipped.

*Commerce.*—The following figures epitomize the commerce of the island in 1899 and 1900:—

| | | | | |
|---|---|---|---|---|
| Total exports | (1899) | $46,301,929 | (1900) | $49,014,962 |
| Total imports | (1899) | 66,783,111 | (1900) | 66,658,589 |

*Leading Articles of Export.*

| | | | | |
|---|---|---|---|---|
| Sugar | (1899) | $19,876,749 | (1900) | $16,886,693 |
| Tobacco | (1899) | 21,084,750 | (1900) | 26,087,968 |
| Fruit and nuts | (1899) | 355,579 | (1900) | 729,719 |
| Wood (unmanufactured) | (1899) | 166,313 | (1600) | 1,050,322 |

| Countries. | Exports. | Imports. |
|---|---|---|
| United States | $33,356,889 | $29,176,002 |
| United Kingdom | 5,427,749 | 10,463,325 |
| Spain | 830,349 | 9,755,693 |
| Germany | 5,545,827 | 2,982,779 |
| France | 1,267,241 | 3,267,570 |

During the year 1900, 12,350 vessels, with a net tonnage of 4,928,814, entered the ports of Cuba, and 11,954 vessels, with a net tonnage of 4,367,246, cleared.

(H. G*.)

## II. Recent History.

The insurrection in Cuba from 1868 to 1878 was only the prelude to the stronger movement which began in 1895, and which was destined eventually to involve the United States in war with Spain, with the result of bringing to an end Spanish sovereignty in the island. In 1878 a policy of conciliation towards the insurgents was determined upon by the Spanish Government, and General Martinez Campos was despatched to Cuba to carry this new policy into effect. Martinez Campos commanded general respect, and found little difficulty in opening negotiations with the insurgents. Reforms in the administration and a free pardon for all who had taken part in the revolt were among the stipulations agreed upon, and the abolition of slavery was decreed, although this measure only took full effect in 1886. In the autumn of 1878 General Campos met the leaders of the insurrection at Zanjon; a treaty was signed embodying the various promises and conditions. It was the non-fulfilment of the terms of this convention (commonly called "El Pacto de Zanjon") which paved the way for the insurrection organized by José Marti in 1895. For all practical purposes there was no reform in administrative methods after the Convention of Zanjon. The island continued, as formerly, to be a rich field reserved for Spanish officialdom. Corruption became more pronounced. Cubans, unless entirely pro-Spanish, were given no share in the Government, although their standard of intelligence was quite equal to, if not higher than, that of the majority of Spaniards in similar conditions of life. In these circumstances the natives bitterly resented the attitude of the Spaniards, and the estrangement between the two peoples became more marked as time went on. In 1886 a number of young students were accused of writing some derogatory verses on the tombstone of a high Spanish official. The supposed ringleaders were arrested, and three of them were condemned to death and shot. It is difficult to find any excuse for this act, and it served to deepen into hatred and fear the hostility of a large section of the population to Spanish authority. Attempts at revolt were occasionally made, but without success, owing to prompt and drastic measures taken by the Government and to the lack of organization on the part of the Cubans.

**Circumstances leading up to the insurrection.**

Meanwhile the economic condition of the island was undergoing great changes. The crisis in the sugar trade in 1883, and the fall in prices in consequence of overproduction, seriously threatened the main industry. The situation was further complicated by the abolition of slavery, which involved severe pecuniary losses to the slave-owners. The energy shown by the people of Cuba at this crisis in their affairs is deserving of the highest praise. The old factories were abandoned and great central sugar-houses erected where the process of converting the cane juice into sugar could be more cheaply effected. The newest machinery was imported and immense areas of new cane fields were planted. The estates were mortgaged to obtain the money for these changes, and so by hard work and intelligent application the principal source of wealth was saved from annihilation and brought round to a comparatively flourishing condition. During this critical period the Spanish Government gave no helping hand. Heavy duties were levied upon Cuban products, although Spanish goods entering the island were allowed important reductions as compared with merchandise from other countries. Cuba was saddled with a gold debt of $162,849,625 for bonds issued in Spain to defray military expenses and other charges from which the island derived no benefit. The population of 1,500,000 souls was called upon to find a revenue of £5,240,000 sterling to meet the service of the bonds issued in Spain and to cover the expense of the Spanish administration of the island. In reality they paid much more than this amount, on account of the extortions systematically practised by the officials. The Cubans bitterly resented the attitude of Spain, but their protests were un-

heeded. Between the years 1889 and 1893 the sugar industry increased rapidly. A treaty with the United States allowing considerable advantages to sugars of Cuban origin was a substantial aid to the situation, and in the season 1893–94 the output amounted to 1,023,719 tons. Prices during this period of expansion had been fairly remunerative. In 1895, however, a change came for the worse. The treaty with the United States was denounced, and Cuban sugars entered only on the same terms as those from other foreign countries. The value of sugar all over the world fell steadily until it reached a price which left little, if any, profit to the producer. The factory owners, who had not had time to recoup themselves for the money which they had laid out in improvements, began to feel the strain severely, and numbers of the cane-growers abandoned their fields. As the economic crisis developed, real misery and hardship began to be felt in nearly every district.

The Government of Spain so far recognized the danger of the situation as to consider seriously the acceptance of some measure of reform. Señor Maura brought forward in the Cortes a project for restricted home rule for Cuba, but after long discussion it was rejected. A scheme of modified local government was then introduced by Señor Abarzuza and accepted; but this acceptance did not entail its immediate application to Cuba and Porto Rico, as the general public was induced to believe would be the case. Indeed, the measure was never applied to the Spanish West Indian colonies, being delayed on one excuse or another until the condition of Cuba had become such that the concessions proposed were inadequate. When conciliatory measures were tried in the island, a different law of constitution was promulgated. The opinion generally expressed in Cuba was that if Señor Abarzuza's proposals had been immediately put in force, the insurrection would not have broken out in 1895, or in any case would not have received the widespread sympathy which was accorded to it. Meanwhile a powerful factor was at work, the strength of which was too lightly estimated by the Spaniards. This was in the person of José Marti, a clever and intelligent man with the gift of oratory to aid him in his work. Love of Cuba, hatred of Spain, and a desire to see the island freed from Spanish domination led him to devote his whole life to pleading for the Cuban cause, and he ended by dying for the country he loved so well, shot down soon after the insurrection broke out. Marti began his work of organization after the Zanjon Convention had been signed. Meetings were held from time to time at Key West, Tampa, and all other places where Cuban colonies were established, and funds were collected for the purchase of arms and ammunition. Ultimately Marti decided to strike before the proposed Abarzuza reforms could be promulgated and the hostility of the Cubans towards Spain be in any degree modified by the concessions granted.

*Outbreak of the insurrection.*

José Marti had made plans for a simultaneous rising in the provinces of Santiago and Matanzas. In the former province 400 persons assembled in the neighbourhood of Yara, and on February 23, 1895, took up arms under the leadership of Jésus Rabi. The movement in Matanzas was attempted on the same day, but was mismanaged at the start and suppressed for the moment. The Government from the first underestimated the sympathy of the public with the outbreak, and declared that it was nothing more than an attempt by a few bandits to commit robbery and outrage under the guise of patriotism. How fallacious was this reasoning soon became apparent from the eagerness shown by people of all classes in watching the progress of events in Santiago. Perhaps the most significant fact in connexion with the revolt was that it was not a *pronunciamiento* of any particular leaders, but the spontaneous uprising of people belonging to the lower classes, without distinction of colour. At the outset the whites were in the minority, hence the mistaken opinion was almost invariably held outside Cuba that the trouble was one of negroes against white men. At the beginning of 1895 Spain had in Cuba a garrison of some 17,000 men, a force amply sufficient to have crushed the revolutionary movement had it been energetically handled. The officials, however, made hardly any effort to disperse the rebels, whose ranks were rapidly increasing, and before the end of March 1895 it was evident that serious trouble was in store for Spain. The Madrid Government raised the garrison of Cuba to a strength of 30,000, and appointed General Martinez Campos as Captain-General of the island. After his arrival in Cuba in April, General Campos found that his hands were tied by the many restrictions imposed from home, and that he would not be permitted to declare in force the Abarzuza reforms until the insurrection was suppressed. The Spanish troops were in a demoralized condition, and the character of the eastern portion of Cuba made military operations difficult.

On April 21, Antonio Maceo, who afterwards played so important a part in the revolt, landed at Duabi, and shortly afterwards was followed by Maximo Gomez, accompanied by Marti. Maceo was a mulatto, and his presence in Cuba at once drew many additional recruits to the insurgent ranks from the coloured population. Maximo Gomez was a native of San Domingo, and had served in the Spanish army during the campaign in that island. Both Gomez and Maceo had taken part in the insurrection of 1868–78, and won for themselves a considerable amount of prestige. To Gomez was confided the post of Commander-in-Chief of the rebel forces, while Maceo was appointed next to him in rank. Marti prepared to return to New York to procure further supplies of arms and ammunition, but on his way to the seacoast he was killed in a skirmish with Spanish troops. His death was a severe blow to the Cuban cause, but the progress of the rebellion continued unchecked. In every town in Cuba secret committees were formed to aid the revolt, and by the month of August Gomez and Maceo had under their orders some 4000 men, and the area of the movement had extended over the whole of the province of Santiago and the greater part of Puerto Principe. Realizing the gravity of the situation, the Captain-General explained to the home Government that it would be necessary to occupy every province of the island and vigorously attack the insurgents in the field. In response to his demand for reinforcements, troops were poured into the island, but they consisted mainly of young and raw recruits, and sickness set in among them to an alarming extent. The wet season, furthermore, rendered any active operations almost impossible. At the close of 1895 the Spanish army in Cuba, including the volunteers and irregular cavalry under arms, numbered 100,000 men. The rebel forces had also steadily increased, and amounted to 10,000, but they were very imperfectly supplied with arms and ammunition.

The condition of the Spanish army was far from satisfactory. The men were obedient and cheerful, but were young, inexperienced, unacclimatized, poorly fed, and badly looked after. No attempt was made to instruct officers or men in their duties, or to improve the musketry practice. The officers were generally ignorant of the topography of the island, and took no trouble to make proper reconnaissances. Such maps as were compiled by order of the Government were so inaccurate as to be of small practical value. In these circumstances it is no wonder that the insurgents were able to elude pursuit and constantly to lead the Spanish troops into carefully prepared

ambushes. The organization of the insurrection developed rapidly. A provisional Government was formed, and the Marquez de Cisneros was named President of the Cuban Republic. The island was divided into districts, and a civilian appointed prefect of each one. Certain taxes were levied by these rebel authorities, non-payment being punished by destruction of the plantation buildings or crops of standing cane and the seizure of cattle and other live stock. Meanwhile the Cuban Junta in New York continued to collect subscriptions and arrange for further supplies of arms.

In January 1896 the insurgent leaders determined to carry the war into the districts in the immediate vicinity of Havana, and so paralyze the industrial life of the island. The Spaniards gave little heed to the rumours concerning the movement, and failed to perceive that the majority of the population sympathized with the rebels. As the insurgents advanced, they burned all the cane-fields and destroyed valuable property, on the ground that as long as industry continued to flourish in Cuba, the Spanish Government could find the money to maintain a large army to operate against the Cubans, but that once the industrial life was stopped, Spain would be unable to bear the burden and would then withdraw her troops. Accordingly, a vast sheet of flame from the burning cane-fields marked the advance of the insurgents. Near Coliseo, in the province of Matanzas, General Campos made his last effort to stem the onward movement with 10,000 men, but the insurgents eluded him and invaded the rich Western Provinces. The town of Havana was thrown into a state of excitement, and Marshal Campos was relieved of his command.

***General Weyler sent out.***

At the opening of 1896 there were still many Cubans in sympathy with, or actively engaged in, the insurrection who would have been satisfied with a liberal measure of home rule, and this aspect of the case was duly impressed upon the Spanish Government, but to no purpose. Meanwhile in the United States the drift of feeling was distinctly in favour of the insurgents, and this had the effect of making Spain more determined than ever to crush the revolt by force of arms, and the task was entrusted to General Weyler, who had a great reputation for energy and relentless severity. Large reinforcements were sent to the island from Spain, and in a few months the army of occupation amounted to 185,000 regular troops, 20,000 guerillas, and 30,000 volunteers. Antonio Maceo, with some 4000 insurgents, had taken up his position in the mountains of Pinar del Rio, and continually harried the Spanish garrisons. In order to prevent him from recrossing towards the eastern provinces and again joining hands with Gomez, a cordon of troops was stationed from north to south of the island between Mariel and Majana, trenches were thrown up, entanglements laid down, and blockhouses erected at short intervals. A corps of 20,000 men was stationed on this *trocha* or military cordon, and 10,000 troops were despatched to Pinar del Rio to march through the province and force a fight with the followers of Maceo whenever possible. These measures did not give the results expected. The rainy season brought sickness among the troops on the *trocha*, and many thousands died of fever, dysentery, and exposure. The columns sent out in Pinar del Rio were exhausted by long marches, and invariably found the mountain passes difficult of approach and strongly guarded by the rebels. Foiled in his attempt to bring about a general engagement, General Weyler issued an order for the "concentration" of the whole rural population in the fortified towns, with a view to prevent the insurgents from obtaining supplies from the country people with them. Some 600,000 people, chiefly women and children, were thus driven from their homes and collected in the towns, where they had no means of gaining a living, and where no due provision had been made for their subsistence. With very few exceptions the men joined the insurrection, and the women and children suffered great privations.

***American grievances against Spain.***

In June 1896 a vessel called the *Competitor* was surprised and captured on the north coast of Pinar del Rio just after landing a cargo of arms and ammunition for Maceo. The crew, with one exception, were United States citizens. They were tried by a military tribunal and sentenced to be shot. Under the treaties existing between Spain and the United States it was specially provided that unless American citizens were captured *with arms in their hands* against the Spanish authority, they could only be arraigned before the ordinary tribunals. The United States Government insisted that these men were not captured with arms in their hands within the meaning of the treaty, and that the summary trial accorded them was illegal. The Spanish authorities maintained that they had right on their side, but at the last moment gave way and ordered a fresh trial by ordinary process. The men were in prison for a long period, but were finally released and sent out of the island. Here the affair nominally ended, but bad blood was created between the two nations. One of the most difficult political questions with which General Weyler was confronted was the treatment of United States citizens in Cuba. Of persons born in the United States there were only a limited number in the island, but of Cubans who had become naturalized citizens of the United States there were some 20,000, and it was this latter class who occasioned friction. It was a common practice for Cubans to reside a sufficient length of time in the United States to obtain naturalization papers, then to return to Cuba and, whenever in trouble, to call upon the United States authorities for assistance. Many of these naturalized citizens who were directly or indirectly implicated in the revolt only owed their immunity from imprisonment to the fact that their arrest would have entailed diplomatic complications with the United States. Occasionally a man was arrested who claimed to be an American citizen; he could talk no language but Spanish, was born in Cuba, and had not been near his adopted country for twenty years; nevertheless he was entitled to and received the active intervention of the United States Consul-General in Havana. Time after time the Spanish authorities were forced to give way to the protests sent from Washington, and each succeeding incident increased the bitterly hostile feeling of the Spaniards towards the United States.

In July 1896, José Maceo, who commanded the rebels in the eastern part of the island, was killed in a skirmish. This loss to the cause was more than compensated for by the landing of Calixto Garcia, a veteran of the former revolt, who became one of the most prominent of the rebel leaders. Garcia had studied military tactics and understood the weak points of the Spanish character. Many members of families of good social standing who had hesitated to serve under Gomez or Maceo, joined Garcia in the field, and the movement in Santiago and Puerto Principe was further strengthened by the landing of arms and ammunition sent by the Cuban Junta in New York. In the month of August an attempt was made to dislodge Antonio Maceo from the mountain heights near Cacarajicara, in the province of Pinar del Rio. The officer commanding the Spanish troops, General Echagüe, was severely wounded, and the Spanish loss was heavy. After hard fighting, the insurgents were forced to retire farther into the mountain fastnesses. In November the strength of the insurrection in Pinar del Rio and the centre of the island showed no sign of exhaustion, and General Weyler

himself took the field with 60,000 men. Shortly before he left on this expedition he repeated his proclamation that a free pardon would be extended to all insurgents who presented themselves to the Spanish authorities. The rebels did not, however, take advantage of this concession, except in the case of sickness, and in that event left the revolt with the advice and consent of their comrades. An order was issued from the military headquarters to the effect that troops when marching through the country would destroy all buildings or crops capable of sheltering or assisting the insurgents in any way, and that all persons encountered who had failed to obey the order to concentrate in the fortified towns were to be treated as rebels. This roused the indignation of the people of the United States, for it showed clearly that the policy Weyler intended to pursue was one of absolute extermination of the recalcitrant sections of the population. The horrors of the march through the provinces of Havana and Pinar del Rio cannot be overestimated. The country people were mercilessly shot down, the animals that could not be made use of were hamstrung, and the smiling country was left a grim mass of smoking ruins. Constant skirmishes occurred with groups of insurgents, but no advantage of importance was gained.

*Weyler's severity.*

Suddenly it was discovered that Antonio Maceo was not in Pinar del Rio, but had slipped through the *trocha* and was in the province of Havana, in the rear of Weyler. Maceo had crossed the Bay of Mariel in a boat with the object of organizing a demonstration and threatening the city of Havana as an offset to the operations of Weyler in Pinar del Rio. This intention was never put into practice for the reason that on December 6 Maceo was killed in a skirmish. His death was a very severe blow to the insurrection, and the Spaniards thought for a time that they would have small further difficulty with the rebels. But here, again, the authorities underestimated the strength and bitterness of feeling on the part of the Cubans. After a few weeks Rius Rivera, who had served throughout the former revolt, landed in Pinar del Rio to take command of the rebels, but in March 1897 he was wounded in a skirmish near San Cristobal, and subsequently captured and deported. About the same time, Layas, another prominent Cuban leader, was killed in the province of Havana, but these two additional difficulties did not cause the insurgents to waver.

General Weyler returned to Havana after the death of Maceo, leaving General Arolas and General Bernal to continue operations against the rebels in Pinar del Rio. Other factors arose to complicate the situation. The authorities declared that the owners of sugar plantations were making regular payments to the rebel leaders in order to protect their property. No doubt it was a fact that such payments were made, but no other course was open to the planters unless they were prepared to abandon their properties. General Weyler issued a decree prohibiting the manufacture of sugar until such time as the different districts might be declared pacified, and stating that work would only be permitted as this pacification progressed. This order affected Spaniards as well as Cubans, and brought upon Weyler a storm of abuse, so much so that he was obliged to rescind the decree. Large numbers of persons suspected of sympathizing with the rebels were arrested and shipped without trial to the Spanish penal settlements of Fernando Po and Ceuta, in Africa, and executions after summary trial took place almost daily.

The Spanish Commander-in-Chief decided to build a second *trocha* across the island for the purpose of isolating the central provinces from the eastern section of Puerto Principe and Santiago, drawing the line from Moron on the north coast to Jucaro on the southern seaboard. Preparatory to initiating this work, General Weyler determined to march through the centre of the island in order to drive the insurgents towards the east, and with this object left Havana early in February 1897 at the head of a large body of troops. The route taken was through Havana and Matanzas to Santa Clara and Cienfuegos. The system followed was similar to the former one through Pinar del Rio. The insurgents made no attempt to oppose the troops, and their inactivity apparently deceived General Weyler, for on his return to Havana he declared officially that the western and central sections of the island might be considered pacified. This statement was no sooner made public than the rebels again began to make their presence known by attacks on Spanish posts and the destruction of a number of plantations where the owners had failed to comply with their demands.

The arrest of an American citizen named Rius served to increase the tension between the United States and Spain. Rius was a Cuban who had obtained naturalization after residing for some years in Philadelphia. The United States Consul-General demanded that he should be immediately tried and released if no offence could be proved against him. While the question was pending, Rius was reported to have died suddenly. The United States Consul-General insisted upon a medical examination of the body, and it was found that Rius had died from the effects of a blow on the back of his head. On the woodwork of a chair in his cell was discovered a statement, scratched with a nail, to the effect that the prison authorities intended to murder him. General Lee, the United States Consul-General in Havana, reported the facts of the case to Washington, and President Cleveland caused instructions to be sent to him to demand a full investigation, promising all necessary support. Ultimately the Spanish authorities appointed a commission of inquiry, but no clear proof was adduced that Rius had been deliberately murdered. The incident then dropped, but it brought one step nearer the intervention of the United States.

Meanwhile the country-people of Pinar del Rio, Matanzas, and Havana, concentrated in the fortified towns, were dying of starvation. In the village of Consolacion del Sur the deaths exceeded 10,000, and in the city of Matanzas the total was still larger. As the true situation became understood in the United States, the opinion that intervention should take place, or in any case the recognition of Cuban independence, every day found expression in emphatic terms in Congress. The number of lives sacrificed in the campaign had reached nearly 50,000 without bringing the end of the trouble in sight, while the cost of the operations in Cuba was calculated at £2,000,000 sterling monthly. In view of the general situation, the United States Government approached the Madrid authorities with suggestions for a very liberal measure of local self-government for Cuba. This pressure from Washington, combined with a change of Ministry in Spain, brought about the recall of General Weyler in October 1897, and the appointment of General Blanco as his successor. The Sagasta Administration determined on a radical change of policy in Cuba and Porto Rico. The Abarzuza reforms were abandoned, and a form of Constitution was drawn up for both islands based on that of Canada, but with certain restrictions as regards financial legislation. General Blanco was instructed to use every endeavour to conciliate the Cubans, but the new policy came too late. The Cubans were convinced that it was only a question of maintaining the insurrection for another year to force Spain to evacuate the island, unless American intervention brought about

*Recall of Weyler.*

this result at an earlier date, and the principal rebel leaders declined to accept the terms offered.

***General Blanco's policy.***

General Blanco arrived in Cuba in November 1897, and immediately annulled the concentration order; but the permission for the people to return to their homes was of little avail to them owing to their weak condition and the ruin of their homes. To the insurgents in the field the abrogation of the concentration decree was, however, an immense boon. They were now able through their friends in the cities to obtain the medicines, clothing, and other necessaries of which they stood sorely in want. General Blanco's next act was to proclaim an amnesty for all rebels who presented themselves to the authorities. A few surrendered, but no leaders of importance. No further executions of captured rebels took place, and arrests for political purposes were rarely effected. The Press, also, was allowed a far greater degree of liberty, although all news concerning the revolt continued to be strictly censured. On January 1, 1898, the new Constitution was proclaimed in force and a Colonial Government appointed, of which Señor Galvin was the nominal leader. The new Administration had, however, very little power, the question in Cuba being a military one as long as the insurrection continued. Finding that the insurgents did not intend to lay down their arms, General Blanco ordered military operations to be energetically carried out; but, as in former years, no decided advantage over the rebels was gained.

***The "Maine."***

A riot, in which many military officers and Spanish volunteers were concerned, occurred in Havana in January, and with a view to the protection of citizens of the United States in the event of any further outbreak the American warship *Maine*, commanded by Captain Sigsbee, was ordered to Havana. Under the direction of the port authorities she was moored in the section of the harbour specially reserved for men-of-war. No discourtesy was shown to the officers and crew of the vessel, and several receptions were held on board by the captain and officers in order to return in some measure the hospitality extended to them by the residents of Havana. On February 15 a large number of guests visited the cruiser. At 9.30 on the evening of that day the inhabitants of Havana were startled by a terrific explosion, and the *Maine* was seen to be in flames and in a sinking condition. Subsequent explosions of ammunition occurred, and the wreck settled down. The boats of the Spanish cruiser the *Alfonso XII.* were promptly lowered, and helped to save the survivors. The complement of the *Maine* in officers and crew was 347 all told. Two officers were absent on leave ashore when the explosion occurred. Of those on board, two officers and 257 men lost their lives. The great loss of life among the crew was due to the fact that the men had turned in, and the explosion took place under their quarters in the forward part of the vessel. Everything that was possible was done by the Spanish authorities to aid the wounded survivors, seven of whom afterwards died. A public funeral was accorded to the victims, and was attended by the principal Spanish officials. In spite of this show of sympathy, it was recognized in Havana that the critical moment had arrived, and that unless the explosion could be satisfactorily accounted for, war between Spain and the United States was inevitable.

Shortly before the disaster two events had occurred rendering the relations between the two countries extremely strained. The first was a letter written by Señor Dupuy de Lome, the Spanish Minister in Washington, to his friend Señor Canalejas, then on a visit to Cuba. It was not intended for publication, but was stolen in Havana and disposed of to a New York newspaper. In this letter the Minister expressed emphatic doubts as to the good faith of the United States Government in dealing with the Cuban question, and made some insulting remarks in reference to President M'Kinley. The result of the publication of this letter was that Señor Dupuy de Lome was forced to resign his post. The second event was a request from Madrid for the recall of General Fitzhugh Lee from his position as Consul-General of the United States in Havana, on the ground of his being a *persona non grata* to the Spanish authorities.

***The "Maine" inquiry and its conseqences.***

The advice of Captain Sigsbee to his Government and the people of the United States was contained in a telegram sent to Washington a little before midnight on the evening of the disaster,—"Suspend judgment pending result of official investigation." A court of inquiry was named, composed of Captain (afterwards Admiral) W. T. Sampson, Captain F. C. Chadwick, Lieutenant-Commander W. P. Potter, and Lieutenant-Commander A. Marix. The court assembled on board the United States steamer *Mangrove* in Havana harbour a few days after the disaster occurred, and sat continuously until March 21. The hull of the *Maine* was examined by divers, and a searching investigation of all facts bearing on the case was made. It was not until early in April that the report of the court was handed to Congress. The finding was:—

"That the loss of the *Maine* was not in any respect due to fault or negligence on the part of any of the officers or members of her crew; that the ship was destroyed by the explosion of a submarine mine, which caused the partial explosion of two or more of her forward magazines; and that no evidence has been obtainable fixing the responsibility for the destruction of the *Maine* upon any person or persons."

The position of the vessel after the explosion was evidence of the correctness of this finding, the keel being bent upwards from the centre and remaining above the level of the main deck. The Spanish authorities held an inquiry, and after a few days drew up a report to the effect that the explosion was due to internal causes. They also stated officially that no submarine mines existed in the harbour of Havana, and that the Government possessed no materials for their construction. This statement was afterwards conclusively proved to be incorrect.

***President M'Kinley's message.***

On April 8, 1898, General Lee received orders to leave Cuba and hand over the charge of United States interests to the British Consul-General. The following day General Lee, with the remainder of the United States citizens still in Havana, embarked on board a United States gunboat and proceeded to Florida, and on Monday, April 11, President M'Kinley sent to Congress his Message on the situation. On April 13 the Foreign Affairs Committees of both Houses reported joint resolutions, and on April 18 a conference between the two Committees resulted in the adoption of the following joint resolution by 42 votes to 35 in the Senate, and by 311 votes to 6 in the House of Representatives:—

"Whereas the abhorrent conditions which have existed for more than three years in the island of Cuba, so near our own borders, have shocked the moral sense of the people of the United States, have been a disgrace to Christian civilization, culminating as they have in the destruction of a United States battleship with 266 of its officers and crew, while on a friendly visit in the harbour of Havana, and cannot longer be endured, as has been set forth by the President of the United States in his Message to Congress of April 11, 1898, upon which the action of Congress was invited; therefore,

"Resolved by the Senate and House of Representatives of the United States of America in Congress assembled—

"*First.* That the people of the island of Cuba are, and of right ought to be, free and independent.

"*Second.* That it is the duty of the United States to demand, and the Government of the United States does hereby demand, that

the Government of Spain at once relinquish its authority and government in the island of Cuba and withdraw its land and naval forces from Cuba and Cuban waters.

"*Third.* That the President be, and hereby is, directed and empowered to use the entire land and naval forces of the United States, and to call into the actual service of the United States the militia of the several States, to such an extent as may be necessary to carry these resolutions into effect.

"*Fourth.* That the United States hereby disclaims any disposition to exercise sovereignty, jurisdiction, or control over the said island, except for the pacification thereof, and asserts its determination when that is completed to leave the government and control of the island to its people."

This resolution was signed by President M'Kinley on April 20, and a copy served upon the Spanish Minister, Señor Polo y Bernabé, who immediately asked for his passports and left Washington. On April 24 the Spanish Government formally recognized the existence of war between Spain and the United States, and on April 25 the United States Congress passed the following Bill without a division :—

"Be it enacted by the Senate and House of Representatives of the United States in Congress assembled, *First*—That war be, and the same is hereby declared to exist, and that war has existed since the 21st day of April A.D. 1898, including the said day, between the United States of America and the kingdom of Spain. *Second*—That the President of the United States be, and he hereby is, directed and empowered to use the entire land and naval forces of the United States, and to call into the actual service of the United States the militia of the several States, to such extent as may be necessary to carry this act into effect."

On April 21 the President of the United States proclaimed the blockade of the Cuban coast from Cienfuegos on the south of the island, thence westwards to Cape San Antonio and thence to the east, passing Havana, to Cardenas on the northern seaboard. From the date of the destruction of the *Maine*, the bulk of the United States navy had been quietly concentrating at Key West, off the coast of Florida, and within eight hours of the proclamation of the blockade the fleet was patrolling Cuban waters. The dominion of Spain in Cuba virtually ceased from this time.

Meanwhile General Blanco decided to make a bold bid for peace with the insurgents, and for their co-operation with the Spanish troops in defending the island against American aggression. On April 10, 1898, he ordered a cessation of hostilities against the rebels, and sent a deputation to their leaders to ascertain what terms they demanded as the price of laying down their arms. The insurgents accepted the armistice offered pending any decided action on the part of the United States, but made no compact with the Spanish authorities not to resume hostilities on the declaration of war, and meanwhile remained in their camps awaiting the development of events. General Blanco withdrew the majority of the garrisons in the interior of the island in order to strengthen the coast defence against any attack by the Americans, and the country districts were left at the mercy of the insurgents. When the declaration of war was made public on April 23, the insurgents immediately resumed their aggressive tactics and harassed the Spanish troops when opportunity offered. Considerable supplies of arms, ammunition, and provisions were despatched by the United States Government to enable the insurgents to carry on operations until the time arrived for the landing of American troops. With a few exceptions, there was at this time no industrial life in the island; it had been reduced to a desert, and on all sides were signs of suffering and distress.

The United States army for the invasion of Cuba was concentrated at Tampa, in Florida, in May 1898. It had been intended to land a force of 5000 men, under the command of Major-General Shafter, near Tunas, on the south coast, and, in conjunction with the insurgents, gradually push the Spaniards to the westward, but the arrival of a Spanish squadron under Admiral Cervera at Santiago de Cuba, and the blockade of that port by Admiral Sampson, made imperative the landing of an army to attack the city, and so render the harbour untenable for the Spanish ships. On June 14 the Fifth Army Corps, consisting of 815 officers and 16,072 men, sailed from Tampa. Shortly before this the transport *Florida* had landed a contingent of 500 Cubans on the north coast of the island. On June 20 the fleet of transports conveying the American troops arrived off Daiquiri, some 15 miles to the east of the city of Santiago, and by the evening of the 24th the entire force had been landed. On the following day, under an arrangement effected by Major-General Shafter, some 5000 Cubans, commanded by Calixto Garcia, were also brought to the scene of operations. No attempt was made by the Spaniards to resist the landing, although the country lent itself admirably to defensive purposes. The garrisons at Daiquiri and Siboney retired in the direction of Santiago, where General Linares was in command of some 7000 men. At Guantanamo, a few miles to the eastward of Daiquiri, a force of some 1400 American marines had been landed a couple of weeks earlier, and held possession of the villages at the entrances to the harbour.

***After the declaration of war.***

Until June 30, Major-General Shafter was engaged in moving his troops towards Santiago, and preparing for a general attack on the outer lines of defence at San Juan and El Caney. The Cubans were usefully employed as scouts and skirmishers. On July 1 the division commanded by General Lawton attacked El Caney. The Spaniards made an obstinate resistance, but their positions were captured. General Vara del Rey, commanding the Spanish forces, and most of his officers were killed. At the same time the divisions under Generals Wheeler and Kent drove the Spaniards from the hill of San Juan, which formed part of the outer line of defence of Santiago. During the night the Spanish General Escario reached Santiago with reinforcements of 3600 men, having made forced marches from Manzanilla. The fighting was continued on the following day, the American lines being drawn closer towards Santiago. On the morning of July 3 (an unsuccessful, but plucky, attempt having been previously made by Lieutenant Hobson to block the channel by sinking the *Merrimac* across it) the Spanish squadron under Admiral Cervera left the harbour and attempted to force the blockade. In half an hour this important section of Spain's navy was destroyed, with a loss of 600 killed and 2000 captured, and the fate of Santiago was sealed. At noon General Shafter demanded the unconditional surrender of the city. General Linares had been wounded on July 2, and had temporarily handed over the command to General Toral, who conducted the negotiations with General Shafter. After a delay of fourteen days and a partial bombardment of the city on July 12, the Spaniards agreed to the terms proposed, namely, the surrender of the city and province of Santiago de Cuba and the entire garrison of the province, this consisting of nearly 23,000 officers and men. The losses of the United States troops in the fighting on July 1, 2, and 3 were officially returned as 22 officers and 208 men killed, and 81 officers and 1203 men wounded, while 79 men were reported missing. The Spanish loss was stated to be, approximately, 1500 officers and men killed and wounded.

General Shafter took formal possession of Santiago on July 17. By some oversight, no official invitation to be present at the ceremony of surrender was extended to Calixto Garcia as representative of the Cubans. This fact, and the order of General Shafter prohibiting the Cubans

from entering the city, were taken as an insult by Garcia, and he withdrew with all his forces to the interior of the island in the direction of Holguin, where he remained until hostilities were suspended.

The sufferings of the non-combatants in Santiago were very great. The foreign Consuls, of whom the British Consul, Mr Ramsden, was the *doyen*, visited the American lines on July 3 and presented a joint petition to General Shafter to the effect that the women, children, and other non-combatants should be allowed to leave the town before further offensive operations were undertaken. This request was granted, and El Caney was designated as the most convenient place to which these people might proceed. Some 22,000 persons took advantage of the permission. The Spanish authorities placed no obstructions in the way, but only allowed the fugitives to take with them such food and worldly goods as they could carry individually, and would permit no wheeled vehicles to leave the city. In the course of a couple of days the food supplies at El Caney were exhausted, and it became necessary for General Shafter to issue rations. These were necessarily limited, and many families were reduced to dire straits. Mr Ramsden died shortly afterwards from the effects of the privations he suffered at this period.

Some further skirmishing took place towards the end of July, and the Spanish gunboats in the harbour of Manzanilla were captured or destroyed by United States men-of-war. The fall of Santiago, however, practically ended the war. On July 26 the French Ambassador in Washington approached the United States Government with peace proposals. A protocol was signed on August 12, and all hostilities were suspended. Under the terms of this agreement Spain was obliged to evacuate Cuba within a reasonable time, as is seen by the following copy of the official document signed by Mr W. R. Day, the Secretary of State, and M. Jules Cambon, the French Ambassador, acting on behalf of the Spanish Government:—

"Protocol of agreement between the United States and Spain, embodying the terms of a basis for the establishment of peace between the two countries.

"William R. Day, Secretary of State of the United States, and his Excellency Jules Cambon, Ambassador Extraordinary and Plenipotentiary of the Republic of France at Washington, respectively possessing for this purpose full authority from the Government of the United States and the Government of Spain, have concluded and signed the following articles embodying the terms on which the two Governments have agreed in respect to the matters hereinafter set forth, having in view the establishment of peace between the two countries, that is to say:—

"Article I. Spain will relinquish all claim of sovereignty over, and title to, Cuba.

"Article II. Spain will cede to the United States the island of Porto Rico and other islands now under Spanish sovereignty in the West Indies, and also an island in the Ladrones, to be selected by the United States.

"Article III. The United States will occupy and hold the city, bay, and harbour of Manila pending the conclusion of the treaty of peace, which shall determine the control, disposition, and government of the Philippines.

"Article IV. Spain shall immediately evacuate Cuba, Porto Rico, and other islands under Spanish sovereignty in the West Indies; and to this end each Government will, within ten days after the signing of this protocol, appoint Commissioners, and the Commissioners appointed shall, within thirty days after the signing of this protocol, meet at Havana for the purpose of arranging and carrying out the details of the aforesaid evacuation of Cuba and the adjacent Spanish islands; and each Government will, within ten days of the signing of this protocol, appoint other Commissioners, who shall, within thirty days after the signing of this protocol, meet at San Juan, in Porto Rico, for the purpose of arranging and carrying out the details of the aforesaid evacuation of Porto Rico and other islands now under Spanish sovereignty in the West Indies.

"Article V. The United States and Spain will each appoint not more than five Commissioners to treat of peace, and the Commissioners so appointed shall meet in Paris not later than October 1, 1898, and proceed to the negotiation and conclusion of a treaty of peace, which treaty shall be subject to ratification according to the respective constitutional forms of the two countries.

"Article VI. Upon the conclusion and signing of this protocol, hostilities between the two countries shall be suspended, and notice to that effect shall be given as soon as possible by each Government to the commanders of its naval and military forces.

"Done at Washington, in duplicate in English and in French, by the undersigned, who have hereunto set their hands and seals, the 12th day of August 1898.

(Seal) William R. Day.
(Seal) Jules Cambon."

The treaty of peace agreed upon in Paris was finally signed on December 10, 1898, and Spanish dominion ceased after having been in force since 1492, a period of 406 years.

It is worthy of note that throughout the insurrection the Church took no part in the political troubles; this was in marked contrast to the attitude of the Clerical authorities in the Philippines and in Spain.

(C. E. A.).

**After cessation of Spanish-American hostilities.**

By the terms of the Spanish surrender of Santiago province, July 1898, that province temporarily became American territory. The remainder of Cuba was still in a state of insurrection, and under Spanish control. The Porto Rico campaign after the fall of Santiago lasted until the signing of the protocol on 12th August 1898. The status of the Cuban insurgents, who were still in arms against Spain, west of Santiago province, remained indefinite. Inasmuch as by the terms of the protocol Spain relinquished all claims to sovereignty and title to Cuba, and promised to evacuate the island as soon as a Commission to be appointed should arrange details of the evacuation, the insurgents themselves, exhausted by the conflict, naturally ceased hostilities, awaiting future action. Within a month of the surrender of Santiago all the Spanish and American forces, with the exception of a small guard of the latter, had returned to their homes. Brigadier-General Leonard Wood was appointed Military Governor of the stricken province. He at once began an enlightened policy of sanitation and public improvements, and gave the Cuban element every official and political recognition. The undertaking of the United States to retain control only until a form of government could be evolved from the chaotic and stricken condition existing upon the island at the end of hostilities was conscientiously maintained. No discrimination was allowed in favour of goods shipped to Cuba from the United States, and the products of all nations were admitted to Cuba on same terms as America. The acts of the temporary American occupation were: (1 the relief of immediate suffering; (2) the successful conducting of an orderly evacuation of the island by Spain without the attending evil of anarchy; (3) the disbandment of the Cuban army; (4) the restoration and betterment of the social, hygienic, and economic condition; and (5) the preparation of the island for independent government.

The condition of the island upon the cessation of hostilities was bad beyond description. The people were impoverished by revolution and starvation, transportation and communication were palsied, agriculture prostrated, brigandage rampant, and commerce dead. Human misery had apparently attained the maximum of possibility. The débris of war and attending disease existed everywhere. Official and private charity immediately hastened to the relief of the starving inhabitants, and was practised upon a scale of munificence never before exhibited in the world. Money, food, medicine, raiment, shelter, and employment were quickly bestowed, all dependants were properly cared

for by the public treasury, and the hordes of maimed beggars which hitherto had infested the streets of Cuban cities were properly dealt with. The relinquishment of Spanish sovereignty was accomplished in an orderly manner and without disturbance on January 1, 1899. By previous arrangement the flag of Spain was lowered and that of the United States temporarily hoisted. The Spanish officials withdrew from the island and the American authorities took up the reins of government. A tragic incident of the evacuation of Cuba, the last colony of Spain in America, was the solemn removal of the supposed remains of Christopher Columbus, the discoverer of America and founder of the first Spanish-American colony, from their tomb in the Cathedral at Havana, and transportation to Spain.

Another serious problem which confronted the American authorities upon the acquirement of Cuba was the disbandment of the Cuban army. It was unfortunate that the tidings of peace in Cuba should have been followed by distrust between the Cubans and Americans, and a mutual misunderstanding followed which for some time proved awkward. This was brought about (see p. 309) by the refusal of the American commander at the battle of Santiago to permit the representatives of the Cuban army under General Calixto Garcia to participate in the investment of that city. The Cubans were hurt and insulted, feeling that there had merely been a change of masters. General Garcia, wounded by the incident, retired with his troops into the interior of Santiago province. In October 1898 the Provisional Cuban (Insurgent) Government, which had existed since 1895, called a meeting of delegates from all sections of the insurgent forces to decide upon a line of policy for the immediate future. This Congress sat at Santa Cruz del Sur for some three weeks. It was finally resolved to dissolve the Provisional Government and nominate a Commission to represent the armed forces which had fought against the Spaniards, leaving the question of the constitution of a Government to be determined at a later period, when the intentions of the United States Administration in the matter of Cuba were more clearly defined. This Commission, the President of which was Calixto Garcia, went to Washington in December 1898 and laid before the United States authorities a carefully prepared statement of the situation of Cuba and the Cubans. The Commission arranged that the Insurgent army be disbanded, with certificates of service to be presented to the future permanent Government of Cuba for pay. General Garcia, at the head of the Commission, declared that the Cubans accepted gratefully the aid of the United States, and trusted implicitly in its promise that a free and independent Government should sooner or later be established in Cuba. This general, who for forty years had laboured and fought for the freedom of Cuba, died in Washington, December 1898, while upon this mission of peace. The American Government sent his remains to Cuba upon a man-of-war, and accorded them full military honours. After the death of Garcia, the details of disbanding the Cuban army became temporarily serious, and resulted in many conferences between the military authorities and the insurgent leaders in Cuba. Finally, through the aid of General Maximo Gomez, all the various elements came to agreement, rosters were made of the insurgent armies, and each soldier was given a sum of money sufficient for his temporary needs, and the arms turned over to the American authorities. In all $3,000,000 was distributed to 48,000 men and 6000 commissioned officers.

By the Treaty of Peace signed December 17, 1898, Cuba's status became that of a foreign Power in the military occupation of the United States, pending the establishment of an orderly Government. By the same treaty Spanish subjects were given twelve months in which to determine whether they were to retain or relinquish their allegiance to Spain. Until the end of that period it was impossible to know who might rightly participate in the work of reconstruction, and therefore the withdrawal of the United States and the establishment of a Cuban Government necessarily became a gradual process requiring much toil and firmness. The War Department issued a formal order in December 1898 making Cuba a military division, with Havana for headquarters. For the purposes of military administration the island was at first divided into military departments, each under a commanding officer carefully chosen from men with broad experiences in civil as well as military administration. The United States assumed entire control of Cuba January 1, 1899. President M'Kinley issued immediate proclamation defining government and organization and establishing custom rates. The supreme authority upon the island was vested in a Commanding-General, whose functions were very similar to those of the Captain-General under the Spanish régime. The first American Military Governor to be appointed upon the retirement of Spanish sovereignty was Major-General John R. Brooke, who entered upon his duties January 1, 1899. The Military Governor preserved and restored the Spanish forms of administration so far as they were compatible with good government. He established an advisory and administrative Cabinet composed of Secretaries, in whom were vested the administration of civil government. The departments and Ministers were known as those of state and government, finance, justice and public instruction, agriculture, commerce, industries, and public works. The military commanders there were instructed to restore local government as soon as possible. In carrying out this order the communal or municipal organization of the Spanish system was retained in spirit as well as form, and the people were permitted as far as possible to manage their local affairs. There are about two hundred municipalities in Cuba, and the alcaldes temporarily appointed were selected with great care.

The chief problems confronting the newly installed American authority were those of relief, police, sanitation, and reform of the judiciary. The last was especially needed. The civil and criminal code which was in existence prior to the relinquishment of Spanish sovereignty was retained in force, with such modifications and changes as might from time to time be found necessary in the interest of good government.

By decree of January 1, 1900, the department of Justice and Public Instruction was divided. The judiciary systems of the Spanish régime early received the attention of the American Military Governor, and was so modified as to result in more speedy attainment for the ends of justice, although retaining the forms of procedure and organization which previously existed. Upon the withdrawal of Spain, General Brooke organized a Supreme Court to hear cases and appeals, which under Spanish rule were sent to Spain for decision. This court, with its seat at Havana, was composed of a president, of a chief justice, six associate justices, one fiscal or prosecuting attorney, two assistant fiscals, one secretary, two deputy clerks, and other subordinate officials. Another court established was the Municipal or Correctional Court of Havana, the powers of which had hitherto been exercised by the mayors, and this system of police courts was afterwards applied to the whole island. A great obstacle to the administration of justice was the absence of remedial writs in the Spanish law of procedure. It was proposed, however, to institute the Habeas Corpus and other procedures for the protection of personal liberty as soon as expedient.

President M'Kinley, on August 17, 1899, ordered the taking of a census of the people of Cuba by disinterested citizens of Cuba as enumerators and supervisors. The proclamation of the President ordering the census was declared to be a preliminary step in the establishment of an effective system of self-government. The census was limited to inquiries concerning population, agriculture, and education as the three subjects of most importance. No previous census of Cuba as one had been taken since 1878. This work was accomplished with great thoroughness under the direction of Brigadier-General Sanger. The results of this census were beneficial in removing popular prejudices against the Cubans in the United States, demonstrating that a majority of the Cubans were of the white race and were generally more literate than the people of Spain and Porto Rico. The census also showed that the mortality due to the insurrection and the reconcentration had been less than had been ascribed. (For the details of the census results, see p. 303 above.)

*Census 1899.*

On January 1, 1900, Brigadier-General Leonard A. Wood succeeded General Brooke as Military Governor of the island. General Wood had shown great success as governor of the province of Santiago, and his appointment was considered eminently appropriate and satisfactory both to the Cubans and the Americans. One of the early acts of his administration was to show his trust in the Cuban people by giving them most of the executive offices. To him fell the difficult task of conducting the elections, and serving as an intermediary between the administration at Washington and the Cuban people. On July 25, 1900, the President directed that a call be issued for an election in Cuba for members of a constitutional Convention to frame a Constitution as a basis for a stable and independent Government in the island. In pursuance thereof Military-Governor Wood issued a proclamation again citing the fact that the United States disclaimed any disposition or intention to exercise sovereignty, jurisdiction, or control over the island except for the pacification thereof, and asserting its determination, when that was accomplished, to leave the government and control of the island to its people. Therefore he ordered a general election to be held on the third Saturday of September in the year 1900, to elect delegates to a Convention to meet in the city of Havana on the 1st Monday of November of the same year to frame and adopt a Constitution for the people of Cuba, and as a part thereof to provide for and agree with the Government of the United States upon the relations to exist between that Government and the Government of Cuba, and to provide for the election by the people of officers under such Constitution, and the transfer of government to the officers so elected. The election was held on the 15th of September, and the Convention assembled on the 5th of November 1900. Military-Governor Wood in opening the Convention said: "It will be your duty, first of all, to frame and adopt a Constitution for Cuba, and when that has been done, to formulate what in your opinion ought to be the relations between Cuba and the United States. The Constitution must be adequate to secure stable, orderly, and free government. When you have formulated the relations which, in your opinion, ought to exist between Cuba and the United States, the Government of the United States will doubtless take such action on its part as shall lead to final and authoritative agreement between the people of the two countries to the promotion of their common interests." The Convention expressed appreciation and gratitude to the United States Government and to General Wood for aid given to the Cuban people in advancing self-government.

*General Wood's appointment.*

By the end of January 1901 the Cuban Constitutional Convention had so far completed the instrument that its character and general features were evident. It was an able and well-written document, following in a general way the essential features of the Constitution of the United States. In one essential feature it was lacking, however—it did not mention the relations which were to exist between Cuba and the United States. In the Constitution as framed there "was no recognition of the United States, no expression of gratitude or even friendliness," and no provision was made for the relations to exist betwen Cuba and the United States, as stipulated in the call for the Convention. On March 2, 1901, Congress, appreciating the fact that the Cuban Constitution ignored the relations to exist between the future Cuban Republic and the United States, and in order to enable the President to withdraw the military forces from Cuba, through an amendment to the Military Appropriation Bill framed the articles known as the Platt Amendment. The Platt Amendment contained eight articles, specifically defining what the relations were to be between the future Cuban Republic and the United States. These articles, in essence, were as follow:—

*Cuban and American relations.*

1. Prohibiting Cuba from entering into treaties with foreign Powers tending to impair Cuban independence, or prohibiting them to obtain lodgment or control over any portion of the island.
2. Regulating Cuba's power to incur debts beyond the capacity of the island's ability to pay.
3. Providing that the United States shall have the right of intervention for the preservation of Cuban independence, the maintenance of an orderly Government, and for discharging the obligations of the United States relative to Cuba stipulated in the Treaty of Paris.
4. Ratification on validation of all acts of the United States while in temporary military occupation.
5. Requiring Cuba to execute and extend the plans for the sanitation of the island.
6. Demanding that the Isle of Pines be omitted from the constitutional boundaries of Cuba, and that its future status be fixed by treaty.
7. Demanding that Cuba sell or lease to the United States suitable sites for coaling or naval stations.
8. Demanding that the foregoing stipulations be embodied in the form of a permanent treaty.

The Radical element in Cuba bitterly advocated the rejection of any dictation from the United States. Finally it was determined in April 1901 that a Commission from the Cuban Constitutional Convention should visit Washington for the purpose of ascertaining the exact intent and meaning of the language of the Platt Amendment. This Commission consisted of Juan Gualberto Gomez, the Radical independent leader; Domingo Capote, the presiding officer of the Convention; Dr Berriel, a noted constitutional lawyer; Judge Florente, an associate justice of the Cuban Supreme Court; Rafael Portuondo, an extreme Radical; Diego Tamayo, and a Nationalist and member of Governor Wood's cabinet. The Cuban Commission reached Washington April 24, 1901, and was given every attention and consideration. After many interviews with the President and Secretary of War, the members were informed that the United States would insist upon its position. President Capote, of the Commission, asked the President to do something for the Cubans upon an economic line, especially in the matter of reciprocal trade relations. He said that it was especially desirable that something of this kind be done before the next crop was harvested, in order that the Cubans might thus realize the advantages of closer political and economic relations with the United States. To this inquiry the reply was made that Congress alone had the power to regulate commerce. It was supposed after the visit of the Commission to Washington that the

Constitutional Convention would appreciate that the United States had no ulterior motives in attempting to establish and protect the Cubans in an independent Government. Upon the return of the Commission the Convention decided to accept the Platt Amendment, and the incident was supposed to be closed. It was subsequently ascertained, however, that the acceptance was accompanied by a Cuban interpretation, whereupon (June 1901) the President issued his dictum that until the Cuban Convention accepted the Platt Amendment in its entirety, the troops of the United States would be retained upon the island. On June 18th, 1901, the Convention, seeing that further dallying was useless, accepted the amendment in its entirety, and a Cuban Republic was inaugurated on May 20, 1902, with Senor Palma as first president.

*Results of American action.*

It is impossible to set forth here what the Americans have done for the social and industrial improvement of the island. Brigandage and mendicity were eliminated. The establishment of a thorough public school system was accomplished, superintendents and teachers being imported. As a result, 150,000 Cuban children were obtaining free education in 1900, while only 27,000 children had hitherto found instruction. In 1900, 1400 Cuban teachers were given free transportation to, and instruction at, Harvard University. Cuban prisons were in bad sanitary condition, and the time of detention was long. In Havana twenty-two Americans were found imprisoned over five months with no hearing. Over 1500 people were found in the jails in Cuba who had never been tried. The sanitary cleansing of the cities was undertaken on a gigantic scale. The sanitation of Havana—a plague-spot which had long menaced the United States—was thoroughly studied and the city changed into one of the cleanest in the world. Colonel Geo. E. Waring, America's ablest sanitary engineer, personally studied the sanitary conditions of Cuba, and died of yellow fever contracted in this work. Not only were matters of public hygiene carefully attended to, but the Surgeon-General of the army established in Havana a corps of medical investigators, who attacked the problem of the causes and dissemination of yellow fever with great energy. In the summer of 1901 they demonstrated by experimentation that the cause of the dissemination of the disease was the mosquito. The death-rate of Havana decreased nearly one-half as a result of the sanitary measures which were taken, and yellow fever, for the first time in the history of Havana, was not epidemic in 1901. It had already become apparent that the army surgeons, through their sanitation and researches, had obliterated the conditions which once made Havana the focus and distributing centre of this disease in the New World. Postal and telegraphic communication was greatly improved and placed upon a systematic basis. The peculations of a few postal authorities, who were duly arrested and punished, was the only blot upon the American administration. The rehabilitation of the fields and plantations has been encouraged. Seeds and animals were at first furnished, but by 1901 all agricultural industries were self-sustaining, and the sugar and tobacco industries had recovered the full development which they possessed before the insurrection in 1895. In 1901 Cuba might be described as better off socially and economically than at any period since 1840. From a political standpoint the acts of the United States have been even more munificent. The United States spent millions of money and many lives in a war with Spain for the sake of Cuba; sent aid to its starving population; paid three million dollars to the insurgent soldiers; and assumed payment of all damages which American citizens sustained during the revolution. (R. T. H.)

**Cuddalore,** a town of British India, in the South Arcot district of Madras; on the seacoast, 125 miles south of Madras. In 1881 it had a population of 43,545; in 1891, of 47,355; and in 1901, of 51,880, showing an increase of 10 per cent. The municipal income in 1897–98 was Rs.51,710. The mouth of the river Gaddilam having silted up, the anchorage is an open roadstead. In 1897–98 the total seaborne trade amounted to Rs.61,46,419, of which nearly half was with foreign countries. The principal exports are sugar, oil-seeds, and indigo. There are two colleges, two high schools with 861 pupils, two printing-presses, and a club.

**Cuddapah,** a town and district of British India, in the Madras Presidency. The town is 6 miles from the right bank of the river Pennar, and 161 miles by rail from Madras. Population, about 18,000. The municipal income in 1897–98 was Rs.47,830. It is now a poor place, but has some trade in cotton and indigo, and manufactures of cotton cloth. There are a high school, two printing-presses, and a literary association.

The DISTRICT OF CUDDAPAH has an area of 8722 square miles. Population (1891), 1,272,072; (1901), 1,291,903. The land revenue and rates were Rs.22,51,654, the incidence of assessment being R.1·8 per acre; the number of police was 1002. In 1897–98, out of a total cultivated area of 1,586,665 acres, 282,702 were irrigated. The principal crops are millet, rice, other food-grains, pulse, oil-seeds, cotton, and indigo. The two last are largely exported. There are two steam factories for pressing cotton; and 570 indigo vats, employing 8417 persons, with an out-turn valued at Rs.6,37,000. In 1896–97 the number of schools was 846, attended by 18,652 pupils. The registered death-rate in 1897 was 25·9 per thousand. The district is served by two lines of railway.

**Cuenca,** a province of Central Spain, with a population of 236,253 in 1877, 242,024 in 1887, and 241,566 in 1897. In 1896, of 47,764 children of both sexes, ranging from 4 to 14 years of age, 28,146 were on the school registers, though only 19,779 attended. The province is divided into 8 administrative districts and 288 parishes, covering an area of 6726 square miles. It is the least thickly peopled province in Spain, and has only 68 miles of railway, but a new line is under construction. The roads are in such a backward condition that they cripple not only the mining interests but also the exports of timber, which is generally floated down the Tagus and other streams. There are but few manufacturing interests. In 1897 the province contained 3 salt mines in working order. An English company bought the principal copper mines near Garabella and Talayuelim in 1898. The province, chiefly owing to its hilly pasture grounds, had a goodly show of live-stock in 1897—291,205 sheep, 51,266 goats, 20,191 pigs, 3232 horses, 25,503 mules, 21,315 asses, 4149 cattle. 225,600 acres were devoted to the culture of wheat, 48,402 to that of barley, 39,157 to rye, 16,250 to oats, 62,207 to vines, 30,320 to olives. CUENCA, the capital, has much decayed in importance. The wool trade has been in part replaced by manufactures of soap, paper, chocolate, matches, and leather. There are many saw mills, worked by steam. The population has grown from 9745 in 1887 to 10,332 in 1897. Cuenca attracted notice by its gallant and prolonged resistance against the Carlists in 1874.

**Cuenca,** a town of Ecuador, and capital of the province of Azuay, about 80 miles south-east of Guayaquil. It is the second town of the interior in importance, and the third in rank of the republic. Population, about 25,000.

**Cuesmes,** a town of Belgium, in the province of Hainaut, 2 miles south-west of Mons, with which it is united by rail. It has a coal-mining industry and railway workshops. Population (1880), 7079; (1897), 8626.

**Cuevas de Vera,** a town of Spain in the province of Almeria, near the Mediterranean, in a plain fringed by the river Almanzora. Population (1897), 20,366. It has two fine squares, de la Constitucion and del Castillo, the latter deriving its name from the residence of the Marquesses of Villafranca, one of whose towers is said to be a Roman structure. The parish church, La Encarnacion, dates from 1758 and is of Doric style. The town is essentially a mart for the products of mines in the Sierra Almaguera, and for the products of the rich agricultural districts around.

**Cullera,** a seaport of Spain, in the province of Valencia, 24 miles south-south-east of Valencia, on the Mediterranean at the mouth of the Jucar. In 1898 the principal imports were sulphate of ammonia, valued at £23,070, and artificial manure, valued at £2600. The return of shipping in 1898 showed that 42 vessels entered with 24,199 tons of cargoes, and 27 in ballast with 8490 tons; 7 English vessels with 4173 tons entered. Twenty-seven Spanish vessels cleared with 8490 tons of cargoes, and 42 vessels in ballast with 24,199 tons cleared, 7 being English.

**Cumberland,** a north-western county of England on the Scottish border, bounded on the S.W. and W. by the Irish Sea, on the N.W. by the Solway Firth, Dumfries, and Roxburgh, on the N.E. by Northumberland, on the E. by Durham, and on the S.E. by Westmoreland and Lancashire.

*Area and Population.*—The area of the ancient, administrative, and registration county is given in the census returns as 970,161 acres or 1516 square miles, with a population in 1881 of 250,647, in 1891 of 266,549 (of whom 132,100 were males and 134,449 females, the number of persons per square mile being 176, and of acres to a person 3·64), and in 1901 of 266,921. The urban population (1891) numbered 150,168, and the rural 116,381. Between 1881 and 1891 the percentage of increase was 6·34. The excess of births over deaths between 1881 and 1891 was 38,597, but the actual increase of resident population was only 15,902. The following table gives the number of marriages, births, and deaths, with the number of illegitimate births for 1880, 1890, and 1898:—

| Year. | Marriages. | Births. | Deaths. | Illegitimate Births. | |
|---|---|---|---|---|---|
| | | | | Males. | Females. |
| 1880 | 1721 | 8504 | 5153 | 347 | 343 |
| 1890 | 1941 | 8441 | 4928 | 342 | 396 |
| 1898 | 2017 | 7543 | 4680 | 281 | 228 |

In 1899 the number of marriages was 1978, of births 7660, and of deaths 4307.

The following table gives the marriage-, birth-, and death-rates per 1000 persons living, with the percentage of illegitimate births for a series of years:—

| | 1870-79. | 1880. | 1880-89. | 1890. | 1888-97. | 1898. |
|---|---|---|---|---|---|---|
| Marriage-rate | 15·5 | 13·8 | 13·8 | 14·6 | 13·4 | 14·5 |
| Birth-rate | 35·1 | 34·2 | 33·6 | 31·8 | 30·2 | 27·2 |
| Death-rate | 21·6 | 20·7 | 19·5 | 19·0 | 17·2 | 16·9 |
| Percentage of illegitimacy | 8·9 | 8·1 | 7·6 | 7·6 | 7·2 | 6·7 |

In 1891 there were in the county 11,826 natives of Scotland, 9628 natives of Ireland, and 404 foreigners.

*Constitution and Government.*—The county is divided into four parliamentary divisions, and it also includes the parliamentary boroughs of Carlisle and Whitehaven. It contains three municipal boroughs—Carlisle (39,176), Whitehaven (18,879), and Workington (23,490). The following are urban districts:—Arlecdon and Frizington (5697), Aspatria (2714), Cleator Moor (9464), Cockermouth (5464), Egremont (6258), Harrington (3535), Holme Cultram (4602), Keswick (4500), Maryport (12,536), Millom (8895), Penrith (8981), and Wigton (3965). The county is in the northern circuit, and assizes are held at Carlisle. The borough of Carlisle has a separate court of quarter sessions and separate commissions of the peace. The ancient county constitutes part of the archdeaconry and diocese of Carlisle, and contains 162 entire ecclesiastical parishes.

*Education.*—At Carlisle is a school of science and art. At St Bees there is an ancient grammar school. The Theological College of St Bees was closed in 1897. The number of elementary schools on 31st August 1899 was 286, of which 105 were board and 181 voluntary schools, the latter including 153 National Church of England schools, 1 Wesleyan, 14 Roman Catholic, and 13 "British and other." The average attendance at board schools was 22,635, and at voluntary schools 22,339. The total school board receipts for the year ending 29th September 1899 were over £85,695. The income under the Agricultural Rates Act was over £32,645.

*Agriculture.*—The county being mountainous, the acreage under cultivation is much below the average—only about three-fifths of the whole; while nearly three-fifths of this acreage is in permanent pasturage. In addition, over 261,000 acres are in hill pasture and over 35,000 acres under woods. Sheep are largely kept and many cattle are reared. Of the corn crops about nine-tenths are under oats, while about three-fourths of the green crop area is occupied by turnips and swedes. The following table gives particulars at intervals of five years from 1880:—

| Year. | Total Area under Cultivation. | Corn Crops. | Green Crops. | Clover. | Permanent Pasture. | Fallow. |
|---|---|---|---|---|---|---|
| 1880 | 574,665 | 94,422 | 47,291 | 105,182 | 322,780 | 4989 |
| 1885 | 579,069 | 92,923 | 46,598 | 107,270 | 329,237 | 3039 |
| 1890 | 593,991 | 89,973 | 47,391 | 114,805 | 339,510 | 2129 |
| 1895 | 579,404 | 85,880 | 46,200 | 115,654 | 330,105 | 1211 |
| 1900 | 582,036 | 78,728 | 42,515 | 115,532 | 344,428 | 561 |

The following table gives the numbers of the principal live-stock for the same years:—

| Year. | Total Horses. | Total Cattle. | Cows or Heifers in Milk or in Calf. | Sheep. | Pigs |
|---|---|---|---|---|---|
| 1880 | 20,654 | 132,032 | 41,429 | 517,410 | 20,574 |
| 1885 | 20,288 | 139,329 | 45,579 | 494,553 | 24,104 |
| 1890 | 20,442 | 138,086 | 46,393 | 562,252 | 31,717 |
| 1895 | 22,542 | 141,937 | 45,941 | 518,276 | 23,708 |
| 1900 | 21,557 | 148,339 | 48,145 | 580,618 | 18,816 |

*Industries and Trade.*—According to the report for 1898 of the chief inspector of factories (1900), the total number of persons employed in factories and workshops in 1897 was 19,371 as compared with 19,598 in 1896. Of these 2212 were employed in textile factories. Non-textile factories employed 14,958 persons, there being between 1895 and 1896 an increase of 15·5 per cent; but between 1896 and 1897 a decrease of 2·5 per cent. Of these 4088 were employed in the founding and conversion, and 2087 in the extraction, of metals, the other principal industries being the manufacture of machines, appliances, conveyances, tools, &c., employing 2135 persons, and food employing 1642. There is some iron shipbuilding. Of the 2201 persons employed in workshops, 1625 were employed in clothing industries. The total number of persons employed in mines and quarries in 1899 was 14,560. Within recent years the mining industries of the county have made rapid progress. Of granite 103,923 tons were raised in 1899, of limestone 524,417 tons, of clays 75,427 tons, and of sandstone 52,352 tons. There is a large production of pig iron, 687,874 tons in 1885, 832,614 tons in 1890, 648,740 tons in 1895 and 954,637 tons in 1899. The seats of the industry are Whitehaven, Workington, Cleator Moor, Maryport, and Millom. The following table gives particulars regarding the output of the more important minerals in 1890 and 1899:—

| Year. | Coal. | | Gypsum. | | Iron Ore. | | Lead. | | Zinc. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Tons. | Value. | Tons. | Value | Tons. | Value. | Tons | Value | Tons | Value. |
| | | £ | | £ | | £ | | £ | | £ |
| 1890 | 1,740,113 | 658,0[illegible] | 20,851 | 5213 | 1,480,159 | 804,474 | 2272 | 18,005 | 4809 | 15,569 |
| 1899 | 2,100,118 | 710,9[illegible] | [illegible],858 | 8772 | 1,137,750 | 833,879 | 825 | 7,691 | 714 | 36,9[illegible] |

On account of the number of lakes, rivers, and streams, the fresh-water fisheries are of considerable importance, and include besides trout and salmon, char, pike, perch, lamprey, and eels. At Whitehaven, Maryport, and Morecambe the amount of fish landed in 1899 was 7766 cwt., valued at £14,241.

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**Cumberland,** capital of Alleghany county, Maryland, U.S.A., situated in the mountainous western portion of the state, at an altitude of 626 feet, on the main western line of the Baltimore and Ohio Railway, and on four other lines. It is on the border of the Cumberland coal-field, and through these railways, and the Chesapeake and Ohio Canal, of which it is the western terminus, it has a large trade in coal. It has rolling-mills, and other iron and steel works, glass and railway works. Population (1880), 10,693; (1900), 17,128.

**Cumberland,** a town of Providence county, Rhode Island, U.S.A., with an area of 27·5 square miles of hilly country. It is bordered on the west by Blackstone river, on which are several small villages, the remainder of the population being rural. Population (1880), 6445; (1900), 8925.

**Cumberland River,** a large southern branch of Ohio river, U.S.A., rising in the highest portion of the Cumberland plateau, in eastern Kentucky. From its source it flows westwards, then south into Tennessee, thence again westwards, passing Nashville, and finally north-westwards across the western part of Kentucky, to its mouth at Smithfield, a few miles above the mouth of Tennessee river. Its entire length is about 700 miles, of which much the greater part is navigable. Its drainage basin comprises 18,573 square miles. During the Civil War Fort Donelson was erected on the Cumberland and Fort Henry on the Tennessee by the Confederates, about 40 miles above their mouths, to prevent navigation by Federal vessels. These forts were captured by General Grant in February 1862, with 14,000 prisoners, and the rivers were thus opened up to Federal gunboats.

**Cumnock,** a police burgh of Ayrshire, Scotland, 33¾ miles south of Glasgow by road. There is a town-hall, an athenæum, a public library, and a monument to "Prophet" Peden, the Covenanter. Coal and ironstone are extensively mined in the neighbourhood, and there are several woollen and tweed mills in the town. The churches are Established, United Free, Congregational Union, Baptist, and Roman Catholic. The public school had an average attendance of 522 in 1898–99, and a Roman Catholic school 102. Population (1881), 3345; (1901), 3087.

**Cundinamarca,** a department of the republic of Colombia, bounded on the N. by Venezuela and the departments of Boyacá and Santander, on the W. by Antioquia and Tolima, on the S. by Cauca, and on the E. by Venezuela. Area, 79,691 square miles. Population, 500,000, of whom one-fourth are whites, the rest Indians and half-breeds. The capital, Bogotá, which is also the capital of the republic, has about 100,000 inhabitants. Principal towns: Zipaquirá, Facatativá, Cáqueza, Fómeque, Choconta.

**Cuneo,** a town, episcopal see, and capital of the province of Cuneo, Piedmont, Italy, 54 miles by rail south-south-west from Turin, on a rocky platform above a tributary of the Tanaro, at the northern foot of the Maritime Alps. Apart from the broad arcaded main street, the streets are narrow and crooked. The chief buildings are the (restored) cathedral, the 12th-century Franciscan church, the town-hall, theatre, and military hospital. The former town walls have been converted into promenades. A monument to Barbaroux was erected in 1879. Silk-spinning, raising of cocoons, and printing are the principal industries. There is a school of the industrial arts and handicrafts. Population of town, about 17,000; of commune, about 29,000.

**Cupar Fife,** a royal, parliamentary (St Andrews group), and police burgh, and the county town of Fifeshire, Scotland, on the river Eden, 45 miles north of Edinburgh by the Forth Bridge and 16 south-west of Dundee by rail. The business of the town chiefly depends on its importance as an agricultural and legal centre. A handsome new Free church was erected in 1877–78. The Madras Academy having received a supplementary endowment from a legacy of Sir David Baxter is now known as the Bell-Baxter school, and is one of the five recognized higher-class schools of the county. The county buildings were enlarged in 1892–93. Population of the parliamentary and police burgh (1881), 5010; (1891), 4729; (1901), 4511; and of the royal burgh (1881), 4964; (1891), 4693.

**Curaçoa** or **Curaçao,** an island in the Caribbean Sea off Venezuela, and the name of a government comprising that island and its dependencies, the other Dutch West Indies—Oruba (Aruba) and Buen Aire (Bonaire), near the coast of Venezuela; Saba, St Eustatius, and the half of St Martin, in the Lesser Antilles. Total area, 530 square miles. The islands near the coast of South America consist of slate, cretaceous formations, and eruptive rocks (diorite and diabase), forming ridges 650 to 1300 feet high, and plateaux or hills 200 to 500 feet. The islands of the Lesser Antilles are of volcanic (Saba, St Eustatius) or Tertiary (St Martin) rocks. The principal occupations are the rearing of cattle, the cultivation of fruit trees (palms), aloe, and divi-divi, and the working of salt and phosphate. The island of Curaçoa is the only one with a good port, Willemstad (population about 8000), with a total traffic valued at £160,240 in 1899, while that for the rest of the islands amounted only to £21,300. The total population in 1898 was 51,693, of whom only 425 were born in the Netherlands. (Curaçoa, 30,119; Bonaire, 4926; Aruba, 9591; St Martin (Dutch part), 3485; St Eustatius, 1383; Saba, 2189.)

WYNMALEN. "Les colonies neerlandaises dans les Antilles," *Revue Colon. Internat.* 1887, ii. p. 391. K. MARTIN. *West-Indische Skizzen.* Leiden, 1887. DE VEER. *La colonie de Curaçoa.* Les Pays Bas, 1898.—MOLENGRAAFF. *De geologie van het eiland St Eustatius.* Leiden, 1886. Also several articles on all the islands in *Tijdschrift v./h. Ned. Aardr. Genootschap* (1883–86).

**Curci, Carlo Maria** (1809–1891), Italian theologian, was born at Naples on the 4th of September 1809. He became a novice of the Order of Jesuits in 1826, and was ordained priest in 1837. For some years he was stationed at the Church of the Gesù at Naples, was made rector of the schools, and also devoted himself to work among the poor and in the prisons. Here he came into close relations with Gioberti, Rosmini, and other advocates for reform in the Italian Church. Curci wrote a preface to Gioberti's *Primato*, published in 1843, but he protested against Gioberti's *Prolegomena*, and wrote against his later books in favour of reform. After the fall of the Papal Government in 1870 Curci delivered discourses on Christian Philosophy at Florence. In 1874 he published

an Introduction to his Exegetical Lessons on the Gospels. In 1879 and 1880 appeared his edition of the New Testament, in the preface to which he made some severe remarks on the neglect of the study of the Scriptures among the Italian clergy. In the meantime he had commenced the campaign against the Vatican which has made him famous. In his *Il Moderno Dissidio tra la Chiesa e l'Italia* (1878) he advocated an understanding between Church and State. In his *La Nuova Italia ed i Vecchi Zelanti* (1881) he inveighed against the condition of the Vatican at that period. In 1883 he published his *Vaticano Regio*, in which he accuses the Church of making merchandise of the holiest things, and declares that her worldliness was due to the false principles she had embraced. He still kept up his sympathy with the working class, and expressed it in a striking treatise on Christian Socialism, in which he invoked State interference to check the inequality with which profits were shared between employer and employed. Excommunicated and deprived, he was reduced to beggary, and in 1884 he retracted "all that he had said contrary to the faith, morals, and discipline of the Church." He passed the remainder of his life in retirement, and died at Villa Careggi, near Florence, on 8th June 1891. (J. J. L*.)

**Curico,** a city of Chile, capital of the province and department of the same name, 114 miles from Santiago by rail, situated in 34° 58′ S. lat. and 71° 19′ W. long. Population, 15,000.

**Curitiba,** a city of Brazil, and capital of the state of Paraná. The population is 20,000, of whom over 12,000 are foreign-born (4000 Germans, 4000 Italians, 2000 Poles, and from 2000 to 3000 Portuguese, Spaniards, &c.). Nearly all the wholesale trade is in the hands of Germans. In the vicinity of Curitiba are prosperous colonies of Italians, Germans, Poles, &c.

**Curling, Thomas Blizard** (1811–1888), British surgeon, was born in London in 1811. Through his uncle, Sir William Blizard, he became assistant-surgeon to London Hospital in 1833, becoming full surgeon in 1849. After filling other important posts in the College of Surgeons, he was appointed President in 1873. In 1843 he won the Jacksonian prize for his investigations on tetanus; and he became famous for his skill in treating diseases of the testes and rectum, his published works on which went through many editions. He died on 4th March 1888.

**Curtea d'Argesh,** a town in Rumania, on the southern slopes of the Carpathians (population in 1900, 4210), north-west of Pitesti, connected by railway with Bucharest. It derives its name from Courtea (the Court), having been the residence of Radu Negru early in the 13th century. It contains two interesting churches, one of which was constructed by Radu himself. About 1½ miles north of the town is the cathedral, a magnificent and unique specimen of Byzantine art. There are myths connected with its foundation, which have been put into beautiful and pathetic verse by the Rumanian poet, B. Alexandri, but as a matter of fact it was constructed by the Prince Nagul Bassaraba, who governed Wallachia from 1512 to 1522, and who studied architecture while a hostage at Constantinople at the court of the Sultan Selim. Aided by another architect, Manoli, he erected this cathedral, which was completely reconstructed with great taste and success at the expense of the Rumanian Government between 1875 and 1885, under the direction of a French architect, M. Lecomte de Nouy. It was reconsecrated with great pomp in the presence of the king on 12th October 1886.

**Curtis, George Ticknor** (1812–1894), American legal writer and constitutional historian, was born in Watertown, Massachusetts, 28th November 1812. He graduated at Harvard University in 1832, became a lawyer, and practised his profession in Boston, New York, and Washington. He was the nephew and close friend of George Ticknor, the historian of Spanish literature, and his association with his uncle was influential in developing his scholarly tastes; while his other personal friendships with eminent Bostonians during the period of conservative Whig ascendancy in Massachusetts politics were of direct influence upon his political opinions and published estimates. After preparing a number of law-books, one of which—on the *Rights and Duties of Merchant Seamen*—elicited the hearty praise of Mr Justice Story, he issued in 1855–58 the first of the two works upon which his place in literature depends: *A History of the Origin, Formation, and Adoption of the Constitution of the United States, with Notices of its principal Framers.* This history, which had been watched in its earlier progress by Daniel Webster, may be said to present the old federalist or "Webster–Whig" view of the formation and powers of the constitution; and it was natural that Mr Curtis should follow it with a voluminous *Life of Daniel Webster* (2 vols., 1870). Both these works were characterized by solidity and comprehensiveness rather than by rhetorical attractiveness or literary perspective. In his later years Mr Curtis, like so many of the followers of Webster, turned towards the Democratic party; and he wrote, among other works of minor importance, an exculpatory life of President James Buchanan (2 vols., 1883) and two vindications of General George B. M'Clellan's career (1886 and 1887). He died in New York, 28th March 1894.

**Curtis, George William** (1824–1892), American man of letters, was born in Providence, R.I., 24th February 1824. He came of old New England stock, and at the time of his birth the New England community was at its best. His mother died when he was two years old. At six he was sent with his elder brother to school in Jamaica Plain, Mass., where he remained for five years. Then, his father having again married happily, the boys were brought home to Providence, where they stayed till, in 1839, their father removed to New York. Three years later, Curtis, being allowed to determine for himself his course of life, and being in sympathy with the spirit of the so-called Transcendental movement, became a boarder at the community of Brook Farm. He was accompanied by his brother, whose influence upon him was strong and helpful. He remained there for two years, brought into stimulating and serviceable relations with many interesting men and women. Then came two years, passed partly in New York, partly in Concord, in order mainly to be in the friendly neighbourhood of Emerson, and then followed four years spent in Europe, Egypt, and Syria. Curtis returned from Europe in 1850, handsome, attractive, accomplished, ambitious of literary distinction. He instantly plunged into the whirl of life in New York, obtained a place on the staff of the *Tribune*, entered the field as a popular lecturer, set himself to work on a volume published in the spring of 1851, under the title of *Nile Notes of a Howadji*, and became a favourite in society. He wrote much for *Putnam's Magazine*, of which he was associate editor; and a number of volumes, composed of essays written for that journal and for *Harper's Monthly*, came in rapid succession from his pen. The chief of these were the *Potiphar Papers*, a satire on the fashionable society of the day; and *Prue and I*, a pleasantly sentimental, fancifully tender and humorous study of life. In 1855 he married Miss

Anna Shaw. Not long after his marriage he became, through no fault of his own, deeply involved in debt owing to the failure of *Putnam's Magazine*; and his high sense of honour compelled him to devote the greater part of his earnings for many years to the discharge of obligations for which he had become only by accident responsible, and from which he might have freed himself by legal process. In the period just preceding the Civil War other interests became subordinate to those of national concern. Curtis made his first important speech on the questions of the day at Wesleyan University in 1856; he engaged actively in the Presidential campaign of that year, and was soon recognized not only as an effective public speaker, but also as one of the ablest, most high-minded, and most trustworthy leaders of public opinion. In 1863 he became the political editor of *Harper's Weekly*, and no other journal exercised during the war and after it a more important part in shaping public opinion. His writing was always clear, direct, forcible; his fairness of mind and sweetness of temper were invincible. He never became a mere partisan, and never failed to apply the test of moral principle to political measures. From month to month he contributed to *Harper's Monthly*, under the title of "The Easy Chair," brief essays on topics of social and literary interest, charming in style, touched with delicate humour, and instinct with generous spirit. His service to the Republican party was such, that more than once he was offered nominations to office of high distinction, and might have been sent as Minister to England; but he refused all offers of the kind, feeling that he could render more essential service to the country as editor and public speaker. In 1871 he was appointed by President Grant chairman of the Commission to report on the reform of the Civil Service. The report which he wrote was the foundation of every effort since made for the purification and regulation of the Service and for the destruction of political patronage. From that time till his death Mr Curtis was the leader in this reform, and to his sound judgment, his vigorous presentation of the evils of the corrupt prevailing system, and his untiring efforts, the progress of the reform is mainly due. He was the President of the National Civil Service Reform League and of the New York Civil Service Reform Association. In 1884 he refused to support the nomination of Mr Blaine as candidate for the Presidency, and thus broke with the Republican party, of which he had been one of the founders and leaders. From that time he stood as the typical independent in politics. In April 1892 he delivered at Baltimore his eleventh annual address as President of the National Civil Service Reform League, and in May he appeared for the last time in public, to repeat in New York an admirable address on James Russell Lowell, which he had first delivered in Brooklyn on the 22nd of the preceding February, the anniversary of Lowell's birth. On the 31st of the following August he died. He was a man of consistent virtue, whose face and figure corresponded with the traits and stature of his soul. The grace and charm of his manner were the expression of his nature. Of the Americans of his time few were more widely beloved, and the respect in which he was held was universal.

See:—*George William Curtis*, by EDWARD CARY, in the series of Lives of American Men of Letters (Boston, 1894); an excellent biography.—"An Epistle to George William Curtis," by JAMES RUSSELL LOWELL, 1874–87. In Lowell's *Poems*. — *George William Curtis*, a Commemorative Address delivered before The Century Association, 17th December 1892, by PARKE GODWIN. New York, 1893.—*Orations and Addresses by George William Curtis*, edited by CHARLES ELIOT NORTON, 3 vols., 8vo. New York, 1894.

(C. E. N.)

**Curtius, Ernst** (1814–1896), German archæologist and historian, was born at Lübeck on 2nd September 1814. On completing his university studies he was chosen by Professor Brandis to accompany him on a journey to Greece for the prosecution of archæological researches. Curtius then became Otfried Müller's companion in his exploration of the Peloponnesus, and on Müller's death in 1840 returned to Germany. In 1844 he became an extraordinary professor at the University of Berlin, and in the same year was appointed tutor to Prince Frederick William (afterwards Emperor Frederick III.)—a post which he held till 1850. After holding a professorship at Göttingen and undertaking a further journey to Greece in 1862, Curtius was appointed in 1863 ordinary professor at Berlin. At the same time he became Secretary of the Royal Academy of Science, of which he had been a member since 1853. In 1874 he was sent to Athens by the German Government, and concluded an agreement by which the excavations at Olympia were entrusted exclusively to Germany. Among the results of these excavations was the discovery of Praxiteles' famous statue of Hermes. He died at Berlin on 11th July 1896. Curtius' best-known work is his *History of Greece* (1857–67; English translation by A. W. Ward, 1868–73). It presented to the public in an attractive style the latest results of scholarly research, but was criticized as wanting in erudition. His other writings are chiefly archæological. The most important are: *Die Akropolis von Athen* (1844); *Naxos* (1846); *Peloponnesos, eine historisch geographische Beschreibung der Halbinsel* (1851); *Olympia* (1852); *Die Ionier vor der ionischen Wanderung* (1855); *Attische Studien* (1862–65); *Göttinger Festreden* (1864); *Sieben Karten zur Topographie von Athen nebst einem erläuternden Text* (1868); *Ephesos* (1874); *Die Ausgrabungen zu Olympia* (1877, etc.); *Olympia und Umgegend* (edited by Curtius and Friedrich Adler, 1882); *Olympia, Die Ergebnisse der von dem Deutschen Regierung veranstalteten Ausgrabung* (also with F. Adler, 1890–98); *Die Stadtgeschichte von Athen* (1891). His collected speeches and lectures were published in 2 vols. under the title of *Altertum und Gegenwart* (1875 and 1882), to which a third volume was added under the title of *Unter drei Kaisern* (1889).

His brother, GEORG (1820–1885), philologist, was born at Lubeck on 16th April 1820. After an education at Bonn and Berlin he was for three years a schoolmaster in Dresden, until (in 1845) he returned to Berlin University as *privat-docent*. In 1849 he was placed in charge of the Philological Seminary at Prague, and two years later was appointed Professor of Classical Philology in Prague University. In 1854 he removed from Prague to a similar appointment at Kiel, and again in 1862 from Kiel to Leipzig. His philological theories had a widespread influence upon the study of that science. The more important of his publications are: *Sprachvergleichung in ihrem Verhältniss zur classischen Philologie* (1845), *Sprachvergleichende Beiträge zur griechischen und lateinischen Grammatik* (1846), *Grundzüge der griechischen Etymologie* (1858–62), *Das Verbum der griechischen Sprache* (1873). From 1868 to 1878 he was general editor of *Studien zur griechischen und lateinischen Grammatik*, and, from 1878 till his death, of a similar publication entitled *Leipziger Studien zur classischen Philologie*. His Greek Grammar for Schools, first published in 1855, passed through a number of editions, and has been edited in English. He died at Hermsdorf on 12th August 1885.

**Curzola,** chief town of the Adriatic island of the same name in the Austrian province of Dalmatia. The

principal resources of the population are boat-building, fishing, and seafaring, the cultivation of the vine, corn, and oil, and breeding of mules. Population of island, 18,749; of town, 6486.

**Cushing, Caleb** (1800–1879), American statesman, was born in Salisbury, Mass., on the 17th of January 1800. He was graduated from Harvard in 1817, and began the practice of law in Newburyport. After serving in each house of the State legislature he was a Representative in Congress from 1835 to 1843. Originally a Whig, he supported President Tyler, and gradually became associated with the Democrats. As Commissioner to China he negotiated the first treaty between that country and the United States. He raised a regiment for the Mexican War, and rose to the rank of brigadier-general. During the administration of President Pierce he was Attorney-General of the United States. In 1860 he associated himself with the Breckinridge wing of the Democratic party. In 1866 he was appointed one of the three commissioners to revise and codify the laws of Congress. In 1868 he was sent on a diplomatic mission to Bogotà. At the Geneva Conference for the settlement of the *Alabama* claims he was one of the counsel for the United States. In 1873 he was nominated Chief Justice of the United States, but the nomination was not confirmed. From 1874 to 1877 he was United States minister to Spain. He died at Newburyport, Mass., on the 2nd of January 1879.

**Cushman, Charlotte Saunders** (1816–1876), the famous American actress, was born of New England stock in Boston, Mass., 23rd of July 1816. She went on the opera stage in 1834 in consequence of her father's financial failure and death, successfully appearing as the Countess Almaviva in *The Marriage of Figaro.* Her voice failing for purposes of singing, she took to the dramatic stage, playing Lady Macbeth (1835) with distinction. Convinced that she had not served a proper apprenticeship, she engaged herself as a stock actress, but was soon given the leading parts, among them high comedy impersonations. In 1844 she accompanied Macready on an American tour, winning great reputation in a series of tragedy parts. In 1844 and in 1853 she played successful engagements in London. She was a keen student, and acquired a large range of classic *rôles.* Her best parts were perhaps Lady Macbeth and Queen Catherine, her most popular being Meg Merrilies. Her figure was commanding and her face expressive, and she was animated by a temperament full of vigour and fire. These qualities enabled her to play with success such male parts as Romeo and Cardinal Wolsey. She died at Boston on the 18th February 1876.

See also *Charlotte Cushman, her Letters and Memories of her Life.* Edited by Emma Stebbins. Boston, 1878.

**Cusset,** a town in the arrondissement of Lapalisse, department of Allier, France, 31 miles south by east of Moulins, with station (2 miles distant) on railway to Vichy. It is situated at the confluence of the Sichon and Jolan, two small affluents of the Allier, and 2 miles north-east of Vichy, with which it is connected by a beautiful avenue. Its mineral waters are renowned, and its industries include paper, linen, oil, and basket-work. The town grew up around a convent founded in 886, and afterwards, in the 13th century, converted into an abbey of St Benoit. Louis XI. improved and fortified the town. A relic of that period is the Grosse Tour, now used as a prison. The fortifications have been replaced by boulevards, but many of the older houses exhibit the architectural features of the 15th and 16th centuries. Population (1881), 4955; (1901), 6444.

**Custer, George Armstrong** (1839–1876), American soldier, was born in New Rumley, Ohio, on 5th December 1839. After graduating at the U.S. Military Academy in June 1861, he entered at once the Union service early in the Civil War. As a young cavalry officer he impressed General M'Clellan, who in May 1862 appointed him an aide-de-camp with the rank of captain. Under General Pleasanton and General Sheridan he subsequently rose rapidly, both in volunteer and regular rank, while the Virginia operations lasted. He participated in all but one of the battles of the Army of the Potomac, led the cavalry division in pursuit of Lee's army, 1865, received its first flag of truce, and was present at the surrender at Appomattox Court House. At the age of twenty-five he was major-general of volunteers. After the war he engaged in service on the Western frontier. In an expedition against the Indians he and his entire command were massacred, after a desperate struggle, on 25th June 1876, by an overwhelming hostile force. Both Custer and his wife wrote interesting books descriptive of Indian frontier life.

**Cüstrin,** a town of Prussia, at the confluence of the Oder and the Warthe, 18 miles north by east of Frankfurt; three railway stations. It has three Protestant churches, a Catholic church, a gymnasium, a higher grade and a burgher school, a school for mechanics, four machinery works, and other manufactures. Population (1890), 16,672; (1900), 16,463.

**Cutch** (Kachh), a native state of India, within the Gujarat division of Bombay, with an area of 6500 square miles. In 1881 it had a population of 512,084, and in 1891 of 558,415, giving an average density of 86 persons per square mile. In 1901 the population was 487,384, showing a decrease of 13 per cent., due to the famine of 1899–1900, compared with an increase of 9 per cent. in the previous decade. The estimated gross revenue is Rs.25,21,670; the tribute for a subsidiary force amounts to Rs.2,00,000. There are special manufactures of silver filigree-work and embroidery. The maritime population supplies the best sailors in India. In 1897–98 the imports by sea were valued at Rs.66,69,273, and the exports at Rs.21,35,605; the customs duties amounted to Rs.8,17,000. There are ten cotton presses and two ginning factories. The number of police was 826; the number of schools was 134, with 7142 pupils, being 2·23 per cent. of the population. The chief institutions are a high school and a school of art, both at Bhuj, the capital. There are seven libraries in the state, with 7246 books. Cutch suffered severely from the recent plague.

**Cuttack,** a town and district of British India, in the Orissa division of Bengal. The town is situated at the head of the delta of the Mahanadi. Population (1881), 42,676; (1891), 47,186. It is the centre of the Orissa canal system, and now an important railway station on the East Coast line from Madras to Calcutta. It contains the Government college, called after Mr Ravenshaw, a former Commissioner; a high school, with 265 pupils; a training school; a survey school; a medical school, with 112 students, of whom 5 were women; a law school; six printing-presses; three vernacular periodicals; a Baptist mission; and a Roman Catholic convent.

The District of Cuttack lies in the centre of Orissa, occupying the deltas of the Mahanadi and Brahmani, together with a hilly tract inland. Its area is 3633 square miles. The population in 1881 was 1,795,065; in 1891 it was 1,937,681, giving an average density of 533 persons per square mile. Classified according to religion, Hindus numbered 1,881,913; Mahommedans, 52,895; Christians, 2733, of whom 128 were Europeans; "others," 140. In 1901 the population was 2,059,719, showing an increase

of 6 per cent. The land revenue and rates were Rs.10,32,983; the number of police was 571; the number of boys at school in 1896–97 was 55,351, being 39·2 per cent. of the male population of school-going age; the registered death-rate in 1897 was 33·39 per thousand. The Orissa canal system, which lies mainly within Cuttack district, irrigated in 1897–98 an area of 200,943 acres, and carried 546,766 tons of cargo. The gross receipts amounted to Rs.5,51,924, showing a net profit of Rs.12,005. The railway across the district towards Calcutta was opened in 1899. Considerable trade is carried on at the mouth of the rivers along the coast, the principal port being near the lighthouse at False Point. In 1897–98 the value of the exports (mostly rice) was Rs.25,76,728 for foreign and Rs.1,50,452 for coasting trade. The imports are insignificant.

**Cuttle-fish.**—The Cuttle-fish, whose general anatomy has already been described in the 9th edition of the *Ency. Brit.*, are classed in the sub-kingdom MOLLUSCA on account of their bilaterally symmetrical, unsegmented bodies, their possession of a fleshy integument, or "mantle," and of a muscular "foot," and the arrangement of their nervous centres in three pairs of ganglia. They are placed in the cephalous division on account of their having a distinct head, and a buccal cavity lined in almost all cases by a toothed lingual ribbon or "odontophore." Within this division they are sharply marked off as an anciently developed distinct class by the following characters. In the earliest stage of their growth a part only of the germinal substance of the ovum is segmented, instead of the whole, as is commonly the case in other molluscs. They are provided with strong parrot-like horny jaws surrounded in the Octopods by eight, and in the Decapods by ten, sucker-bearing arms; their brain is encased in cartilage; their eyes are enormous; and on their ventral side is an ejecting siphon or funnel, at the base of which lies the ink-bag. These characters combine to make them the most active, intelligent, and predaceous of all the marine invertebrates.

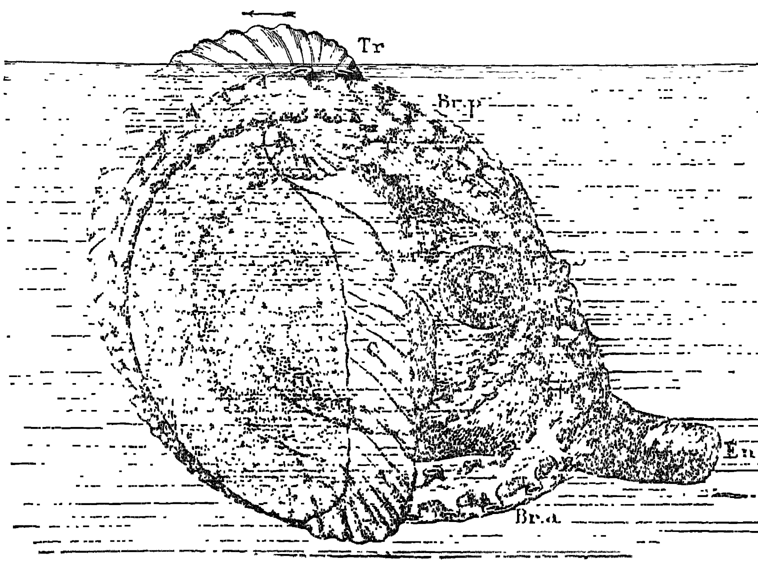



FIG. 1—The Argonaut in life. (*After Lacaze-Duthiers.*) *Tr*, float; *Br.a*, anterior arms; *Br.p*, posterior arms; *V*, the expanded portion of them, once called the sails; *B*, the beak; *C*, the shell; *En*, the funnel.

The class *Cephalopoda*, of which the general characters are thus indicated, includes as a distinct group the members of the Pearly Nautilus Order, which differ only in the living animals by minor peculiarities, as follows:—They are protected by an external camerated shell; their jaws are calcareous and of different form; their arms are in lobes, with clinging tentacles in place of suckers; their siphon is not a complete tube, and there is no ink-bag; their eyes have no lens, but only a pin-hole aperture; and they have four branchiæ instead of two, each of which is provided with a sense-organ or *osphradium*, but there are no branchial hearts. These characters indicate a less active and intelligent animal, and one less removed by development from the primitive type of the class. The number of the branchiæ has been used for the purpose of nomenclature, so that while the Nautilus Order belongs to the *Tetrabranchiata*, the Cuttle-fish Order belongs to the *Dibranchiata*. Besides these two orders there is an immense number of fossil forms, of whose branchiæ nothing is ever likely to be known, and they have accordingly been sometimes classed as Tetrabranchiates and sometimes as Dibranchiates, but they ought rather to be called Ignotobranchiates.

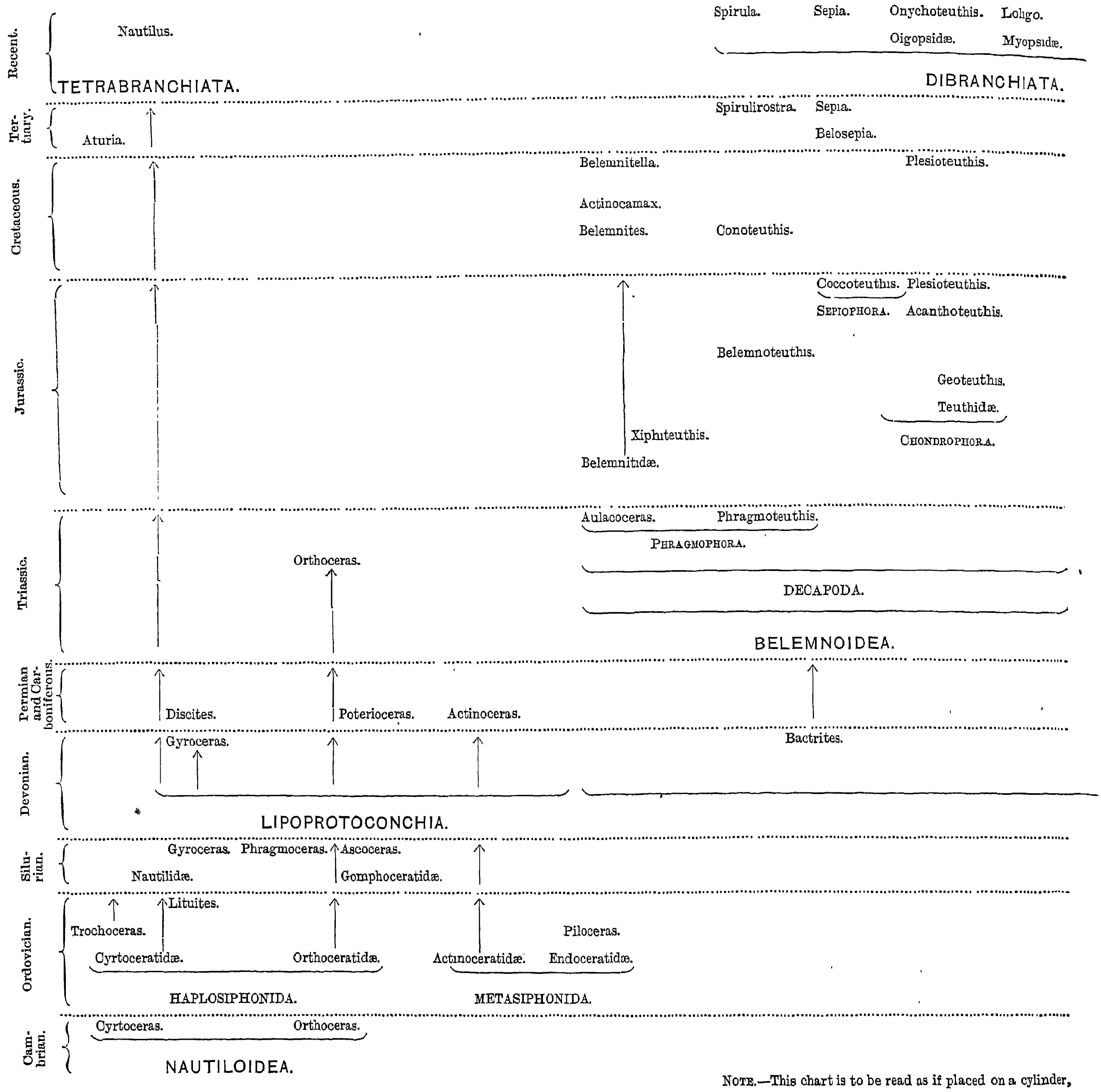
Much discussion has taken place as to the true homology of the arms and their relation to the head of the Cuttle-fish. The majority of naturalists consider the arms to be part of the "foot," which has grown up so as to surround the mouth, because they originate at the same part of the embryo as does the foot of a snail, and are innervated from a ganglion corresponding in its connexions with the pedal ganglion. In this view the siphon and its appendages form the remainder of the foot, and the animal is represented, for comparison, as standing with its head downwards and its body obliquely upwards. Others consider the siphon to represent the whole of the foot, and the arms to be organs special to the class. The origin of the arms in the development of the embryo is certainly very distinct at first from that of the siphon.

***Recent forms.***

The number of distinct forms now included amongst existing Cuttle-fish is very large, the latest census giving 464 species. These may be described as clustering principally round certain well-known types, as the *Octopus* or Poulpe, the *Sepia* or Squid, and the *Loligo* or Calamary, with a few specially isolated and interesting forms. Of these latter may be enumerated the *Cirroteuthis* and the *Opisthoteuthis*, which are finned Octopods in which no odontophore has been found, while their arms are webbed together like an umbrella; and the latter has its siphon directed backwards. These are probably retrograde forms. Others are the *Argonauta* and the *Spirula*, on which of late years fresh light has been thrown. Of the Argonaut many fables have been told as to its position in the shell, and its mode of progression, but in 1892 Lacaze-Duthiers had an opportunity of watching the living animal for a fortnight (Fig. 1). It forsakes its shell in adverse circumstances, but enters it again under favourable conditions. The front edge of the shell is then kept nearly vertical, and the early part of the coil encloses air which serves as a float. The funnel projects in front below, and the beak above, the eye. The broad pair of arms embrace only the hinder part of the shell, leaving the front part uncovered, and the other arms in swimming are tucked inside the shell between it and the body.

A well-preserved specimen of the animal of the *Spirula*, as obtained by the *Challenger* Expedition, has been described by Pelseneer. The shell is naked and exposed both on the front and back of the animal, and coils towards the ventral side, on which the siphuncle lies. The mantle sac at first

CLASSIFICATION OF CUTTLE-FISH AND THEIR



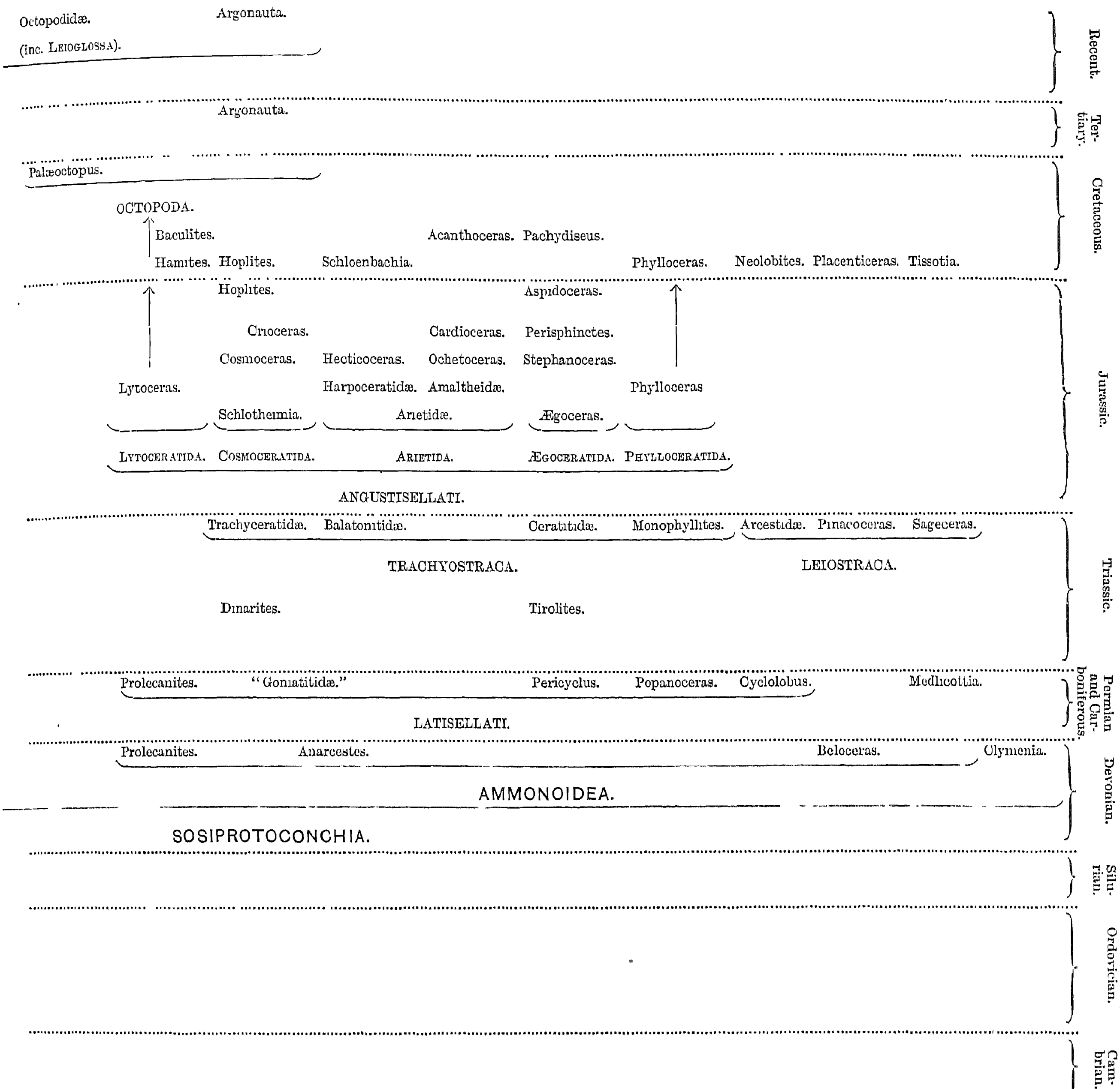

NOTE.—This chart is to be read as if placed on a cylinder,

only covers the chamber adjacent to it, but afterwards grows over the sides and coalesces below. At the base is a flat depressed disc, which is not a sucker, but may be a pad to prevent shocks in swimming backwards. At the sides hang two fins which are parallel to each other, in the direction from back to front and not in one transverse line behind. The ovary lies against the right-hand side of the coil of the shell and the oviduct against the left, and the last chamber is occupied by part of the liver. The eyes are on peduncles sunk below the level of the head, but are not covered, as in higher groups. The *Spirula* thus represents an early stage in the development of the Order.

The shells of the Cuttle-fish Order, on which we principally depend for our knowledge of their relations to fossil forms, are not in great variety at the present day, but the *Spirula*-shell itself suffices to connect them on the one hand with the Pearly Nautilus, and on the other with an infinite series of extinct allies. The *Spirula*, like the Nautilus, has its shell in the form of a conical tube, coiled in one plane and divided by cross partitions—the "septa"—into chambers connected by an inner tube—the "siphuncle." Fossils showing these same general characters can be traced back to the earliest fossiliferous or Cambrian strata. With these, as the primitive ancestors, the history of the Cuttle-fish commences. These earliest forms of shell are, as might be expected, very simple. The tube is oval or round, the coiling is slight (*Cyrtoceras*), or absent (*Orthoceras*), the septa mere shallow basins, the siphuncle a simple narrow tube with no fixed position, and the ornaments no more than lines of growth. In the later history we find one after another of the several elements becoming a centre of variation, till fixity is reached, or the element, or even the shell itself, is dispensed with. The first element to vary was the siphuncle, the complexity of which gave rise to such early genera as *Endoceras*, *Piloceras*, and *Actinoceras*, forming a separate group, METASIPHONIDA, the remainder

**Extinct forms.**

ALLIES DURING SUCCESSIVE EPOCHS.




like a map of the World on Mercator's projection.

being Haplosiphonida. This condition of things continued to the Carboniferous period, after which no complex siphuncles are known; the organ then became insignificant, and is finally lost in all the recent Cuttle-fish except the *Spirula*. The position of the siphuncle was variable at first, and in those forms which are the special ancestors of the Nautilus it continued to be so. But in Devonian times a cleavage of the class took place, and a new group was developed, in which the siphuncle is permanently pushed to the ventral side in the adult, where it is also now found in the archaic *Spirula*. This group is also characterized by having a thin and fragile shell, and by the peculiarities of the initial chamber or *protoconch*, which is of globular form, has a restricted neck, and contains the commencement of the siphuncle at its centre, as seen in *Spirula*. We thus obtain two great subdivisions of the Class: on the one hand the Nautiloidea, presumably tetrabranchiate and certainly less progressive; on the other, the remaining Cephalopoda then existing. The only collective name yet suggested for this new group, unless we assume them all to have belonged to the Dibranchiata, is the Sosiprotoconchia of Bather, who calls the Nautiloids at the same time Lipoprotoconchia. As the Cuttle-fish proper must have descended from these Sosiprotoconchia, we need follow the Nautiloids no more.

Within the *Sosiprotoconchia* there was soon a new and fundamental cleavage dependent on the variation of the coiling. On the one side are the *Belemnoids*, which have practically no coiling at all, and whose fragile shells are protected, if at all, by a massive external guard, while their septa remain simple; on the other side are the *Ammonoids*, whose globular protoconch is closely enveloped by the later coils, which often overlap each other and whose septa become complex, their surface being partially convex forwards, and their edges or "sutures" folded or wrinkled.

Both these modifications seem adapted to give greater strength in relation to a more active life.

The modern Decapod Cuttle-fish are undoubtedly the descendants of the Belemnoids. The earliest of these belong to Triassic times where they are known as *Aulacoceras*, *Atractites*, and *Phragmoteuthis*. It is very probable that there were earlier, as yet undiscovered, representatives, and that a cleavage had already taken place, for in the succeeding, Liassic, period a new group is well established. In this group, the *Chondrophora*, all signs of the original septate shell are lost, and the protecting pen, now horny, alone is left. The genera, known as *Teudopsis*, *Beloteuthis*, *Geoteuthis*, &c., differ in little beyond their broader pens from the modern Calamaries, so that they rapidly attained their acme of development, and then remained stationary. The other group, the *Phragmophora*, developed the *Belemnites* proper. These retain throughout their whole development the original thin shell—or "proostracum," its internal septa and siphuncle forming together the "phragmocone." It is the guard that changes, either in form or markings. It is very feeble in *Belemnoteuthis* and said to be absent in *Conoteuthis*; it commences to be absorbed in *Belemnitella*, and is caducous in *Actinocamax*. So far we are on safe ground, for the Belemnites were certainly Cuttles, since their guard is known to have been internal, by its earlier layers being enveloped by the later ones; and further, they are found with the guard in position at the extremity of a perfectly outlined body with characteristic fins, ten arms with hooks, ink-bag, and eyes.

The history of the divergence from the general Belemnoid type into the two branches represented respectively by the *Spirula*, with phragmocone and no mucro (or modified guard), and the *Sepia*, with mucro and no phragmocone (unless the cancellous tissue represent it), is obscure. For the only possible suggestion for an ancestor of the former would be the doubtful *Conoteuthis*, and the latter is said to have a near ally in *Coccoteuthis* of the Solenhofen limestone. Both of these are anterior to the disappearance of Belemnites, so that it is not certain whether the latter have been modified into, or superseded by, the representatives of the modern Cuttles. Nor is it clear whether the peculiar cancellous substance in the *Sepia* represents a series of modified septa, or of special shell layers. Each lamella is supported by sinuous partitions rising vertically from the one below, and these appear to spread out horizontally at intervals and coalesce to form the new lamella, the whole being calcified in horizontal layers. The spaces bounded by the calcified partitions and the lamellæ are occupied in the very fresh shell by a number of thin walled, apparently empty, cells in two or more horizontal layers, whose adpressed walls give the appearance of free membranes, but these are without regularity. It is probable that these secrete some gas, so that the lamellæ coincide in function, if not in origin, with the septa of a phragmocone.

The history of the Ammonoids, including their probable modern representatives, the Octopods, is more complex. In this group the first element to form a centre of variation was the septum, and its outline the suture. This variation in the early stages of growth has been made the basis of Branco's classification into the *Asellati*, *Latisellati*, and *Angustisellati*; in the later or adult stages it gives the principal generic characters of the *Goniatite* and *Ceratite* groups, and of those remarkable forms of the Trias in which it reaches its acme of complexity, as in *Sageceras*, *Pinacoceras*, and the *Arcestidæ*. After this, the Ammonoids settle down into a "normal" type of suture, which, though showing abundant differences of detail, can all be described, without straining, as modifications of a definite arrangement of "lobes" and "saddles." The centre of variation next passes to the build and ornament of the external shell. Whilst the sutures were the principal seat of variation the shells remained smooth—*Leiostraca*; now they became ornamented or rough—*Trachyostraca*; doubtless this, on the principle of corrugated iron, made them stronger and less dependent on their septa. From these latter the majority of the later Ammonoids have descended, the genera depending principally upon the build and ornaments, so called, of the shell; till in Cretaceous times their abnormal forms, *Hamites*, *Baculites*, &c., indicate their decadence and presage their disappearance. Other abnormal forms have, however, appeared at various epochs of Ammonite history.

What became of the Ammonites? and whence are the Octopods derived? are two correlated questions on which more light is desirable. The wide distribution of Ammonites in all latitudes and in all varieties of strata, shows that neither change of temperature nor of circumstance can have caused their extinction. The forward convexity of their septa suggests the secretion of gas at great depths which expanded as they rose to the surface before the last septum was fully formed. In this case they must have been pelagic animals, and therefore have been superseded by other pelagic animals performing their function more efficiently—such as more highly developed members of the same class.

It is now known that Octopods were actually in existence in the Cretaceous period, thus overlapping the

Fig. 2.—*Palæoctopus Newboldi*, the oldest Octopod known. From the Cretacious rocks of Lebanon. (*After H. Woodward.*)

Ammonoids in time, since a member of that group, the *Palæoctopus* (Fig. 2), has left an impression of its body, head, arms, and two fins, as in the *Pinnoctopus*, on rocks of that age in the Lebanon. This was naked, so that in part of the group the shell was already dispensed with. On the other hand we have in the living Argonaut an Octopod whose shell has a great external resemblance to

that of an Ammonite, particularly to such an early type as the *Trachyceras*, or late type as the *Hoplites*.

It has usually been considered, but not without various protests, that this resemblance is superficial only, since there are no septa, and the shell has been supposed to be the product of the arms which partially embrace it. That such is not the case has been shown by Steinmann, and can be easily verified on the shell itself. The most solid part is a transverse bar, projecting from either side of the apex and spreading out in a double fold over its surface. It is actually inaccessible to the arms, and cannot be produced by them. This bar passes insensibly into the remainder of the shell, which consequently has the same origin. This is composed of two principal layers. The inner layer is a comparatively thin basement membrane, irregularly folded and thickened by calcareous matter in irregular lines running parallel to the margin of the shell, and in no way interrupted in passing from one side to the other of the median line. The outer layer, which has a tendency to split into two parts, consists of very fine vertical rods, arranged as in a pile carpet, which readily coalesce and are calcified into the solid shell. It is these two layers that are produced by the mantle. Besides these there is a thin amorphous periostracum, often coloured with a brownish tint and rough on the surface from the sporadic deposit of calcareous particles. This is found only on the outside of the shell where it is covered by the arms, that is, it is wanting near the margin and for some distance on either side of the median line.

The relation of this shell to the animal is similar to that of the Nautilus, and thus presumably of the Ammonite also, and different from that of the Sepia, inasmuch as the outer part of it lies on the siphonal or ventral side of the mouth; while in the Sepia it lies on the antisiphonal or dorsal side. Such is the evidence at present available for the view that Octopods are descended from Ammonites which have dispensed with their septa, or with their entire shell. On the other hand is the fact that no ink-bag has ever been found in association with an Ammonite.

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(J. F. BL.)

**Cuxhaven,** a seaport town of Germany, belonging to the state of Hamburg, and situated at the extremity of the west side of the mouth of the Elbe, 71 miles by rail north-west from Hamburg. A new harbour was made in 1891–96, having an area of 71,800 square yards and a depth of 26½ feet, with a fore port 1000 feet long by 800 feet wide; and it is now the place of departure and arrival of the mail steamers of the Hamburg-American Steamship Company, who in 1901 transferred here a part of their permanent staff. The port is free, *i.e.*, outside the Customs Union (*Zollverein*), and in 1899 was entered by 331 vessels of 73,090 tons; the imports being principally coals, bricks, and timber, and the exports fish. There is a fishing fleet, for which a new harbour was opened in 1892. Population (1900), 6898.

**Cuzco,** the largest department of Peru, with an area of 156,270 square miles and a population of 438,646. It contains twelve provinces—Convención, Urubamba, Talca, Puacartamba, Anta, Cuzco, Quispicanchi, Paruro, Acomayo, Chumbivilicas, Canas, and Canchis. The capital, Cuzco, has a population of 30,000.

**Cyclades.** See GREECE (*Ionian Islands*).

**Cycling.**—The history of the pastime, the sport, and the trade of cycling really begins with the year 1885. The method of self-propulsion upon two, three, or four wheels—bicycles, tricycles, or multicycles—has been practised, with more or less perseverance, for at least a hundred years. But before 1885 its votaries were either athletes, or persons carried away by a temporary craze; either venturesome pioneers, balancing and propelling themselves, with varying degrees of speed and uncertainty, upon "boneshakers" and "ordinaries," tall bicycles, or the timid, sometimes the comfort-loving, who rode tricycles, velocipedes, or multicycles. Had it not been for the practical and commercial introduction of the safety bicycle, brought out by J. K. Starley, of Starley and Sutton, in 1885, cycling would never have gained its popularity or become a universally recognized method of locomotion. The invention of the safety bicycle is claimed by numberless inventors. From 1818, the year of the craze for the Draisnene of Baron Drais de Saverbrun of Mannheim, who propelled his bicycle by half-sitting, half-standing upon a bar fitted with a saddle, connecting two equal-sized wheels, with a handle in front for steering and also for rest, and by pushing with his toes which just touched the ground, until 1840 and 1846, when Kirkpatrick Macmillan, a blacksmith of Dumfriesshire, and Gavin Dalziel, a cooper of Lanarkshire, fitted cranks and pedals to these Draisnene or similar vehicles, there is no authentic historical record. It has also been asserted that similar machines were used in Paris in 1816, one by M. Niepice in the Luxembourg Gardens. There was also a machine shown in the historical collection in Class 30 at the Paris Exhibition of 1900, which was stated to have been made in 1799, but there is no authentic proof of the correctness of any date before 1818. Macmillan's and Dalziel's machines had pedals, which moved levers backwards and forwards, connected with the rear axle, and thus drove them. Credit, therefore, for the invention of balancing and rear driving seems to belong to Macmillan; for direct steering to Baron Drais. By 1855 cranks and pedals had been affixed to the front wheel, which was driven, and in 1866 came Michaux with his velocipede, a heavy lumbering

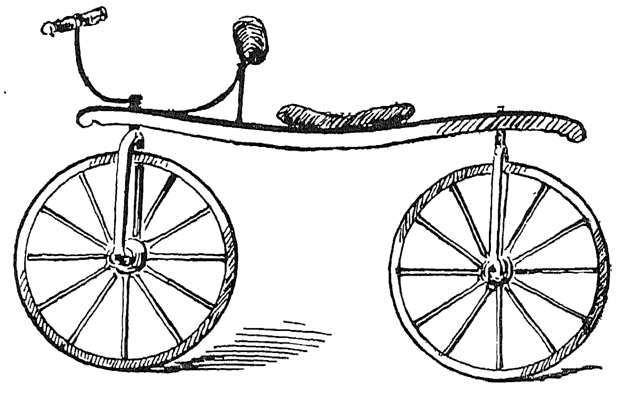


FIG. 1.—Gentleman's Hobby Horse, 1816–30.

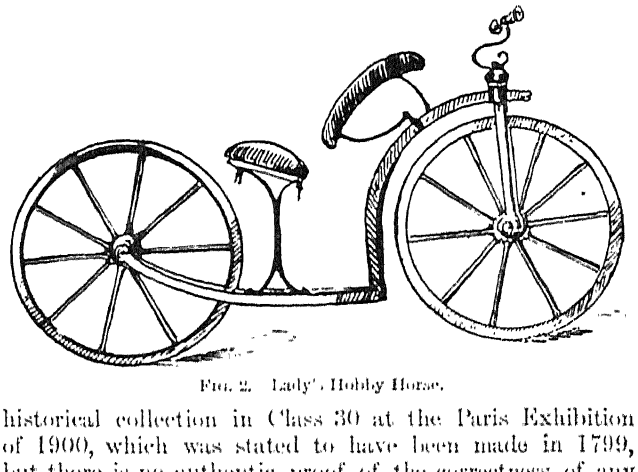


FIG. 2. Lady's Hobby Horse.

affair of steel, iron, and wood. The rider sat upon a wooden or iron frame, or a long steel spring connecting the wheels, and he propelled and steered the cycle, known as a bone-shaker, by the front wheel. In 1866 also, Pierre Lallemant took out in the United States a patent for a wheel driven by a crank and pedals; this patent was upheld for many years, and later it had much to do with the development, or want of development, of the American cycle industry. A similar patent was granted to E. Gillman in England a few months earlier. Lallemant's machine was shown by Michaux in the Paris Exhibition of 1867. In the same year the first modern machine with a large wheel in front is said to have been made in England, but the maker's name is unknown. Crank-action, however, had been applied to velocipedes with three or

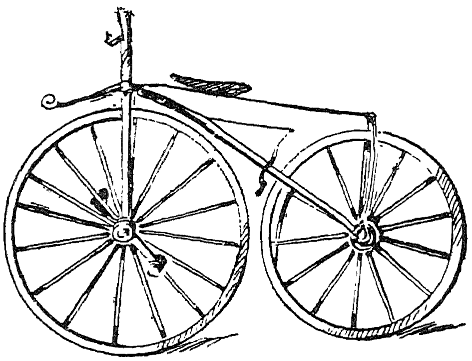


Fig. 3.—The Boneshaker, 1868.

four wheels many years before. In 1868 the bone-shaker was imported into England from Paris by Mr Turner. And in 1869 Michaux is reputed to have produced in France the first bicycle with a big front wheel, the "ordinary." These two statements seem contradictory, but it would be impossible to prove, or disprove their truth at the present time—that is, to prove whether the bicycle with the large front wheel was first made in England or in France. There is no doubt, however, that the tall bicycle was at first used more generally in England. There was unquestionable delight and pleasure in riding this machine, and very long tours and very fast times on the road and path were made on it. H. L. Cortis covered 20 miles 300 yards in the hour, in 1882. In 1884 Thomas Stevens started from San Francisco to ride round the

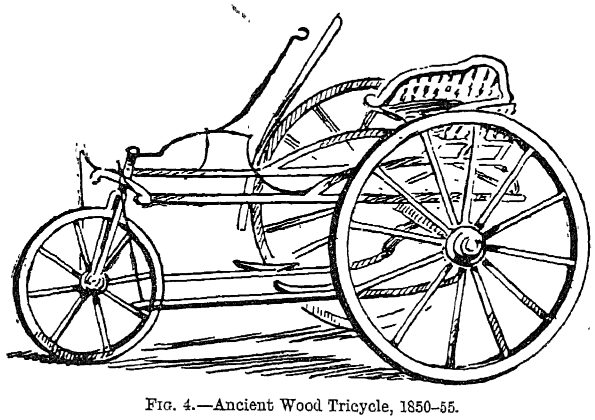


Fig. 4.—Ancient Wood Tricycle, 1850–55.

world, a feat of most surprising pluck, energy, and endurance, which he accomplished in three years. Endless attempts were made to produce dwarf or safety bicycles which should combine the safety of the tricycle with the speed of the ordinary. Among the most popular were the "Extraordinary Challenge," the "Facile," the "Kangaroo," the "American Star," but, though they possessed scarcely greater safety than the ordinary, they were very complicated, and have all disappeared. Starley's "Rover," however, was safe, and was a success from the start. He returned to the form of the "Draisnene," but the "Rover" was driven by a chain carried on a gear wheel, so that the

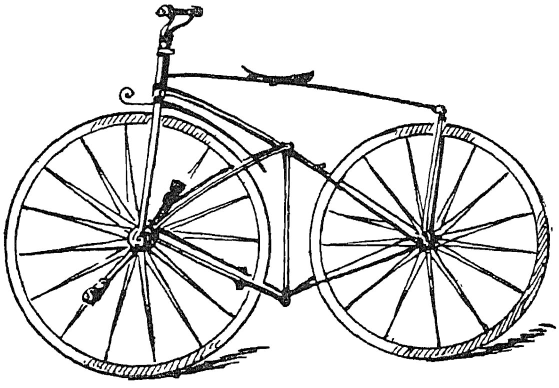


Fig. 5.—The "Phantom," 1869.

rider by one revolution of the pedals propelled his cycle as far as or farther than the rider of the tall ordinary. This chain travelled from a crank axle, fitted between the two wheels, to the hub of the back wheel, and the machine was steered by the front wheel. Save in structural details the safety is the same to-day as in 1885.

About 1870, or possibly before — the exact date is unknown — steel suspension wheels had been substituted for wooden spokes, and solid rubber for iron tyres. But even with rubber tyres (by 1887 to 1888 large cushion tyres had been fitted to the wheels and powerful springs to deaden vibration added to the frame) the progress of the cyclist along the road was anything but pleasant. The vibration on the tall bicycle, produced by the small back wheel, often only from 14 to 18 inches in diameter, though the front wheel had grown from 50 to 60 inches, was most trying, and the jolting on the safeties, with their tiny tyres, was almost equally bad, producing not only nervous exhaustion and fatigue, but, with most people, ultimate

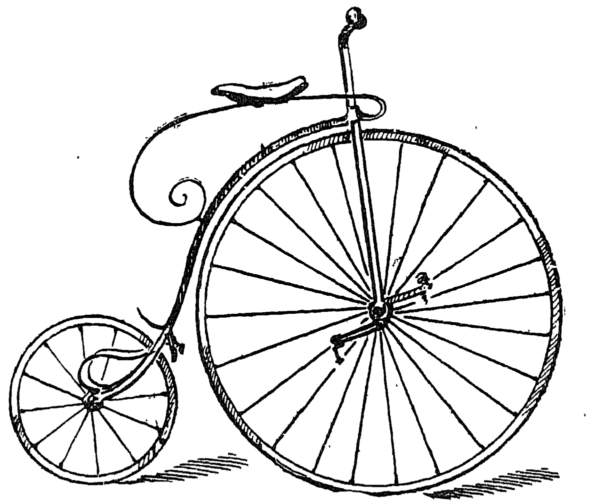


Fig. 6.—Grout's Tension, 1871.

distaste for the pastime. Sir Benjamin Ward Richardson was the first to draw serious attention to the mental and physical danger of vibration. But no satisfactory solution was to be found. The safety not infrequently was totally unmanageable. The frames had no uniformity. They were either made in a series of curves, or with two crossed tubes like an open pair of scissors stayed by wires. The diamond frame, now universal, was faintly suggested by imaginary lines, and the diagonal one was unthought of.

In 1888 a veterinary surgeon of Belfast, J. B. Dunlop, substituted for the solid, or cushion tyre,—the latter a much enlarged rubber tyre with a hollow core, both of them cemented to the rim,—a bandage composed of a rubber tube, about two inches in diameter, vulcanized or solutioned to a canvas cover, which encircled the whole rim and was then inflated by an air pump. The idea was not new; in 1846 Mr William Thompson had taken out a patent for a pneumatic tyre, for carriages, little used at the time and afterwards completely forgotten. Upon a machine fitted with the Dunlop tyre, races were won by Messrs Ducros in Ireland in the spring of 1888, and also at an autumn meeting of the Surrey Bicycle Club at the Kennington Oval in the same year, while a few tourists made experiments with the new tyre on the road. It was at once seen that

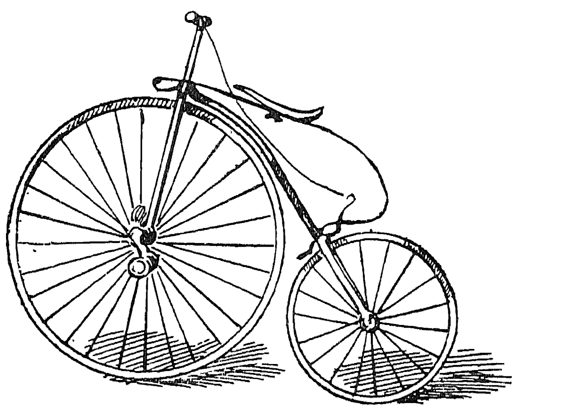


FIG. 7.—Humber's "Spider," 1872.

not only had vibration been greatly lessened, but speed wonderfully increased, and this invention of the veterinary surgeon, who did not even ride a bicycle, when applied to the safety, gave cycling its universal popularity. Within a few years the ordinary or tall front-driven bicycle and the tricycle almost disappeared. The former has gone almost entirely save as a dwarf, and the latter only survives as the carrier, though a certain number are still manufactured of the Humber Cripper type. The safety also solved the problem of women cycling without being compelled to adopt male attire. There was an attempt to change women's costume, and for safety and ease such a radical change might be an improvement. But the general feeling, warranted by the general result, when the experiment was made, was against it. Women had for years ridden the tricycle. But tricycles weighed ordinarily from

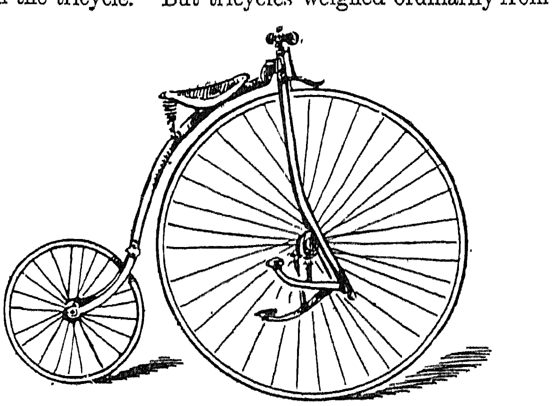


FIG. 8.—The "Facile," 1879–84.

60 to 100 ℔ or more, and were therefore unsuitable for them, unless in the form of tandems and sociables, on which the greater part of the work was usually done by a male rider. Still, as far back as 1883 or 1884 the whole of Europe had been covered by women on tricycles. Bicycles for women were introduced about 1887 or 1888 by Starley Brothers, the makers of the "Psycho," and by 1890 or 1891 they had been generally adopted. The first machine of this sort is said to have been made by J. M'Cammon of Belfast in 1884. Tandem bicycles first became practical about 1889 or 1890, and in a few years

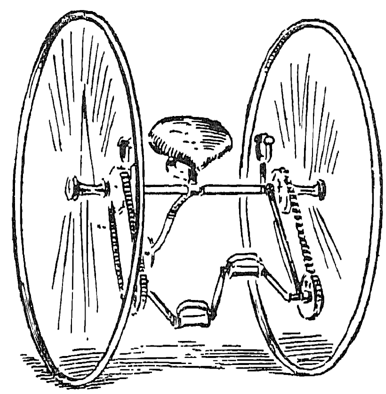


FIG. 9.—Otto Dicycle, 1879.

they virtually superseded the tandem tricycle. Save that they are strengthened and simplified in construction there is little change in them. Certain makers of cycles deserve to be remembered. A few names will always stand out prominently. Among them are D. Rudge, Thomas Humber, James Starley, for his balance gear, W. Bown, the inventor of ball-bearings, and J. K. Starley—men who more than any others impressed their inventive genius on the industry and the trade, though the present mechanical position of the cycle industry is the result of the untiring labour of multitudes of inventors everywhere. J. K. Starley, practically and commercially, made the safety bicycle in 1885. But nine years before this, in 1876, Messrs Henry Bate and George Shergold were working at the safety idea, Bate by gearing up, Shergold by means of a small front wheel. In the same year, too, Mr H. J. Lawson patented a lever-driven safety, but the rear wheel was from 50 to 84 inches, and, in 1879, he produced Lawson's bicyclette. This, however, was, in many details, very like the bone-shaker of a few years before, though it had a small back wheel which was geared up and chain-driven.

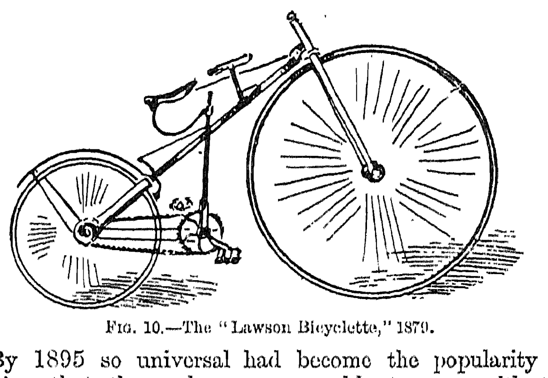


FIG. 10.—The "Lawson Bicyclette," 1879.

By 1895 so universal had become the popularity of cycling that the makers were unable to cope with the demand. New factories were started, small shops grew into large companies, and where the capital invested in them before had been reckoned by hundreds it speedily became millions. Nor was the new activity confined to cycles alone or to Great Britain. Tyres, component parts, lamps, saddles, every sort of accessory, acquired enormous financial importance. The Dunlop Co., started in 1889 with a capital of £25,000, was floated in 1894 for £5,000,000.

The makers who by their mechanical genius had brought the manufacture of cycles well on the way towards perfection, each one striving to improve his own detail, were now swallowed up by company promoters and adventurers, bent simply upon lining their own pockets, at any cost, by supplying a world which had suddenly gone cycle-mad. The result was that energy was mainly turned to the payment of dividends by the grossly over-capitalized companies. Machines, instead of being built by mechanics proud of their work, in many cases were simply put together in the shortest possible time, and turned out in the greatest possible numbers in one or more standard patterns. For these the world clamoured, and for a year the makers could not produce them fast enough. In another year the demand decreased. The inventive spirit had become dormant, the British market was over-stocked, and, as the British manufacturers refused to consider the wants of foreign customers, their store rooms remained crowded with unsold machines, dividends were unpaid, and all but the strongest firms went to the wall. Although cycling remained as popular as ever, the trade became disorganized, through seeking, frequently by cheapness and the resurrection of antiquated ideas, to bolster itself up, rather than by individual excellence to regain its lost position. The only attempt to meet individual requirements was to be found among a few makers who built cycles to fit their riders, as was done at the very beginning of the industry. A similar state of affairs, more or less, exists in almost all other countries. In America a huge trust was organized, by which it was hoped that the wants of manufacturers, rather than the desires of purchasers, would be promoted. But ever since Lallemant's patent was purchased by one company, and sustained, it has been the effort of the American cycle makers to compel riders to purchase machines made in the fashion which was most profitable for them. Hence dropped steel forgings, wood rims, and single tube tyres were for a time all but universal in America. As American cycles are made by the most perfect automatic machinery, and as the parts can be duplicated, the whole of Europe, as well as America, for a year or two, was all but monopolized by the manufacturers of the United States. They, however, paid little more attention than the English makers to European wants, so that they, too, began to lose their hold. With the 20th century, however, the outlook became more hopeful.

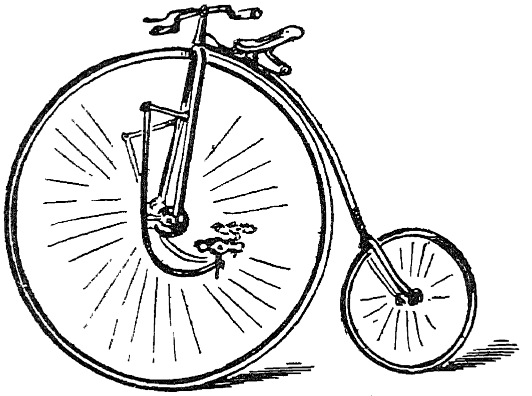


FIG. 11.—Singer's "'Xtra," 1879.

Although cycle tours were taken and cycle clubs established almost as soon as the cycle appeared (the Pickwick Bicycle Club of London was founded in 1870, and is the oldest bicycle club in the world), and although the Cyclists' Touring Club, then known as the Bicycle Touring Club, was organized in 1878, it was not until 1895 that this organization assumed its present importance. To-day it numbers about 56,000 members, scattered throughout Europe and America and even the East. It is the only international organization of the kind, though almost every other country possesses a national club. The League of American Wheelmen, started in 1880 in a very small way, was able, after a period, to claim a membership of over 100,000, a degree of prosperity which it could not maintain, for by 1900 its members had dwindled to 28,000. The Touring Club de France, founded 1895, at the present time is numerically the strongest, with 72,000 members, but cycling is only one, if the chief, of its objects. An International Touring League has been formed by the national clubs, and it numbers a quarter of a million members. The aim of these associations is the promotion of cycle touring. They publish road-books, maps, and journals; they recommend hotels in their own and other countries with fixed tariffs; they appoint representatives to aid their members when touring; and they have succeeded in inducing most governments to allow their members to travel freely across frontiers without paying duty on their cycles. Another important branch of the work of these clubs, either directly or indirectly, is the improvement of the roads. This is accomplished either, as in Belgium, where all the roads are paved, by the taxation of cycles and the consequent demand on the part of riders for side paths; or by grants of money, as in France, to aid the State; or, as in Great Britain, by the publication, through a body known as the Roads Improvement Association, of good-roads literature, and by watching, promoting, or suppressing, when possible, various parliamentary and local government and railway bills affecting cyclists. In the United States also the League of American Wheelmen is devoting itself more and more to the good-roads question with satisfactory results, laws for improved road legislation having been passed in many states. The clubs have in all countries erected a system of warning-boards upon dangerous hills. In France even the best route is suggested by a sign-post, while cyclists who come to grief in lonely places find a repair outfit for their free use. The large touring organizations have therefore, to a great extent, superseded the old clubs. If these still exist in a quiet way—a few possessing well-appointed club-houses—they have lost their usefulness, now that all the world cycles, and survive merely as social organizations. The Stanley is an exception. It continues to promote the large annual show of cycles, held almost regularly since 1877, the makers of England and other countries having borrowed the idea, until the big yearly exhibition of machines has become an institution everywhere.

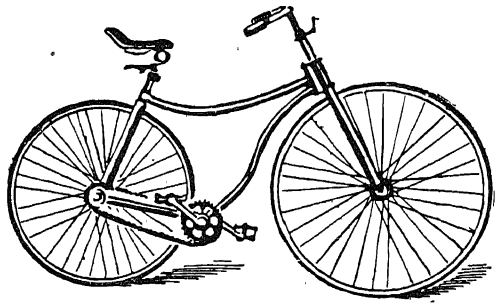


FIG. 12.—The "Rover," 1885.

Each country also possesses an organization for the government of cycle racing; and although these unions, one object of which—usually the main one—is the encouragement of cycle racing and cycle legislation, boast an enormous membership, their membership is often composed of clubs and not individuals. Among the most important are the National Cyclists' Union of England and the Union

Vélocipédique of France. These bodies are also bound together by the International Cyclists' Association, which is devoted mainly to the promotion of racing and legislation connected with it all over the world. The National Cyclists' Union, originally the Bicycle Union, which was the parent body of all, formed in February 1878, was the first to put up danger-boards, and also was early instrumental, alone and with the C.T.C., in framing or suggesting laws for the proper government and regulation of cycle traffic, notably in establishing its position as a vehicle in securing universal rights, in endeavouring, again in conjunction with the C.T.C., but unfortunately with little success, to increase facilities for the carriage of cycles on the railways, in securing the opening of parks, and in promoting many other equally praiseworthy objects. For a number of years, however, it has been more prominent as the ruling race-governing body. But cycle racing has fallen upon

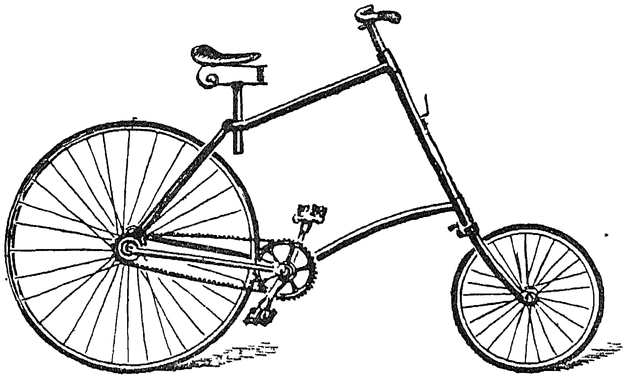


Fig. 13.—The Humber Pattern Safety, 1888.

the same evil days as cycle making. As in all other forms of sport, racing apparently occupies a great deal of public attention, and at one time a cycle race drew a large number of spectators, but now it has lost the public favour, or rather it is ignored by the public. The reason is that cycle racing has been mainly an advertisement for cycle makers. The presence of the man, directly or indirectly, in the employ of, or aided by a maker, and the consequent mixing up of trade and sport, have lowered racing not only in the public estimation, but in that of all genuine amateurs. There have always been a few amateurs who have raced for the love of the sport, but the greater number of prominent racing men have raced for the benefit of a firm, so much so that, a few years ago, an entire section of racing men were classed as "makers' amateurs." They did not confine themselves to the race track, but appropriated the public roads until they became a danger and a nuisance, and road-racing finally was abolished, though record rides, as they are called, are still indulged in, being winked at by the police and by the cycling authorities. The makers' amateurs at least rode to win and to make the best time possible. But the scandal was so great that a system of licensing riders was adopted by the N.C.U., and if this did not effectively kill the sport, the introduction of waiting races did. There probably is considerable skill in riding two-thirds of a race as slowly as possible, and only hurrying the last part of the last lap, but it does not amuse the public, who want to see a fast race as well as a close finish. This also accounts for the fact that some of the early records have not yet been beaten. The introduction of pacing by multicycles and motors next took from cycle racing what interest was left. A motor race, in which the machines are run at top speed, is more exciting than the spectacle of a motor being driven at a rate which the cyclist can follow with the protection of a wind-shield. In America this system of proving what cyclists can do with racing machines, has been carried so far that in 1899 a board track was laid down on the Long Island railway for about two miles between the metals, and a cyclist named Murphy, following a train, and protected by enormous wind-shields, succeeded in covering a mile in less than a minute in the autumn of 1900. W. Stinson covered forty miles in an hour on a safety, thus doubling Cortis's record on the tall machine. Other cyclists have devoted themselves, at the instigation of makers, to the riding of a hundred miles a day every day for a year. It would be difficult to say what advantage there is in these trials and contests. They are not convincing records, and only prove that some people are willing to take great personal risks for the benefit of their employers. E. Hale during 1899–1900 covered 32,496 miles in 313 days. For many years also long-distance races, mostly of six days' duration, have been promoted on covered tracks. Though condemned by all cycling organizations, they find a great deal of pecuniary support. Racing is probably at the present day in the most flourishing condition in France, where more money is offered in prizes on the track, the city of Paris granting funds for the purpose, and where also, on certain occasions, as in the race from Bordeaux to Paris, held annually in May, the high roads are given up unreservedly for twenty-four hours to a carnival of recklessness.

The cycle has also been taken up as a war machine. For this idea the army is indebted to Colonel A. R. Savile, who in 1887 organized the first series of cycle manœuvres in England. Since then military cycling has been continued and somewhat encouraged by the organization of cycling sections among volunteers and a special corps, the 26th Middlesex, and to a less extent in the regular army. On the Continent cyclists are attached to many army corps, if not to every regiment, as scouts, messengers, and despatch-bearers, in which capacity they may at times be of great use.

Cycling has produced a literature of its own, both of the pastime and of the trade. Owing to the enormous profits which, for several years, were obtained by cycle makers, a trade press appeared which simply lived by, and out of, its advertisers; and though each country has one or more genuine trade journals, the large proportion of these sheets have been worth, in a business aspect, as little practically, as from a literary standpoint. On the

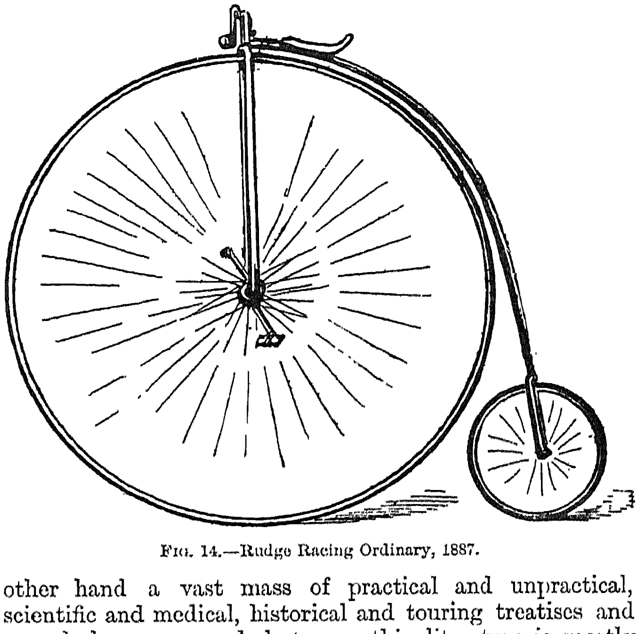


Fig. 14.—Rudge Racing Ordinary, 1887.

other hand a vast mass of practical and unpractical, scientific and medical, historical and touring treatises and records have appeared, but even this literature is mostly of a rather ephemeral character.

The history of cycling on the continent of Europe and in America is virtually a repetition of the happenings in Great Britain. Though the invention of the modern cycle is probably due to Michaux, a Frenchman, cycle-making reaches its greatest perfection in England. Improvements in many ways have been made in France and America, but English cycles of the best makes are still regarded as the most trustworthy. France, however, has done more for the cyclist than any other country, owing to the fact that she possesses the best roads, kept up to a certain extent by the cycle tax, thus giving the cyclist a certain official position and right; moreover, cycles are conveyed free on railways, and State aid is given to the sport and the pastime, with the result that trade for some years has been in a very flourishing condition. In Germany, Italy, Switzerland, and Holland much the same state of

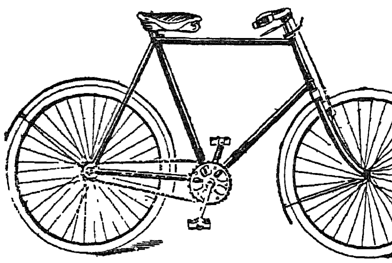


FIG. 15.—Safety, 1901.

affairs exists, though in a lesser degree. In Belgium the cycle has worked a veritable revolution in the national life. The surface of the greater part of the country is loose and sandy, and the roads therefore have been all paved, and are impossible for light traffic, because the paving is so bad. The cycle tax consequently has been devoted, first, to the construction of cycle-paths, on which wheelmen have equal rights with pedestrians, and secondly, to the replacing of the paving by macadam. In this way alone cycling has proved of inestimable benefit to Belgium and Luxembourg. In the United States also, though it has not yet been possible to procure uniform legislation, good-roads and side-path Bills have been introduced in various states, mainly at the instigation of wheelmen, while state aid has been obtained by law for the free carriage of cycles.

*World's Records in 1900.*

The following are the world's records to the end of 1900, which have been accepted by the Union Cycliste Internationale :—

| Miles. | Time. | Holder and Place. | Date. |
|---|---|---|---|
| $\frac{1}{4}$ flying | 20″ | Major Taylor at Chicago | Nov. 9, 1899 |
| $\frac{1}{4}$ standing | $27\frac{2}{5}$″ | Green at London . . | Aug. 2, 1899 |
| $\frac{1}{2}$ flying | 41″ | Major Taylor at Chicago | Nov. 10, 1899 |
| $\frac{1}{2}$ standing | $51\frac{1}{5}$″ | Green at London . . | Aug. 2, 1899 |
| $\frac{3}{4}$ flying | 1′:$04\frac{3}{5}$ | Chase at London . . | July 26, 1900 |
| $\frac{3}{4}$ standing | 1′:15 | Green at London . . | Aug. 2, 1899 |
| 1 flying | 1′:$22\frac{2}{5}$ | Major Taylor at Chicago | Aug. 3, 1899 |
| 1 standing | 1′:$38\frac{3}{5}$ | Chase at London . . | July, 26, 1900 |
| 2 ,, | 2′:$51\frac{2}{5}$ | Stinson at Brockton . | Oct. 24, 1900 |
| 3 ,, | 4′:18 | Elkes at Brockton . | Nov. 8, 1900 |
| 4 ,, | 5′:$44\frac{3}{5}$ | Elkes at Brockton . | Nov. 8, 1900 |
| 5 ,, | 7′:$11\frac{2}{5}$ | Elkes at Brockton . | Nov. 8, 1900 |
| 10 ,, | 14′:$22\frac{2}{5}$ | Bauge at Paris . . | Aug. 28, 1900 |
| 20 ,, | 29′:33 | Elkes at Brockton . | Oct. 27, 1900 |
| 25 ,, | 37′:$02\frac{3}{5}$ | Elkes at Brockton . | Oct. 27, 1900 |
| 30 ,, | 44′:49 | Elkes at Brockton . | Oct. 27, 1900 |
| 40 ,, | 59′:$43\frac{2}{5}$ | Stinson at Brockton . | Oct. 25, 1900 |
| 50 ,, | $1^h$:14:$55\frac{3}{5}$ | Bauge at Paris . . | Nov. 4, 1900 |
| 100 ,, | $2^h$:33:$40\frac{4}{5}$ | Bauge at Paris . . | Nov. 4. 1900 |
| 200 ,, | $6^h$:37:43 | Walters at Paris . . | Sept. 15–16, 1900 |
| 300 ,, | $10^h$:12:$45\frac{1}{5}$ | Walters at Paris . . | Sept. 15–16, 1900 |
| 400 ,, | $14^h$:04:24 | Walters at Paris . . | Sept. 15–16, 1900 |
| 500 ,, | $18^h$:19:$19\frac{3}{5}$ | Walters at Paris . . | Sept. 15–16, 1900 |
| 600 ,, | $22^h$:40:$05\frac{4}{5}$ | Walters at Paris . . | July 8–9, 1899 |

(J. P.*)

**Cyprus,** an island situated in the easternmost basin of the Mediterranean, in size only inferior to Sicily and Sardinia. It is nearly equally distant from the coast of Asia Minor to the north and from that of Syria to the east, lying between 34° 33′ and 35° 41′ N. lat., and 32° 20′ and 34° 35′ E. long. Its greatest length from west-south-west to east-north-east is about 140 miles, and its greatest breadth from north to south about 60 miles. The mean temperature is about 69° Fahr.; mean maximum, 78° Fahr.; mean minimum, 57° Fahr.; average rainfall for the last ten years, 19·16 inches. Where there are marshes there is malarial fever, but this is rarely of a severe type.

*Area and Population.*—In 1885 a trigonometrical survey and a map on the scale of 1 : 63360 were executed by Captain (now Lord) Kitchener, R.E., who made the area 3584 square miles. The population in 1881 was 186,173; in 1891, 209,286. The island is divided into six districts, which contain, besides their chief towns, 687 villages and 58 monasteries. LIMASOL (Gr. *Lemessos*), on the south coast, is the chief seat of the wine and carob trade. KYRENIA (Gr. *Kyreneia*), on the north coast, has a small harbour recently improved, and carries on some trade with the Cazamanian coast, which is plainly visible. Its castle, a virgin fortress, for it has never been captured, was built in the earliest years of the 13th century. For NICOSIA, FAMAGUSTA, LARNACA, and PAPHOS, see under those heads.

*Constitution and Government.*—Under a convention signed at Constantinople, 4th June 1878, Great Britain engaged to join the Sultan of Turkey in defending his Asiatic possessions (in certain contingencies) against Russia, and the Sultan, "in order to enable England to make necessary provision for executing her engagements," consented to assign the island of Cyprus to be occupied and administered by England. The British flag was hoisted on 12th June, and the conditions of the occupation were explained in an annex to the convention, dated 1st July. An Order in Council of 14th September, modified so far as related to legislation by another of 30th November, regulated the government of the island. The administration was placed in the hands of a High Commissioner with the usual powers of a Colonial Governor. Executive and Legislative Councils were established; and in each of the six districts into which, for administrative and legal purposes, the island was divided, a commissioner was appointed to represent the Government. The *Executive Council* consists of the High Commissioner, the Chief Secretary, the King's Advocate, the senior officer in charge of the troops, and the Receiver-General, with, as "additional" members, two Christians and one Mussulman. The *Legislative Council* consists of six non-elected members, being office-holders, and twelve elected members, three being chosen by the Moslems and nine by the non-Moslem inhabitants. British subjects and foreigners, who have resided five years in Cyprus, can exercise the franchise as well as Ottoman subjects. The qualification otherwise is the payment of any of the taxes classed as Vergi Taxes (see below). The courts in existence at the time of the occupation were superseded by the following, constituted by an Order in Council dated 30th November 1882:—(1) a supreme court of criminal and civil appeal; (2) six assize courts; (3) six district courts; (4) six magistrates' courts; and (5) village courts, at present ten in number. Actions are divided, according to the nationality of the defendant, into "Ottoman" and "Foreign"; in the latter, the president of the court alone exercises jurisdiction as a rule, so also in criminal cases against foreigners. The law administered is that contained in the Ottoman codes, modified by 337 ordinances passed by the Legislative Council.

*Religion.*—In 1891, 47,296 of the inhabitants were Moslems; nearly all the remaining 161,990 were Chris-

tians of the Orthodox Greek Church. The Mussulman religious courts, presided over by Cadis, are strictly confined to jurisdiction in religious cases affecting the Mahommedan population.

*Instruction.*—A general system of grants in aid of elementary schools was established in 1882. There are some 200 connected with the Greek Orthodox Church, receiving about £2730; about £650 is granted to some 70 elementary Moslem schools. Aid is also given to Armenian schools at Nicosia, a Maronite school at Kormakiti, a Moslem high school (maintained entirely by Government at a cost of about £200 a year), and a training college at Nicosia for teachers in the Orthodox Church schools, to which also £200 is granted annually. There are Greek high schools at Larnaca and Limasol. By a law of 1895 separate Boards of Education for Moslem and Greek Christian schools have been established, and in each district there are separate committees, presided over by the commissioner. The total enrolment is about 17,900—4400 Moslems and 13,500 Christians.

One hundred and twenty lepers are treated in a farm specially assigned to them. Eight weekly newspapers in Greek, and one in Turkish, are published in the island.

*Finance.*—The principal sources of revenue are:—

(1) Vergi taxes, or taxes on house and land property, and trade profits and incomes (not including salaries); (2) Military exemption tax, now payable by Moslems and Christians alike, but not by foreigners, of 2s. 6d. a head on males between 18 and 60 years of age; (3) Tithes. All tithes have been abolished, except those on cereals, carobs, silk cocoons, and, in the form of 10 per cent. *ad valorem* export duties, those on cotton, linseed, aniseed, and raisins (all other export duties and a fishing tax have been abolished); (4) Sheep, goat, and pig tax; (5) An excise on wine, spirits, and tobacco; (6) Import duties; (7) Stamps, court fees, royalties, licenses, &c.; (8) Salt monopoly.

There is a temporary tax of ½ per cent. on tithes and certain incomes to provide means for the destruction of the locusts. Foreigners are now liable to all the above taxes except the military exemption tax. The annual sum of £92,800, payable to Turkey as the average excess (according to the years 1873–78) of revenue over expenditure, but really appropriated to the interest on the British guaranteed loan of 1855, is a heavy burden. But if not lightened, taxation has at least been better apportioned.

*Production and Industry.*—Rock crystal and asbestos are still found in the district of Paphos. Gypsum is exported unburnt from the Carpas, and as plaster of Paris from Limasol and Larnaca. Statuary marble has been found on the slopes of Buffavento in the northern range. Excellent building stone exists throughout the island. The salt lakes of Larnaca and Limasol are practically inexhaustible. The most important species of the few trees that still remain in the island are the Aleppo pine, the Pinus laricio, Cypress, Cedar, Carob, Olive, and Quercus alnifolia. Recent additions are the Eucalyptus, Casuarina, Pinus pinea, and Ailanthus. Since 1878 some protection has been afforded to existing plantations, and some attempt made to extend their area; but the budget of the Forest Department is starved, and the progress made is slow. The soil is extremely fertile, and with a fair rainfall, say 13 inches, between November and April, yields magnificent crops, but the improvements in agriculture are scarcely satisfactory. The methods and appliances used are extremely primitive, and inveterate prejudice debars the average peasant from the use of new implements, of fresh seed, of manure; he cares nothing for the rotation of crops, or for the cleanliness of his land. A director of agriculture was appointed in 1896, and leaflets are issued pointing out improvements within the means of the villager, and how to deal with plant diseases and insect pests. The rehabilitation of the French vineyards has contributed almost fatally to the depreciation of the native wines, which are pure and strong, but not always palatable. The experiments made to improve the quality and to secure a European market have not, so far, proved remunerative. Very large sums have been expended on the destruction of locusts; they are now practically harmless, but live locusts and locusts' eggs are diligently collected every year. A committee exists "for the improvement of the breeds of Cyprus stock"; stallions of Arab blood have been imported, and prizes are offered for the best donkeys. Cattle, sheep, mules, and donkeys are sent in large numbers to Egypt. Cyprus mules have found favour in war in the Crimea, India, Uganda, Eritrea, and Egypt. Out of the £314,000 advanced under the Colonial Loans Act, 1899, £60,000 has been allotted for irrigation; and under the superintendence of an officer lent by the Government of Madras, two great works are in process of construction. The smaller includes a reservoir at Syncrasi (Famagusta D.), with a catchment of 27 square miles and a capacity of 70 million cubic feet. It reclaims 360 acres, and should irrigate 4320. The larger scheme includes three large reservoirs in the Mesaoria to hold up and temporarily store the flood waters of the Pedias and Yalias rivers. It is estimated that, at a cost of £50,000, 42,000 acres will be irrigated and 10,000 reclaimed. The net return is calculated at 5 per cent. on the cost of both schemes. Manufactures are unimportant.

*Commerce.*—During 1887–98 the annual value of imports and exports, as calculated for the financial year ending 31st March, fluctuated considerably. In 1887–88 the total imports were £356,375, and in 1887–89 the total exports averaged £205,781 (specie neglected). In 1899 the imports were—of goods, £289,962, and of specie, £27,799, a total of £317,761; and the exports were—of goods, £264,851, and of specie, £43,398, a total of £308,249. The most important items of imports in 1899 were manufactured cotton, £29,545; raw cotton, £18,498; tobacco, £21,961; woollens, £18,902; timber, £14,618; leather, £13,632; corn, &c. (mainly flour), £12,784; and of exports, carobs, £68,213; corn, &c. (mainly barley and wheat), £38,105; wine, £32,064; animals, £20,340; fruit (chiefly raisins), £19,829; silk cocoons, £14,708. The export of sponges reached 140 cwts.

*Shipping.*—In 1899, in the coasting trade, 2297 vessels (2080 sailing), of 146,465 tons entered, and 2358 (2141 sailing) of 145,462 tons cleared the ports; in the foreign trade 1149 vessels (932 sailing) of 258,454 tons entered, and 1144 (927 sailing) of 260,046, cleared.

*Internal Communications.*—(i.) ROADS: 488 miles of roads classed as "good" or fair "carriage roads" have been constructed between 1878–99, at a cost of £139,720. (ii.) POSTS AND TELEGRAPHS: There are 23 post offices, 18 rural mail sections, and 7 money order offices. In 1898–99, 268,670 internal letters were dealt with, 212,200 external, and 148,000 newspapers. The total cost of the postal service was £3094, leaving a surplus of £240. There are 9 telegraph offices. The Imperial Ottoman Telegraph Company has 67 miles of line, and a cable connecting the Carpas with Syria; the Eastern Telegraph Company has 170 miles of line, and a cable connecting Larnaca with Alexandria. In 1898–99 the former despatched 2650 messages, and the latter 17,750.

*Banking and Currency.*—The Imperial Ottoman Bank has branches at Larnaca, Nicosia, and Limasol. In 1882 the following coins were decreed legal currency: gold—sovereign, half-sovereign, Turkish lira, and French 20-franc piece; silver—florin, shilling, sixpence, and threepenny piece: limit of tender, £3; bronze—piastre (9 = 1s.), half-piastre, and quarter-piastre: limit of tender, 27 piastres. A law relating to weights and measures was passed in 1890. Those in use are the Turkish standards. The oke = 2·8 ℔ avoirdupois, and the donum = about ¼ acre.

AUTHORITIES.—*An Attempt at a Bibliography of Cyprus*, by C. D. COBHAM (4th ed., Nicosia, 1900), registers over 700 works which deal with Cyprus. No one full and comprehensive account of the island exists, though such is being compiled by Dr EUGEN OBERHUMMER, of Munich. The most interesting travels may be found under the names of FELIX FABER. *Evagatorium.* Stuttgart, 1843.—DE VILLAMONT. *Voyages.* Arras, 1598.—VAN KOOTWYCK. *Cotovici Itinerarium.* Antwerp, 1619.—R. POCOCKE. *Description of the East.* London, 1743.—A. DRUMMOND. *Travels.* London, 1754.—E. D. CLARKE. *Travels.* London, 1812.—Sir S. BAKER. *Cyprus in 1879.* London, 1879.—W. H. MALLOCK.

*In an Enchanted Island.* London, 1879.—The geology of the island has been well handled by A. GAUDRY. *Géologie de L'Île de Chypre.* Paris, 1862. Its natural history by F. UNGER and T. KOTSCHY. *Die Insel Cypern.* Wien, 1865. Numismatics by the DUC DE LUYNES. *Numismatique et Inscriptions Cypriotes.* Paris, 1852.—R. H. LANG. *Numism. Chronicle,* vol. xi. 1871.—J. P. SIX. *Rev. Num.* pp. 249–374. Paris, 1883; and E. BABELON. *Monnaies Grecques.* Paris, 1893. The coins of mediæval date have been described by P. LAMBROS. *Monnaies inédites.* Athens, 1876; and G. SCHLUMBERGER. *Num. de l'orient latin.* Paris, 1878. Inscriptions in the Cypriot character have been collected by M. SCHMIDT. *Sammlung.* Jena, 1876; and W. DEECKE. *Die Griechisch Kyprischen Inschriften.* Gottingen, 1883; in Phœnician in the C. I. P. Paris, 1881.—J. MEURSIUS, *Cyprus,* Amsterdam, 1675, marshals the classical authorities; and W. ENGEL, *Kypros,* Berlin, 1841, gives a good summary of the ancient history of the island. For the Phœnician element, see F. MOVERS, *Die Phonizier.* Bonn and Berlin, 1841–56.—L. COMTE DE MAS LATRIE published between 1852–61 one volume of *History* (1191–1291), and two of most precious documents in illustration of the reigns of the Lusignan kings.—FRA STEFANO LUSIGNANO, *Chorograffia di Cipro,* Bologna, 1573, and BP. STUBBS, *Two Lectures,* Oxford, 1878, are useful for the same period; and perhaps a score of contemporary pamphlets—the best of them by N. MARTINENGO, *Relatione di tutto il successo di Famagosta,* Venezia, 1572, and A. CALEPIO (in Lusignan's Chorograffia)—preserve the details of the famous sieges of Nicosia and Famagosta.—G. MARITI, *Viaggi,* Lucca, 1769, and CYPRIANOS, *History,* Venice, 1768, are the best authorities of Cyprus under Turkish rule. Mediæval tombs and their inscriptions are recorded and illustrated in T. J. CHAMBERLAYNE, *Lacrimæ Nicossienses,* Paris, 1894; and C. ENLART's charming and valuable volumes, *L'Art Gothique et la Renaissance en Chypre,* Paris, 1899, deal with mediæval architecture.—J. HACKETT treats exhaustively *The Church of Cyprus,* London, 1900. (C. D. C.)

## CYPRIOTE ARCHÆOLOGY.

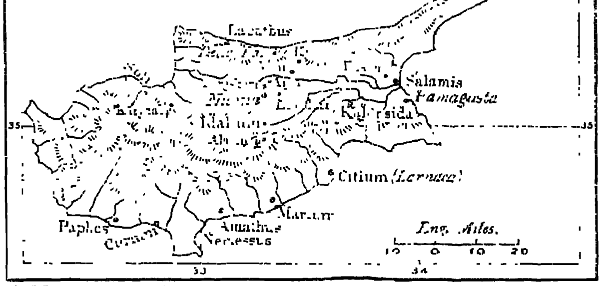
At the time when the article CYPRUS was written for the ninth edition of this Encyclopædia, little was known of the archæological history of the island. A few chance finds of vases, inscriptions, and coins; of a hoard of silver bowls at Dali (anc. *Idalium*)[1] in 1851; and of a bronze tablet with Phœnician and Cypriote bilingual inscriptions,[2] also at Dali, and about the same time, had raised questions of great interest as to the art and the language of the ancient inhabitants; Mr T. B. Sandwith, British Consul 1865–69, had laid the foundations of a sound knowledge of Cypriote pottery;[3] his successor Mr R. H. Lang (1870–72) had excavated a sanctuary of Aphrodite at Dali;[4] and at the time of writing[5] General Louis P. di Cesnola, American Consul 1872–76, was already exploring ancient sites, and opening tombs, in all parts of the island, though his results were not published till 1877.[6] But though his vast collection, now in the Metropolitan Museum of New York, remains the largest series of Cypriote antiquities in the world, the accounts which have been given of its origin are so inadequate, and have provoked so much controversy,[7] that its scientific value is small, and a large part of subsequent excavation has necessarily been directed to solve the problems suggested by its practically isolated specimens. From 1876 to 1878 Major Alexander P. di Cesnola continued his brother's work, but the large collection which he exhibited in London in 1880 was dispersed soon afterwards.[8]

On the British occupation of Cyprus in 1878, the Ottoman Law of 1874 in regard to antiquities was retained in force. Excavation is permitted under Government supervision, and the finds are apportioned in thirds, between the excavator, the landowner (who is usually bought out by the former), and the Government. The Government thirds lie neglected in a "Cyprus Museum" maintained at Nicosia by voluntary subscription. There is no staff, and no effective supervision of ancient sites or monuments. A catalogue of the collections was published by the Oxford University Press in 1899.[9] Since 1878 more than seventy distinct excavations have been made in Cyprus, of which the following are the most important.

In 1879 the British Government used the acropolis of *Citium* (Larnaca) to fill up the ancient harbour; and from the destruction a few Phœnician inscriptions, and a proto-Ionic capital, were saved. In 1882 tombs were opened by Mr G. Hake at *Salamis* and *Curium* for the South Kensington Museum, but no scientific record was made. In 1883 the Cyprus Museum was founded by private enterprise, and on its behalf Mr Max Ohnefalsch-Richter, who had already made trial diggings for Sir Charles Newton and the British Museum, excavated sanctuaries at Vóni and Kythréa (*Chytri*), and opened tombs on some other sites.[10]

In 1885 Dr F. Dümmler opened tombs at Dali, Alámbra, and elsewhere, and laid the foundations of knowledge of the Bronze Age and Early Iron Age;[11] and Mr Richter, on behalf of officials and private individuals, excavated parts of Frángissa (*Tamassus*), Episkopì, and Dali.[12]

In the same year 1885, and in 1886, a syndicate opened many tombs at Póli-tis-Khrýsochou (*Marium, Arsinoe*), and sold the contents by auction in Paris. From Mr Richter's notes of this excavation, Dr P. Herrmann




*B. V. Darbishire & O. J. R. How* *Oxford, 1901*

CYPRUS (EXCAVATION SITES).

compiled the first scientific account of Græco-Phœnician and Hellenistic Cyprus.[13] In 1886 also, M. le Vicomte E. de Castillon de St Victor opened rich Græco-Phœnician tombs at Episkopì, the contents of which are in the Louvre.[14]

The successes of 1885–86 led to the foundation of the Cyprus Exploration Fund, on behalf of which (1) in 1888 the sanctuary of Aphrodite at *Paphos* (Kouklia) was excavated by Messrs E. Gardner, M. R. James, D. G. Hogarth, and R. Elsey Smith;[15] (2) in 1889–90 more tombs were opened at Poli by Messrs J. A. R. Munro and H. A. Tubbs;[16] (3) in 1890–91 extensive trials were

[1] De Longpérier, *Athenæum français,* 1853, pp. 413 ff.; *Musée Napoléon,* pl. x. xi.

[2] De Luynes, *Numismatique et Inscriptions Chypriotes,* 1852.

[3] *Archæologia,* xlv. (1877), pp. 127–142.

[4] *Trans. Roy. Soc. Literature,* 2nd ser. xi. (1878), pp. 30 ff.

[5] *Ency. Brit.,* 9th edition, "Cyprus" *ad fin.*

[6] *Cyprus: its Cities, Tombs, and Temples,* London, 1877.

[7] See Cobham, *An Attempt at a Bibliography of Cyprus,* Nicosia, 4th edition, 1900, Appendix, "Cesnola Controversy," p. 54.

[8] *The Lawrence-Cesnola Collection,* London, 1881; *Salaminia, id.* 1882.

[9] Myres and Ohnefalsch-Richter, *A Catalogue of the Cyprus Museum, with a Chronicle of Excavations since the British Occupation, and Introductory Notes on Cypriote Archæology,* Oxford, 1899.

[10] *Mitt. d. Arch. Inst.* (Athens), ii. (1881).

[11] *Mitt. d. Arch. Inst.* (Athens), vi. (1886). *Bemerkungen z. ält. Kunsthandwerk,* &c., ii. "Der Kypr. Geometrische Stil," Halle, 1888.

[12] Summarized in *Cyprus, the Bible, and Homer,* London and Berlin, 1893.

[13] *Das Gräberfeld von Marion,* Berlin, 1888.

[14] *Archives des Missions Scientifiques,* xvii., Paris, 1891.

[15] *Journal of Hellenic Studies,* ix., London, 1888.

[16] *Id.* xi., 1890; xii., 1891.

made at *Salamis*, by the same;[1] (4) minor sites were examined at Leondári Vounò (1888),[2] Amargetti (1888),[3] and Limniti (1889);[4] (5) in 1888 Mr Hogarth made a surface-survey of the Karpass promontory;[5] and finally, (6) in 1894, the balance was expended by Mr J. L. Myres in a series of trials, to settle special points, at Agia Paraskevì, Kalopsída, and Larnaca.[6] In 1894 also, Dr Richter excavated round *Idalium* and *Tamassus* for the Prussian Government: the results, unpublished up to 1902, are in the Berlin Museum.[7] Finally, a legacy from Miss Emma T. Turner enabled the British Museum to open numerous tombs, by contract, of the Græco-Phœnician Age, in 1894, at Palæò-Lemessò (*Amathus*); and of the Mycenæan Age, in 1894–95 at Episkopì, in 1895–96 at Enkomi (near *Salamis*), and in 1897–99 on small sites between Larnaca and Limasol.[8] Many important sites remain still unexplored, and many problems unsolved; but the outline of Cypriote archæology which follows may give some idea of the conclusions established hitherto.

The Stone Age has left but few traces in Cyprus; no sites have been found, and even single implements are very rare. The "megalithic" monuments of Agia Phaneroméni and Halat Sultàn Teké, near Larnaca, may perhaps be dolmens of the Palestinian type; the vaulted chamber of Agia Katrína, near Enkomi, may be Mycenæan or later; the perforated monoliths at Ktima belong to oil-presses of uncertain date.

The Bronze Age, on the other hand, is of peculiar importance in an area which, like Cyprus, was one of the chief early sources of copper. It has been carefully studied both on settlement sites at Leondári Vounò and Kalopsída, and in tombs in more than thirty places, notably at Agia Paraskevì, Psemmatisméno, Alámbra, Episkopì, and Enkomi. Cypriote Bronze Age culture falls into three stages. In the first, the implements are rather of copper than of bronze, tin being absent or in small quantities (2 to 3 per cent.); the pottery, of gourd-like and often fantastic forms, is all hand-made, with a red burnished surface, with simple geometrical ornaments incised. Zoomorphic art is very rare, and imported objects are unknown. In the second stage, implements of true bronze (9 to 10 per cent. tin) become common; painted pottery appears alongside the red-ware, and foreign imports occur, such as Egyptian blue-glazed beads (xii.–xiii. dynasty: 2500–2000 B.C.) and Asiatic cylindrical seals (one of Sargon I. +2000 B.C.). In the third stage, intercourse with Palestine and Egypt, following the conquests of Thothmes III. (*c.* 1500 B.C.), brought over new fabrics of pottery, which were freely copied; and Ægean colonists introduced the Mycenæan culture and art, which rapidly dominated the primitive native industries: new types of weapons, and wheel-made pottery appear; gold and ivory become abundant, and glass and enamels are known. The magnificent tombs from Enkomi and Episkopì (in the British Museum) illustrate the wealth and advancement of Cyprus at this time.[9]

The early Iron Age which succeeds is a period of obscurity and relapse. Iron, which occurs rarely, and for ornaments, in some of the tombs at Enkomi suddenly superseded bronze for tools and weapons, and its introduction was accompanied, as in the Ægean, by economic, and probably by political changes, which broke up the high civilization of the Mycenæan colonies, and brought about a return to poverty, isolation, and comparative barbarism. Gold, and even silver, become rare; foreign imports almost cease; engraved cylinders are replaced by conical or pyramidal seals like those of Asia Minor, and dress-pins by brooches (*fibulæ*) like those of Greece; representative art languishes (except a few childish attempts to model in clay), and the decorative art becomes once more purely geometrical in character.

But while Mycenæan traditions lingered in Cyprus after their extinction in the Ægean, new Oriental influences from the Syrian coast were felt there earlier than farther west. Two lines of foreign tradition may be distinguished, originating in Egypt and Assyria respectively. Of these, the former predominates somewhat earlier than the latter, a historical date for which is given by the Assyrian conquest of Cyprus in 704 B.C. The effects are best seen in sculpture and in metal-work, though it remains doubtful whether the best examples of the latter were made in Cyprus or on the mainland. Among the great series of engraved silver bowls, some examples show almost unmixed imitation of Egyptian types; in others, Assyrian types are introduced among the Egyptian in senseless confusion; while in others both classes are merged in a mixed art which betrays a return to naturalism, and a new sense of style, and from its intermediate position between the art of Phœnicia and its colonies, and the earliest art of Hellenic Greece, has been called *Græco-Phœnician*. The same succession of styles is represented in sculpture by the votive statues from the sanctuaries of Aphrodite at Dali and of Apollo at Vóni and Frángissa; by the elaborately painted terra-cottas from the "Toumba" site at Salamis; and by magnificent examples in the Cesnola collection. Gem-engraving and pottery-painting follow very similar lines; the latter, however, with greater naïveté of treatment, and closer adherence to Mycenæan traditions.

Meanwhile, Ægean influences, which had been predominant in the Mycenæan Age, and had never wholly ceased, grew stronger as Hellenic culture matured, and slowly repelled Phœnician Orientalism. Imported vases of "Dipylon," "Proto-Corinthian," and "Rhodian" fabric (though not of orientalizing "Corinthian") occur rarely, and were imitated by the native potters, and early in the 6th century the influence of Ionia, and still more of Naucratis, becomes perceptible in imports, in ceramic, and in sculpture. Finally, from the later 6th century, and the period of "black-figured" vases onwards, a rapidly increasing mass of Attic imports (chiefly vases) brings Cyprus at last into full contact with Hellenism. Unable, however, to rival, or fully to acquire, this higher culture, native art and industry languished and became extinct even before the Ptolemaic conquest (295 B.C.), except, perhaps, in Citium, the headquarters of Phœnician influence in the island. A rare and beautiful class of terra-cottas like those of Myrina and Tanagra *may* be of Cypriote fabric, but their style is wholly of the Ægean. The Greek colonists in Cyprus traced their origin, at Curium, from Argos;[10] at Lapathus from Laconia;[11] at Paphos from Arcadia;[12] at Salamis from the Attic Salamis;[13] and at Soli also from Attica.[14] The settlements at Paphos and Salamis, and probably also at Curium, were believed to date from the period of the Trojan War; the name of Teucer, the legendary founder of Salamis, probably represents a memory of the piratical Tikkara who harried the Egyptian coast under Rameses III.; and the discovery of Mycenæan settlements at Curium and Salamis, and of traces of sub-Mycenæan occupation at Paphos and Lapathus, goes far to confirm the belief that the legends have a historical basis. The Greek dialect of Cyprus points in the same direction; it shows marked resemblances to that of Arcadia,[15] and forms with it a "South Achæan" or "South Æolic" group related to the northern Æolic of Thessaly and other parts of north and central Greece. No Greek alphabet was used in Cyprus, except by visitors,[16] until the 4th century, and the numerous inscriptions of earlier date than this are written in a peculiar and elaborate syllabary[17] which can be traced in use in late Mycenæan times,[18] and is apparently related to the linear and pictographic scripts of Crete and the South Ægean.[19] In the Phœnician centres, Citium and Idalium, a Semitic dialect and the Phœnician alphabet were in use from the 8th century at least[20]; and a cuneiform inscription recording the conquest of the island by Sargon II. has been found at Larnaca.[21]

The coins of the Greek dynasts and autonomous towns are struck on a variable standard, with a stater of 170–180 grs.[22]

For Ptolemaic (Hellenistic) Cyprus the evidence is most inadequate. Excavation in the great sanctuaries at Paphos and Idalium, and in the public buildings of Salamis, which were all wholly remodelled during this period, have produced but few works of art; and the sculpture from local shrines at Voni and Vitsada, and the frescoed tombstones from Amathus, only show how inadquately the Cypriote copied debased Hellenistic models.

For the Roman period there is abundant evidence from the sites of Salamis and Paphos, and from tombs everywhere; but little that

[1] *Journal of Hellenic Studies*, xii., 1891. [2] *Id.* ix., 1888.
[3] *Id.* ix., 1888. [4] *Id.* xi., 1890.
[5] *Devia Cypria*, Oxford, 1889. [6] *J. H. S.* xvii., 1897.
[7] Summarized in *Cyprus Museum Catalogue*, Oxford, 1899.
[8] *Excavations in Cyprus*, London, 1900.
[9] The official publication stands alone in referring these tombs to the Hellenic period (800–600 B.C.).

[10] Hdt. 5. 117; Strabo, 683. [11] Strabo, 682.
[12] *Id.* 683. [13] *Id.* 682. [14] *Id.* 683.
[15] Moriz Schmidt, *Z. f. Vergl. Sprachw.*, 1860; H. W. Smith, *Tr. Am. Philol. Ass.*, 1887; R. Meister, *Zum Eleischen, Arkadischen u. Kyprischen Dialekte*, 1890; Otto Hoffmann, *Die Griechischen Dialekte*, vol. i., 1891. Full bibliography in Cobham (see above).
[16] *E.g.*, Ionic inscriptions of early 5th century from Amathus. *Excavations in Cyprus* (Brit. Mus.), 1900, p. 95.
[17] George Smith, *Tr. Soc. Bibl. Arch.* i. (1872); Moriz Schmidt, *Sammlung Kyprischer Inschriften*, 1876; Deecke, *Ursprung der Kypr. Sylbenschrift*, 1877, cf. Deecke in Collitz, *Samml. d. Gr. Dialekt-inschriften*, i., 1883; Meister, *Gr. Dialekte*, ii.; *Ber. d. K. Sächs. Ges. d. Wiss.*, 1894; *Indo-Germ. Forsch.* iv. 175 ff. (cf. Cobham, *l.c.*).
[18] *Excavations in Cyprus*, 1900, p. 27.
[19] Evans, *Journ. Hell. Stud.* xiv. (1894), xvii. (1897).
[20] *Corpus Inscr. Semit.* ii. (1881), cf. Cobham, *l.c.*
[21] Schrader, *Die Sargon-stele des Berliner Museums*, 1882.
[22] De Luynes, *Numismatique Chypriote*, 1852; De Vogüé, *Mélanges d'Archéologie Orientale*, 1869; Six, *Revue Numismatique*, 3rd Ser., i. (1883); Pecz, *Num. Zeitschr.* xvi. (1884); Babelon, *Catalogue des Monnaies Grecques de la Bibl. Nationale*, 1893.

is characteristic or noteworthy; little attention has been paid to the sequence of style.

Of the Byzantine period little remains but the ruins of the castles of St Hilarion, Buffavento, and Kantára,[1] a magnificent series of gold ornaments[2] and some silver plate,[3] found near Kerynia in 1883 and 1897 respectively. Christian tombs usually contain nothing of value.

The Frank conquest is represented by the "Crusaders' tower" at Kolossi, and the church of St Nicholas at Nicosia; and, later, by masterpieces of a French Gothic style, such as the church (mosque) of St Sophia, and other churches at Nicosia; the cathedral (mosque) and others at Famagusta, and the monastery of Bella Pais; as well as by domestic architecture at Nicosia and elsewhere, and by a rich series of inscribed tombstones in the churches. The elaborate wood-carvings of the church at Aschelia[4] belong to the 15th century, and the "miraculous" picture at the monastery of Kykkou apparently to the 16th. The architecture of the Renaissance is illustrated by fortifications and remains of public buildings (now being quarried away) at Famagusta, by walls, gates, and domestic buildings at Nicosia, and by forts at Kerynia, Limasol, and elsewhere.

The Turks and English have added little, and destroyed much, converting churches into mosques and grain-stores, and quarrying the buildings and walls of Famagusta. There is an iron bridge over the Pedias river, and a harbour at Famagusta has been proposed. (J. L. M.)

**Cyprus, Church of.**—The Church of Cyprus is in communion and in doctrinal agreement with the other Orthodox Churches of the East (see ORTHODOX EASTERN CHURCH), but is independent (αὐτοκέφαλος) and subject to no patriarch. This position it has always claimed (see, however, W. Bright, *Notes on the Canons*, on Ephesus 8). At any rate, its independence "by ancient custom" was recognized, as against the claims of the patriarch of Antioch, by the Council of Ephesus, A.D. 431, by an edict of the Emperor Zeno (to whom the church had sent a cogent argument on its own behalf, the alleged body of its reputed founder St Barnabas, then just discovered at Salamis), and by the Trullan Council in 692. Attempts have been made subsequently by the patriarchs of Antioch to claim authority over it, the last as recently as 1600; but they came to nothing. And excepting for the period during which Cyprus was in the hands of the Lusignans and the Venetian Republic (1193–1571), the Church has never lost its independence. It receives the holy ointment (μῦρον) from without, till 1860 from Antioch and subsequently from Constantinople, but this is a matter of courtesy and not of right. Of old there were some twenty sees in the island. The bishop of the capital, Salamis or Constantia, was constituted metropolitan by Zeno, with the title "archbishop of all Cyprus," enlarged subsequently into "archbishop of Justiniana Nova and of all Cyprus," after an enforced expatriation to Justinianopolis in 688. Zeno also gave him the unique privileges of wearing and signing his name in the imperial purple, &c., which are still preserved. A Latin hierarchy was set up in 1196 (an archbishop at Nicosia with suffragans at Limasol, Paphos, and Famagusta), and the Greek bishops were made to minister to their flocks in subjection to it. The sees were forcibly reduced to four, the archbishopric was ostensibly abolished, and the bishops were compelled to do homage and swear fealty to the Latin Church. This bondage ceased at the conquest of the island by the Turks: the Latin hierarchy disappeared (the cathedral at Nicosia is now used as a mosque), and the native church emerged into comparative freedom. In 1821, it is true, all the bishops and many of their flock were put to death by way of discouraging sympathies with the Greeks; but successors were soon consecrated, by bishops sent from Antioch at the request of the patriarch of Constantinople, and on the whole the Church has prospered. The bishops-elect required the *berat* of the Sultan; but having received this, they enjoyed no little civil importance. Since 1878 the *berat* has not been given, and the bishops are less influential. The suppressed sees have never been restored, but the four which survive (now known as Nicosia, Paphos, Kition, and Kyrenia) are of metropolitan rank, so that the archbishop, whose headquarters, first at Salamis, then at Famagusta, are now at Nicosia, is a primate amongst metropolitans. There are several monasteries dating from the 11th century and onwards; also an archiepiscopal school at Nicosia, founded in 1812 and raised to the status of a "gymnasion" in 1893; and a high school for girls. But there is no theological seminary, and the ignorance of the clergy is great. Still, there are signs of progress, especially since the island passed into British hands; and if the great revenues of the Church can be redistributed and better administered, excellent results will doubtless follow.

AUTHORITIES.—PH. GEORGIOU. Εἰδήσεις Ἱστορικαὶ περὶ τῆς Ἐκκλησίας τῆς Κύπρου. Athens, 1875.—K. KOURIOKURINEOS. (Archbishop of Cyprus). Ἱστορία χρονολογικὴ τῆς νήσου Κύπρου. Venice, 1788.—DE MAS LATRIE. *Histoire de l'Île de Chypre sous les Princes de la Maison de Lusignan.* Paris 1852 f.—H. T. F. DUCKWORTH. *The Church of Cyprus.* London, 1900.—J. HACKETT. *History of the Orthodox Church of Cyprus.* 1901. (W. E. Co)

**Cytology (Vegetable).**—Remarkable progress has been made of late years in our knowledge of minute cell structure, or Cytology, around which so much of the biological research of the present time revolves, and upon which the ultimate solution of important problems in physiology depends. This has been due largely to the application of the ribbon section-cutting microtome to histological research, to more refined methods of fixing, staining, and mounting, and to the immense improvements made in optical instruments. Among the more important subjects in which progress has been made are the minute structure of protoplasm; the phenomena of nuclear division; the structure and development of the sexual cells and germ-nuclei; the phenomena of fertilization; the structure and development of the cell-wall, starch-grains, and plastids; the protoplasmic connexions between the cells; and the structure and development of sieve-tubes and laticiferous tissue. But although much has been accomplished, we are still far from a complete understanding of minute cell-structure, and, unfortunately, the brilliant results which have been obtained by the investigation of dead stained tissues have so dominated the attention of students during this period that the living cell has been neglected, and doubt has, in consequence, been cast upon some of the results obtained. It is probable, therefore, that in the future any substantial advance in our knowledge will come, not from the exclusive study either of dead or living cells, but from a judicious correlation of observations upon both.

The contents of a living cell are collectively termed protoplasm. This consists of a semi-fluid granular substance, called the cytoplasm, one or more nuclei, and sometimes centrospheres or centrosomes, and plastids. Cells from different parts of a plant differ very much in their cell-contents. Young cells are often full of cytoplasm; old cells generally contain a large vacuole or vacuoles, and may have only a thin, almost invisible, layer of cytoplasm on their walls. Others contain chlorophyll-grains or chromatophores, starch-grains, or oil-globules. Very little is known of the finer structure of the cytoplasm of a vegetable cell. When observed under the microscope it is usually seen to consist of a homogeneous substance containing numerous granules of various sizes, and vacuoles, which are probably full of a watery

[1] Cf. *Handbook to Cyprus*, 1901, p. 7.
[2] Cyprus Museum; cf. Myres, *Reliquary, &c.*, March 1898.
[3] British Museum; cf. Dalton, *Archæologia*, lvii. p. 159.
[4] Hogarth, *Devia Cypria*, pp. 42–4. For a full list cf. *Handbook to Cyprus*, 1901, pp. 7–8.

sap. It is sometimes differentiated into a clearer outer layer, of hyaloplasm, commonly called the ectoplasm, and an inner granular endoplasm. In some cases it shows, when submitted to a careful examination under the highest powers of the microscope, and especially when treated with reagents of various kinds, traces of a more or less definite structure which is sometimes very complicated. This exhibits itself in the form of a meshwork which consists of a clear homogeneous substance containing numerous minute bodies known as *microsomes*, the spaces being filled by a more fluid *ground-substance.* This structure, which is visible both in living cells and in cells treated by reagents, has been interpreted by many observers as representing a network of threads embedded in a homogeneous ground-substance. Bütschli, on the other hand, interprets it as an extremely finely vacuolated foam-structure or emulsion, comparable to that which is observed when small drops of a mixture of finely powdered potash and oil are placed in water, the vacuoles or alveoli being spaces filled with liquid, the more solid portion representing the mesh-work in which the microsomes are placed. According to Strasburger, the cytoplasm consists of *trophoplasm*, or nutritive plasm, and *kinoplasm*, which is concerned in the division of the cell. The former is of alveolar, the latter of fibrillar, nature. The structure of the protoplasm as revealed by the action of reagents is regarded with scepticism by many observers, and it has been shown, by Fischer especially, that some of the appearances observed in dead cells can be produced artificially by treating albumen and other substances of a similar nature with various reagents. But whilst due weight must be attached to such observations, it would not be wise to push them too far. The objects which are actually visible in the living cell are reproduced with striking fidelity in the fixed and hardened cell, and one might expect that their finer structure would also be to some extent preserved.

Living protoplasm is alkaline or neutral, and, so far as is known at present, is a mixture of complicated chemical compounds. By the gross analysis of simple organisms which consist mainly of protoplasm, it has been found that there are two main groups of compounds, in one of which phosphorus is present, in the other not. The phosphorus is especially abundant in the nucleus, where it enters into the composition of that important substance known as *nuclein.* It may also be present in smaller quantities in other parts of the cell. By means of a simple micro-chemical test Macallum finds that it occurs in the chromatin of all nuclei, in nucleoli, and in pyrenoids; and that it is present in small quantities in cytoplasm and chromatophores, in the central body (nucleus?) of the Cyanophyceæ and in Yeast, where it is sometimes located in a definite organ of the cell which is commonly regarded as of a nuclear nature.

***Chromatophores.***

The chromatophores or plastids are protoplasmic structures, denser than the cytoplasm, and easily distinguishable from it by their colour or greater refractive power. They are spherical, oval, fusiform, or rod-like, and are always found in the cytoplasm, never in the cell-sap. They appear to be permanent organs of the cell, and are transmitted from one cell to another by division. In young cells the chromatophores are small, colourless, highly refractive bodies, principally located around the nucleus. As the cell grows they may become converted into *leucoplasts* (starch-formers), *chloroplasts* (chlorophyll-bodies), or *chromoplasts* (colour-bodies). And all three structures may be converted one into the other (Schimper). The chloroplasts are generally distinguished by their green colour, which is due to the presence of chlorophyll; but in many Algæ this is masked by another colouring matter—*Phycoerythrin* in the Florideæ, *Phycophæin* in the Phæophyceæ, and *Phycocyanin* in the Cyanophyceæ. These substances can, however, be dissolved out in water, and the green colouring matter of the choloroplast then becomes visible. Its structure is difficult to make out, but the views put forward by various observers lead to the conclusion that the chloroplast consists of two parts, a colourless ground substance, and a green colouring matter, which is contained either in the form of fibrils, or in more or less regular spherical masses, in the colourless ground-mass. The chloroplasts increase in number by division, which takes place in higher plants when they have attained a certain size, independent of the division of the cell. In *Spirogyra* and allied forms the chloroplast grows as the cell grows, and only divides when this divides. The division in all cases takes place by constriction, or by a simultaneous splitting along an equatorial plane. In the chromatophores of many Algæ and in the Liverwort *Anthoceros* there are present homogeneous, highly refractive, crystal-like bodies, called *pyrenoids* or starch-centres, which are composed of proteid substances and surrounded by an envelope of starch-grains. In *Spirogyra* the pyrenoids are distinctly connected by cytoplasmic strands to the central mass of cytoplasm, which surrounds the nucleus, and according to some observers, they increase exclusively by division, followed by a splitting of the cytoplasmic strands. Those chromatophores which remain colourless, and serve simply as starch-formers in parts of the plant not exposed to the light, are called leucoplasts or amyloplasts. They are composed of a homogeneous proteid substance, and often contain albuminoid or proteid crystals of the same kind as those which form the pyrenoid. If exposed to light they may become converted into chloroplasts. The formation of starch may take place in any part of the leucoplast. When formed inside it, the starch-grains exhibit a concentric stratification; when formed externally in the outer layers, the stratification is excentric, and the hilum occurs on that side farthest removed from the leucoplast. As the starch-grains grow, the leucoplasts gradually disappear. Chromoplasts are the yellow, orange, or red colour-bodies found in some flowers and fruits. They arise either from the leucoplasts or chloroplasts. The fundamental substance or stroma is colourless and homogeneous. The colour is due to the presence of xanthophyll, or carotin, or both. The colouring matters are not dissolved in the stroma of the chromoplast, but exist as amorphous granules, with or without the presence of a protein crystal, or in the form of fine crystalline needles, frequently curved and sometimes present in large numbers, which are grouped together in various ways in bundles, and give the plastids their fusiform or triangular crystalline shape. Such crystalline plastids occur in many fruits and flowers (*e.g.*, *Tamus communis*, *Asparagus*, *Lonicera*, berries of Solaneæ, flowers of *Cacalia coccinea*, *Tropæolum*, bracts of *Strelitzia*, &c.), and in the root of the carrot. In some cases the plastid disappears and the crystalline pigment only is left. In the red variety of *Cucurbita pepo* these crystals may consist of rods, thin plates, flat ribbons, or spirals. Starch grains may often be seen in contact with the pigment crystals. The crystalline form appears to be due entirely to the carotin, which can be artificially crystallized from an alcohol or ether solution. In addition to the plastids, there are found in some plant-cells, *e.g.*, in the epidermal cells of the leaf of species of *Vanilla* (Wakker), and in the epidermis of different parts of the flower of *Funkia*, *Ornithogalum*, &c. (Zimmermann), highly refractive bodies of globular form, *elaioplasts*, which consist of a granular protein ground-

substance containing drops of oil. They are stained deep red in dilute solution of alkannin. There appears to be one in each cell, and in *Orithogalum umbellatum* it occurs at one of the poles of the elongated nucleus. An oily substance in the form of drops may also occur in chromatophores, and, in the Hepaticæ, oil-bodies are found which may have some relation to elaioplasts. Although no special oil-forming plastid has been observed, it appears from these observations that oil may sometimes be formed by special structures, or may accumulate in them (Pfeffer). The eye-spot which is found in motile cells of the Algæ, *Protococcus*, *Euglena*, &c., may also have something in common with the elaioplast. In *Euglena* it consists of a protoplasmic substance, in which are embedded numerous spherical or irregular drops of a red oily substance. The red colouring matter turns blue in concentrated sulphuric acid, and is probably related to the red colouring matter of chromoplasts. The eye-spot appears to be concerned in some way with the response to the light-stimulus which is exhibited by cells containing it.

It is highly probable that starch is only produced as the result of the activity of chromatophores, either in connexion with chromoplasts, chloroplasts, or leucoplasts. Starch exists, in the majority of cases, in the form of grains, which are composed of stratified layers arranged around a nucleus or hilum. The stratification, which may be concentric or excentric, appears to be due to a difference in density of the various layers. The outer layers are denser than the inner, the density decreasing more or less uniformly from the outside layers to the centre or hilum. The outermost, newly-formed layer is composed of a more homogeneous, denser substance than the inner one, and can be distinguished in all starch-grains that are in process of development. The separate layers of the starch-grain are deposited on it by the activity of the chromatophore, and according to Meyer the grain is always surrounded by a thin layer of the chromatophore which completely separates it from the cytoplasm. The layers appear to be made up of elements which are arranged radially. These are, according to Meyer, acicular crystals, which he calls *trichites*. The starch grain may thus be regarded as a crystalline structure of the nature of a sphere-crystal, as has been suggested by many observers.

***Nucleus.***

The nucleus appears to be an essential constituent of the cell. Its presence has been demonstrated in all plants with the exception of the Cyanophyceæ and Bacteria, and even here structures have been observed which resemble nuclei in some of their characteristics, and are thought to be such by some observers. The nucleus is generally regarded as a controlling centre of cell-activity, upon which the growth and development of the cell in large measure depends, and as the agent by which the transmission of specific qualities from one generation to another is brought about. If it is absent, the cell loses its power of assimilation and growth, and soon dies. Haberlandt has shown that in plant cells, when any new formation of membrane is to take place in a given spot, the nucleus is found in its immediate vicinity; and Klebs found that only that portion of the protoplasm of a cell which contains the nucleus is capable of forming a cell-wall; whilst Townsend has further shown that if the non-nucleated mass is connected by strands of protoplasm to the nucleated mass, either of the same cell or of a neighbouring cell, it retains the power of forming a cell-membrane.

The nucleus consists of an irregular network of threads surrounded by a nuclear membrane, which separates it from the cytoplasm. The nuclear cavity in which the network is placed contains a more or less fluid nuclear sap, and in the majority of plant-nuclei, but not in all, one or more spherical or slightly irregular bodies, the *nucleoli*. In the living condition the nucleus appears granular, and the thread structure is in most cases invisible, but the nucleolus is sometimes distinguishable by its more refractive appearance. The structure of the nuclear thread can only be made out by the use of reagents. It consists of a ground-substance called *Linin*, which is only slightly stained by the ordinary nuclear stains, and, embedded in it, numerous grains of a substance called *Chromatin*, having a strong affinity for stains. These chromatin-granules are looked upon by some observers as independent morphological units, the *ids* of Weismann. The staining reactions of the various parts of the nucleus depend to some extent upon their chemical constitution, especially with regard to the amount of phosphorus they contain. The chromatin is practically identical with nuclein, a complex albuminoid compound containing about 3 per cent. of phosphorus. This has a strong attraction for basic aniline dyes, and can usually be distinguished from those parts of the cell which are more easily coloured by acid anilines. But the staining reactions of nuclei may vary at different stages of their development; and it is probable that there is no method of staining which differentiates with certainty the various morphological constituents of the nucleus.

The formation of new cells by division is, in the case of uninucleate cells, preceded by or accompanied by the division of the nucleus. In multinucleate cells the division of the nucleus is independent of the division of the cell. Nuclear division may be indirect or direct, that is to say it may either be accompanied by a series of complicated changes in the nuclear structures called *mitosis* or *karyokinesis*, or it may take place by simple direct division, *amitosis*, or fragmentation. Direct division is a much less common phenomenon than was formerly supposed to be the case. It occurs most frequently in old cells, or in cells which are placed under abnormal conditions. It may also take place where rapid proliferation of the cell is going on, as in the budding of the Yeast plant. It takes place in the internodal cells of Characeæ; in the old internodal cells of *Tradescantia*; and in various other cells which have lost their power of division. It has been shown that, in cells of *Spirogyra* placed under special conditions, amitotic division can be induced, and that normal mitosis is resumed when they are placed again under normal conditions. Amitosis is probably connected by a series of intermediate gradations with karyokinesis.

In indirect nuclear division the nucleus undergoes a series of complicated changes, which result in an equal division of the chromatic substance between the two daughter nuclei. Four stages can be recognized. (1) *Prophase.*—The nucleus increases in size; the network disappears, and a much convoluted thread takes its place (Fig. 1, B). The chromatin substance increases in amount; the thread stains more deeply, and in most cases, presents a homogeneous appearance. This is commonly called the spirem-figure. The chromatin thread next becomes shorter and thicker, the nucleoli begin to disappear, and the thread breaks up into a number of segments—*chromosomes*—which vary in number in different species, but are fairly constant in the same species (Fig. 1, C, D). Coincident with these changes the nuclear membrane disappears and a spindle-shaped or barrel-shaped group of threads makes its appearance in the midst of the chromosomes, the longitudinal axis of which is at right angles to the plane of the division (Fig. 1, F). At each pole of this spindle figure there often occur fibres radiating in all directions into the cytoplasm, and sometimes a minute granular body, the *centrosome*, is also found there. (2) *Metaphase.*—The chromosomes pass to the equator of the spindle and become attached to the spindle-fibres in such a way that they form a radiating star-shaped

figure—*Aster*—when seen from the pole of the spindle. This is called the nuclear plate (Fig. 1, E, F, G, H). As they pass into this position they undergo a longitudinal splitting by which the chromatin in each chromosome becomes divided into equal halves. (3) *Anaphase.*—The longitudinal division of the chromosomes is completed by the time they have taken up their position in the nuclear plate, and the halves of the chromosomes then begin to move along the spindle-fibres to opposite poles of the spindle (Fig. 1, I, J). Many observers hold the view that the chromosomes are pulled apart by the contraction of the fibres to which they are attached. (4) *Telophase.*—When they reach the poles the chromosomes group themselves again in the form of stars—*Diaster*—with spindle-fibres extending between them (Fig. 1, K). The chromosomes then fuse together again to form a single thread (Fig. 1, L), a nucleolus appears, a nuclear membrane is formed, and daughter nuclei are thus constituted which possess the same structure and staining reactions as the mother nucleus. When this nuclear division is followed by cell-division, a cell-wall is formed between the two daughter nuclei. The spindle-fibres which extend between the daughter nuclei increase in number and extend laterally until they touch the cell-walls. They then thicken in the middle, and form a layer of granules across the cell—the cell-plate. These then disappear and the new cell-wall appears in their place. In the lower plants the new cell-wall may be formed as an outgrowth on the old one (*Spirogyra*, &c.), or it may be formed directly in the cytoplasm.

The spindle figure is probably the expression of forces which are set up in the cell for the purpose of causing the separation of the daughter chromosomes. It arises partly from the cytoplasm, partly from the nucleus, or it may be derived entirely from the nucleus—intranuclear spindle—as occurs in many of the lower plants (Fungi, &c.). The formation of the spindle begins in the prophases of division. A layer of delicate filamentous cytoplasm—kinoplasm—may collect around the nucleus, or at its poles, out of which the spindle is formed. As division proceeds, the filamentous nature of this cytoplasm becomes more prominent, and the threads begin either to converge towards the poles of the nucleus, to form a bipolar spindle, or may converge towards, or radiate from, several different points, to form a multipolar spindle. The wall of the nucleus breaks down, and the cytoplasmic spindle-fibres become mixed with those derived from the nuclear network. The formation of the spindle differs in details in different plants.

The longitudinal splitting of the chromosomes appears to take place in order to ensure that one-half of each chromatin unit—*id*—shall be distributed to each daughter nucleus. The longitudinal division of the linin thread is in fact probably initiated by the division of these chromatin granules, which are arranged in a single row along the thread. In many cases the granular nature of the chromosome is masked by the shortening of the thread and the absorption of additional chromatin substances during the various stages of the prophase, so that the chromosome appears to be a homogeneous structure. In other cases the longitudinal splitting takes place before the chromosome stage, in which case two rows of granules are visible on the linin thread at an early stage, and the shortening and thickening do not take place until the daughter chromosomes have become visible as separate threads. This phenomenon is especially prominent in the nuclear divisions which lead to the formation of the sexual cells. Here certain other features also present themselves which are not observed in the vegetative nuclei, the most important being the reduction in the number of chromosomes—to one-half. This takes place in the spore mother-cells of all those Vascular Cryptogams and Phanerogams which have been investigated, and is probably of general occurrence. We know very little of the phenomenon as it takes place in the lower plants, but in *Fucus* it occurs in the oogonial stage, so that the cells of the vegetative plant have the full number. Inasmuch as the essential feature of fertilization is the fusion of two nuclei, it is evident that unless this reduction took place the number of chromosomes would be doubled at each generation. In the higher plants this reduced number is found in all the cells of the gametophyte, the full

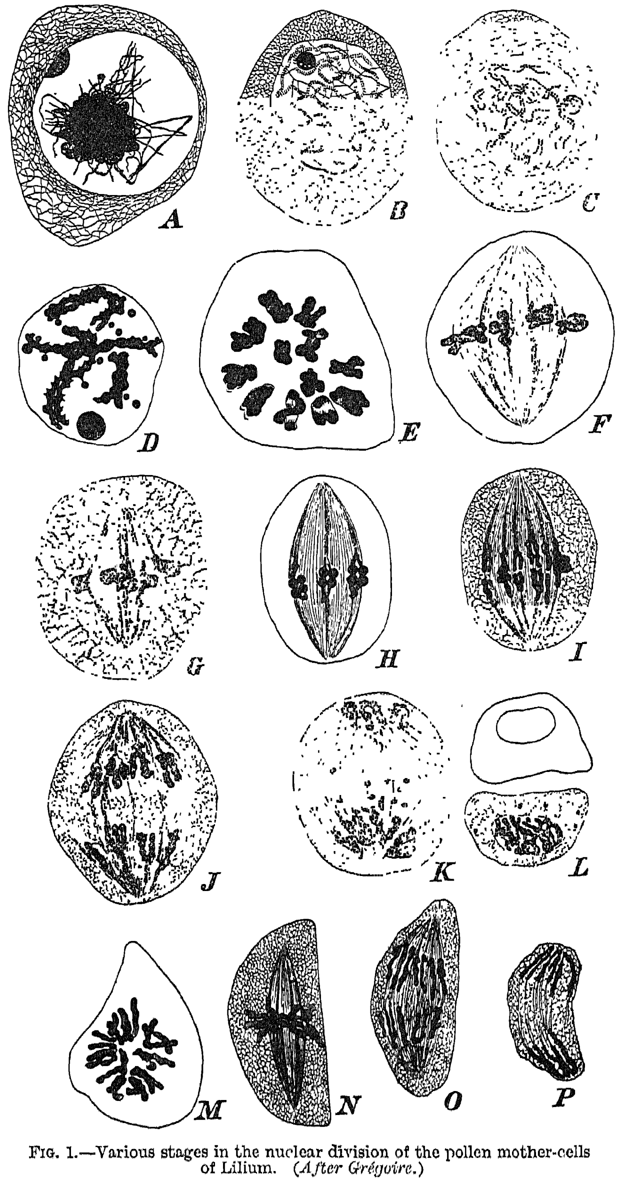



Fig. 1.—Various stages in the nuclear division of the pollen mother-cells of Lilium. (*After Grégoire.*)

number in those of the sporophyte. The reduction is brought about simply by the segmentation of the spirem thread into half the number of segments instead of the normal number; but there is no diminution in the actual amount of nuclear substance. During the second division, however, it has been stated that a qualitative reduction is brought about by the transverse division of the chromosomes, and that different chromatin granules, or ids, are thus distributed to the daughter nuclei. This has an important bearing upon the supposed function of the ids as the bearers of hereditary qualities in fertilization; but the most recent investigations seem to show that, so far as

plants are concerned, such transverse divisions do not take place. In the process of division of a spore mother-cell the spirem thread is divided longitudinally before the segmentation occurs (Fig. 1, B), and this is preceded by a peculiar contraction of the thread around the nucleolus which has been termed *synapsis* (Fig. 1, A). It has been suggested that this may be connected with the early splitting of the thread, but some observers regard it as a contraction due to reagents. The segments of each chromosome are usually twisted upon each other and may be much contorted (Fig. 1, C, D). Soon after the segmentation the chromosomes begin to shorten and thicken, and another peculiar phenomenon is then observed—each longitudinal half of the chromosome exhibits a double row of dots instead of a single row, probably due to a second division of the chromatin granules. This is not, however, accompanied by a longitudinal fission of the linin segment, and the granules are soon obscured by the continued shortening and thickening of the chromosome, which finally becomes homogeneous (Fig. 1, E). The longitudinal segments of the chromosome become more or less fused together, especially at the ends, by which variously shaped figures are produced of greater or less regularity (Fig. 1, E). The chromosomes now become attached to the spindle-fibres (Fig. 1, F, G), and as the daughter chromosomes become pulled asunder they often appear more or less V-shaped, so that each pair appears as a closed ring of irregular shape, the ends of the V's being in contact thus—<> (Fig. 1, H, I, J, K.). This V has been variously interpreted. Some observers consider that it is due to bending, others to the early longitudinal splitting, of the daughter chromosomes, the segments of which remaining connected together at one end, produce a V-shaped figure. From the recent observations of Strasburger it appears probable that the latter interpretation is the correct one in most cases, and that the former only occurs exceptionally. The form of division which is thus characterized by the early longitudinal fission of the chromosomes and the formation of more or less regular rings is called the *heterotype* division. In the one case, therefore, this ring is formed by a single longitudinal fission and subsequent bending of the two halves of the chromosome; in the other, by two longitudinal fissions at right angles to one another. In either case the first division of the germ-nucleus in which the reduced number of chromosomes appears, results in an equal division of the chromatin granules or ids to each daughter nucleus, just as in the vegetative nuclei. But now comes the important question. Is the division which next takes place in the daughter nuclei of this nature, or is it effected in such a manner as to produce a qualitative separation of the chromatin? In other words, is the division of the chromosomes of the daughter nuclei longtitudinal or transverse? Some observers contend that where the V shape is produced by a bending of the chromosome, the division is accomplished by a separation of the V's at the apex, and that in this way we get a true transverse or qualitative division. But from the observations of Farmer, Sargant, Grégoire, Strasburger, and others, it appears that in all such cases the division takes place by a longitudinal splitting of the V, and not by its separation at the apex; and where the V's are produced, not by bending, but by the early longitudinal splitting of the chromosomes, it is evident that their separation at the apex is simply the completion of this longitudinal fission, and not a transverse division at all (Fig. 1, L to P).

**Nucleolus.**

In the majority of plant-nuclei, both in the higher and lower plants, there is found, in addition to the chromatin network, a deeply stained spherical or slightly irregular body (sometimes more than one) called the nucleolus (Fig. 1, A to D). It is often vacuolar, sometimes granular, and in other cases it is a homogeneous body with no visible structure or differentiation. The special function of this organ has been a source of controversy during the past few years, and much uncertainty still exists as to its true nature. There does not appear to be any staining reaction which absolutely separates it from other structures in the cell. In resting nuclei it often stains more deeply than any other of the nuclear constituents. In nuclei in a dividing stage it tends to disappear or break up into granules, and always stains less intensely than in the resting stage. So far as we know at present, there are two distinct types of nucleoli in plants, one of which stains exactly like chromatin in the chromosome stage, the other more like the cytoplasm. Many observers are inclined to the view that true nucleoli do not contain chromatin, but our knowledge of their behaviour towards the various reagents which are stated to differentiate chromatin is not sufficiently definite to allow that view to pass uncriticized. Nor is our knowledge of the morphological behaviour of the nucleolus sufficient to enable us to draw a definite distinction between "true nucleoli" and nucleolus-like bodies. It may be that all these structures should be regarded as true nucleoli of a different chemical nature (Montgomery). The nucleolus is most commonly considered to be a store of reserve material for the use of the nucleus during division, serving also in part to nourish the chromosomes. This view, which was formerly held by Strasburger, is supported by the behaviour of the nucleolus during division. In the resting condition it stains more deeply than the chromatin network, but as the chromosomes are formed it loses its capacity for stains to a large extent, and the staining capacity of the chromosomes at the same time increases; in some cases the nucleolus breaks up, and particles of nucleolar substance are often found attached to the chromosomes, other particles being at the same time found in the cytoplasm. According to Strasburger's more recent explanation, the nucleolus is concerned mainly in the formation of the nuclear spindle. As it dissolves, it is taken up by the kinoplasm, which is thereby stimulated to form the spindle-figure, and the maximum development of the spindle fibres coincides with the complete or partial disappearance of the nucleolus. Another explanation given, which is probably the best, is that the nucleolus is a store of reserve material both for the chromosomes and for the production of the spindle.

**Centrosome.**

The centrosome is a minute homogeneous granule found in the cytoplasm of some cells in the neighbourhood of the nucleus. It is generally surrounded by a clear space, which is in turn surrounded by a granular or radiating cytoplasmic substance, the whole being known as the *centrosphere* or *attraction-sphere*. According to the researches of Van Beneden, Boveri, and others, it is an important special organ of the animal cell, and has been regarded as a regular constituent of it, like the nucleus. It is not so common in plant cells, and its presence has only been certainly demonstrated in the Thallophytes and Bryophytes. In the higher plants the structures which have been often described as centrosomes are too indefinite in their constitution to allow of this interpretation being placed upon them. Even in the lower plants, while the centrospheres may be very apparent, the granules found in them are not sufficiently uniform either in number or general character to allow of their being regarded as centrosomes (Farmer), and many of the centrosomes described are probably nothing more than granules of the fragmented nucleolus, or possibly extra-nuclear nucleoli. They do not appear to be permanent organs of the cell. They are prominent during cell-division, but may disappear in the resting stage. They are more easily seen, when the nucleus is about to undergo mitosis, at the ends

of the spindle, where they form the centres towards which the radiating fibres in the cytoplasm converge. The centrosome or centrosphere is usually regarded as the dynamic centre of the cell and a special organ of division; but its absence in many groups of plants does not lend support to this view so far as plant-cells are concerned.

***Cell membrane.***

The membrane which surrounds the protoplasts in the majority of plants is typically composed of cellulose, together with a number of other substances which are known as pectic compounds. Some of these have a neutral reaction, others react as feeble acids. They can be distinguished by their insolubility in cuprammonia, which dissolves cellulose, and by their behaviour towards stains, some of which stain pectic substances but not cellulose. Cellulose has an affinity for acid stains, pectic substances for basic stains. The cell-membrane may become modified by the process of lignification, suberization, cuticularization, or gelatinization. In the Fungi it is usually composed of a modified form of cellulose known as Fungus cellulose, which, according to Mangin, consists of callose in combination either with cellulose or pectic compounds. It is formed by the protoplasm, either by the direct conversion of the outer cytoplasmic layer into the cell-wall, or by the excretion of the substances which form the cell-wall. In the formation of the new transverse walls which are produced in cell-division, the cell-plate or protoplasmic membrane produced in the equatorial plane of the spindle-fibres appears to be transformed directly into the primary cell-wall. According to Gardiner's recent researches, the nodes of the spindle-fibres persist as the connecting threads of the protoplasts, and are not, as was formerly supposed, merged in the substance of the cell-wall. It is probable, therefore, that the cell-plate is not, as is usually stated, formed by the fusion of the thickened connecting fibres, but that it is formed out of plasmatic substances conducted to and deposited in the cell-plate region by them. According to Strasburger, the cell-plate splits into two, and the new cell-wall is formed as a secretion product between them. Thick cell-walls exhibit a distinct stratification, and the separate layers are composed of thin lamellæ. The primary cell-wall persists as the middle lamella, which appears to be of different chemical composition from the rest of the wall, and to be composed of pectic acid, or a salt of it. By the solution of this middle lamella the cells can be separated from each other. This may take place even in young cells with thin cell-walls. The substance contained in the intercellular spaces, which are formed in some cases between the cells, is probably related to the pectic substances. In many cells there is a distinct striation visible in the cell-wall in addition to the lamination and stratification. These striæ run obliquely and across each other, but the two systems do not occur in the same lamella. We know very little of the minute structure of the cell-wall beyond its lamination and striation. Nägeli considered it to be composed of minute particles of cellulose—*Micellæ*—each surrounded by water. Wiesner suggests that it consists of minute particles or dermatosomes connected together by a delicate protoplasmic network; and there is a certain amount of evidence to show that it is composed of radiating elements somewhat similar to those which are supposed to occur in starch grains. The growth of the cell-wall takes place by the addition of new layers to those already formed. These layers are secreted by the protoplasm by the direct apposition of substances on those already in existence; and they may go on increasing in thickness, both by apposition and by the intussusception of particles probably carried in through the protoplasmic fibres, which penetrate the cell-wall as long as the cell lives. The growth of the cell-wall is very rarely uniform. It is thickened more in some places than in others, and thus are formed the spiral, annular, and other markings, as well as the pits which occur on various cells and vessels. Besides the internal or centripetal growth, some cell-walls are thickened on the outside, such as pollen grains, oospores of Fungi, cells of Peridineæ, &c. This centrifugal growth must apparently take place by the activity of protoplasm external to the cell. The outer protective walls of the oospores of some Fungi are formed out of protoplasm containing numerous nuclei, which is at an early stage separated from the protoplasm of the oosphore. In the Peridineæ, Diatoms, and Desmids, according to recent researches, the thickenings on the outer walls of the cells are due to the passage of protoplasm from the interior of the cell to the outside, through pores which are found perforating the wall on all sides.

Cell-walls may become modified by the impregnation of various substances. Woody or lignified cell-walls appear to contain substances called *coniferin* and *vanillin*, in addition to various other compounds which are imperfectly known. Lignified tissues are coloured yellow by aniline sulphate or aniline chloride, violet with phloroglucin and hydrochloric acid, and characteristic reactions are also given by mixtures containing phenol, indol, skatol, thallin sulphate, &c. (see Zimmerman's *Microtechnique*). Staining reagents can also be used to differentiate lignified cell-walls. Cuticularized or suberized cell-walls occur especially in those cells which perform a protective function. They are impervious to water and gases. Both cuticularized and suberized membranes are insoluble in cuprammonia, and are coloured yellow or brown in a solution of chlor-iodide of zinc. It is probable that the corky or suberized cells do not contain any cellulose (Gilson, Wisselingh); whilst cuticularized cells are only modified in their outer layers, cellulose inner layers being still recognizable. The suberized and cuticularized cell-walls appear to contain a fatty body called suberin, and such cell-walls can be stained red by a solution of alcannin, the lignified and cellulose membranes remaining unstained.

***Protoplasmic continuity.***

Except in the unicellular plants the cell is not an independent unit. Apart from their dependence in various ways upon neighbouring cells, the protoplasts of all plants are probably connected together by fine strands of protoplasm which pass through the cell-wall (Tangl, Russow, Gardiner, Kienitz-Gerloff, and others) (Fig. 2). In *Pinus* the presence of connecting threads has recently been demonstrated throughout all the tissues of the plant. These protoplasmic strands are, except in the case of sieve tubes, so delicate that special methods have to be employed to make them visible. The basis of these methods consists in causing a swelling of the cell-wall by means of sulphuric acid or zinc chloride, and subsequent staining with Hoffmann's blue or other aniline dyes. Fresh tissue may be used, or tissue killed and hardened in dilute solution of iodine, or in osmic acid—uranium-nitrate mixture. Alcohol is not suitable. The results so far obtained show that the connecting threads may be either "pit-threads" which traverse the closing membrane of the pits in the cell-walls (Fig. 2, B), or "wall-threads" which are present in the wall of the cell (Fig. 2, A). Both pit-

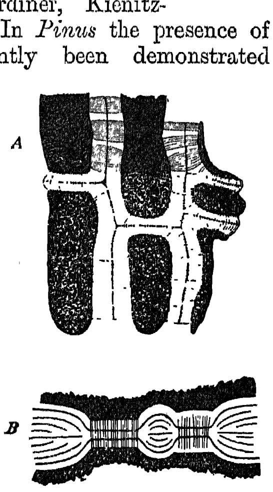



FIG. 2.—Continuity of protoplasm of cells of *Tamus communis* (A) and endosperm of *Lilium Martagon* (B). (*After Gardiner.*)

threads and wall-threads may occur in the same cell, but more often the threads are limited to the pits. The pit-threads are larger and stain more readily than the wall-threads. The threads vary in size in different plants. They are very thick in *Viscum album*, and are well seen in *Phaseolus multiflorus* and *Lilium Martagon*. In epidermal cells (*Tamus communis*, *Lilium Martagon*) the external walls are penetrated by threads which extend to the cuticle. In dead cells the threads appear to be converted into mucilage. These connecting threads probably consist of ectoplasm. They are present from the beginning of the development of the cell-wall, and arise from the spindle fibres, all of which may be continued as connecting threads (Endosperm of *Tamus communis*), or part of them may be overlaid by cellulose lamellæ (Endosperm of *Lilium Martagon*), or they may be all overlaid as in pollen mother-cells and pollen grains of *Helleborus fœtidus*. The presence of these threads between all the cells of the plant shows that the plant body must be regarded as a connected whole; the threads themselves probably play an important part in the growth of the cell-wall, the conduction of food and water, the process of secretion, and the transmission of impulses. In certain cells of the root-apices of plants, however, there exist, according to Němec, longitudinal protoplasmic fibrils which are especially concerned in the conduction of stimuli.

The component parts of the tissues of which plants are composed may consist of but slightly modified cells with copious protoplasmic contents, or of cells which have been modified in various ways to perform their several functions. In some the protoplasmic contents may persist, in others they disappear. The formation of the conducting tubes or secretory sacs which occur in all parts of the higher plants is due either to the elongation of single cells, or to the fusion of cells together in rows by the absorption of the cell-walls separating them. Such cell-fusions may be partial or complete. Cases of complete fusion occur in the formation of laticiferous vessels, and in the spiral, annular, and reticulate vessels of the xylem. Incomplete fusion occurs in sieve tubes. Tubes formed by the elongation of single cells are found in bast fibres, tracheides, and especially in laticiferous cells.

**Laticiferous tissue.**

The laticiferous tissue consists of a network of branching or anastomosing tubes which contain a coagulable fluid known as latex. These tubes penetrate to all parts of the plant and occur in all parts of the root, stem, and leaves. A protoplasmic lining is found on their walls which contains nuclei. The walls are pitted, and protoplasmic connexions between the laticiferous tubes and neighbouring parenchyma-cells have been seen. The fluid sap contains various substances, either in solution or suspended in the form of minute globules, such as sugar, tannin, malic acid in combination with lime, starch-grains, and small globules composed of caoutchouc or resin, which give to the fluid its milky appearance. There are two types of laticiferous tissue—non-articulate and articulate. The non-articulate tissue which occurs in Euphorbiaceæ, Apocyneæ, Urticaceæ, Asclepiadeæ, consists of long tubes, equivalent to single multinucleate cells, which ramify in all directions throughout the plant. The development of laticiferous cells takes place quite early in the embryo, from a group or groups of cells which form a single layer in the pericycle around the central cylinder of the embryo at the cotyledonary node. The number of these initial cells appears to be constant for each species. In some cases a second layer is found just external to the central cylinder, in the cortex, from which a separate cortical system is developed. In other cases the single layer of initial cells gives off branches which penetrate the cortex, central cylinder, and pith (Chauveaud). Laticiferous vessels arise by the coalescence of originally distinct cells. The cells not only fuse together in longitudinal and transverse rows, but put out transverse projections, which fuse with others of a similar nature, and thus form an anastomosing network of tubes which extends to all parts of the plant. They are found in the Compositæ (*Cichoriaceæ*), Campanulaceæ, Papaveraceæ, Lobeliaceæ, Papayaceæ, in some Aroideæ and Musaceæ, and in Euphorbiaceæ (*Manihot*, *Hevea*). The nuclei of the original cells persist in the protoplasmic membrane. Kny has shown that in the Cichoriaceæ hairs containing latex are commonly present, connected to the laticiferous network by means of a narrow opening at the base. The rows of cells from which the laticiferous vessels are formed can be distinguished in many cases in the young embryo while still in the dry seed (Scott), but the latex vessels in process of formation are more easily seen when germination has begun. In the process of cell-fusion the cell-wall swells slightly and then begins to dissolve gradually at some one point. The opening, which is at first very small, increases in size, and before the cross-wall has entirely disappeared, the contents of the two cells become continuous (Scott). The absorption of the cell-walls takes place very early in the germinating seedling.

**Sieve tubes.**

The sieve tubes consist of partially fused rows of cells, the transverse or lateral walls being perforated by minute openings, through which the contents of the cells are connected with each other, and which after a certain time become closed by the formation of callus on the sieve plates. The sieve tubes contain a thin lining layer of protoplasm on their walls, but no nuclei, and the cell sap contains albuminous substances which are coagulable by heat. Starch grains are sometimes present. In close contact with the segments of the sieve tubes are companion cells which communicate with the sieve tubes by delicate protoplasmic strands; they can be distinguished from ordinary parenchymatous cells by their small size and dense protoplasm. Companion cells are not found in the Pteridophyta and Gymnosperms. In the latter their place is taken by certain cells of the medullary rays and bast parenchyma. The companion cells are cut off from the same cells as those which unite to form the sieve tube. The mode of formation of the sieve plate is not certainly known; but from the fact that delicate connecting threads of protoplasm are present between the cells from their first development, it is probable that it is a special case of the normal protoplasmic continuity, the sieve pores being produced by a secondary enlargement of the minute openings, through which these delicate strands pass. According to Lecomte, the young wall consists partly of cellulose and partly of a substance which is not cellulose, the latter existing in the form of slight depressions, which mark the position of the future pores. As the sieve plate grows, these non-cellulose regions swell and gradually become converted into the same kind of mucous substance as that contained in the tube; the two cells are thus placed in open communication. If this is correct, it is easy to see that the changes which take place may be initiated by the original delicate protoplasmic strands which pass through the cell-wall. (For further information regarding tissues, see Anatomy of Plants.)

**Fertilization.**

The formation of the zygote or egg-cell takes place usually by the fusion of the contents of two cells, and always includes, as an essential feature, the fusion of two germ nuclei. In many of the lower plants the fusing cells—*gametes*—are precisely similar so far as size and general appearance are concerned; and the whole contents of the two cells fuse together, cytoplasm with cytoplasm, nucleus with nucleus, nucleolus with nucleolus, and plastid with plastid. The gametes

may be motile (some Algæ) or non-motile, as in *Spirogyra*, *Mucor*, *Basidiobolus*, &c. In many of the lower plants and in all higher plants there is a difference in size in the fusing cells, the male cell being the smaller. The reduction in size is due to the absence of cytoplasm, which is in some cases so small in amount that the cell consists mainly of a nucleus. In all cases of complete sexual differentiation the egg-cell is quiescent, but the male cell may be motile or non-motile. In many of the Fungi the non-motile male cell or nucleus is carried by means of a fertilizing tube actually into the interior of the egg-cell, and is extruded through the apex in close proximity to the egg nucleus. In the Florideæ, Lichens, and Laboulbeniaceæ the male cell is a non-motile spermatium, which is carried to the female organ by movements in the water. In *Monoblepharis*, one of the lower Fungi, in some Algæ, in the Vascular Cryptogams, in Cycads (*Zamia* and *Cycas*), and in *Ginkgo*, an isolated genus of Gymnosperms, the male cell is a motile spermatozoid with two or more cilia. In the Algæ such as *Fucus*, *Volvox*, *Oedogonium*, *Bulbochœte*, and in the Fungus *Monoblepharis*, the spermatozoid is a small oval or elongate cell containing nucleus, cytoplasm, and sometimes plastids. In the Characeæ, the Vascular Cryptogams, in *Zamia* and *Cycas*, and in *Ginkgo*, the spermatozoids are more or less highly modified cells with two or more cilia, and resemble in many respects, both in their structure and mode of formation, the spermatozoids of animals. In Characeæ and Muscineæ they are of elongate spiral form, and consist of an elongate dense nucleus and a small quantity of cytoplasm. At the anterior end are attached two cilia or flagella. In the Vascular Cryptogams the structure is much the same, but a more or less spherical mass of cytoplasm remains attached to the posterior spirals, and a large number of cilia are grouped along the cytoplasmic anterior portion of the spiral. In *Zamia* (Fig. 4, A), *Cycas*, and *Ginkgo* they consist of large spherical or oval cells with a coiled band of cilia at one end, and a large nucleus which nearly fills the cell. They are carried by the pollen tube to the apex of the prothallus, where they are extruded, and by means of their cilia swim through a small quantity of liquid, contained in a slight depression to the oosphere. In the other phanerogams the male cell, which is non-motile, is carried to the oosphere by means of a pollen tube. In the spermatozoids of *Chara*, Vascular Cryptogams, and in those of *Cycas*, *Zamia*, and *Gingko*, the cilia arise from a centrosome-like body which is found on one side of the nucleus of the spermatozoid mother-cell. This body has been called a *blepharoplast*, and in the Pteridophytes, Cycads, and *Gingko* it gives rise to the spiral band on which the cilia are formed. Belajeff regards it as a true centrosome; but this is doubtful, for while in some cases it appears to be connected with the division of the cell, in others it is independent of it. The egg-cell or oosphere is a large cell containing a single large nucleus, and in the green plants the rudiments of plastids. In plants with multinucleate cells, such as *Cystopus*, *Peronospora*, and *Vaucheria*, it is usually a uninucleate cell differentiated by separation of the nuclei from a multinucleate cell, but in *Cystopus Bliti* it is multinucleate, and in *Sphæroplea* it may contain more than one nucleus. In some cases the region where the penetration of the male organ takes place is indicated on the oosphere by a hyaline receptive spot (*Œdogonium*, *Vaucheria*, &c.), or by a receptive papilla consisting of hyaline cytoplasm (Peronosporeæ). Fertilization is effected by the union of two nuclei only in all those cases which have been carefully investigated. Even in the multinucleate oosphere of *Cystopus Bliti* the nuclei fuse in pairs; and in the oospheres of *Sphæroplea*, which may contain more than one nucleus, the egg nucleus is formed by the fusion of one only of these with the spermatozoid nucleus (Klebahn). In the higher Fungi nuclear fusions take place in Basidia or Asci which involve the union of two and sometimes more nuclei, which may be regarded as physiologically equivalent to a sexual fusion. The union of the germ nuclei has now been observed in all the main groups of Angiosperms, Gymnosperms, Ferns, Mosses, Algæ, and Fungi, and presents a striking resemblance in all. In nearly all cases the nuclei appear to fuse in the resting stage (Fig. 3, C). In many Gymnosperms the male nucleus penetrates the female nucleus before fusing with it (Blackman, Ikeno). In other cases the two nuclei place themselves side by side, the nuclear membrane between them disappears, and the contents fuse together—nuclear thread with nuclear thread, and nucleolus with nucleolus—so completely that the separate constituents of the nuclei are not visible. It was at one time thought that the centrosomes played an important part in the fertilization of plants, but recent researches seem to indicate that this is not so. Even in those cases where the cilia band, which is the product of the centrosome-like body or blepharoplast, enters the ovum, as in *Zamia* (*c* in Fig. 4, B, C, D), it appears to take no part in the fertilization phenomena, nor in the subsequent division of the nucleus. During the process of fertilization in the Angiosperms it has been shown by the researches of Nawaschin and Guignard that in *Lilium* and *Fritillaria* both generative nuclei enter the embryo sac, one fusing with the oosphere nucleus, the other with the polar nuclei (Fig. 3 A, B). A double fertilization thus takes place. Both nuclei are elongated vermiform structures, and as they enter the embryo

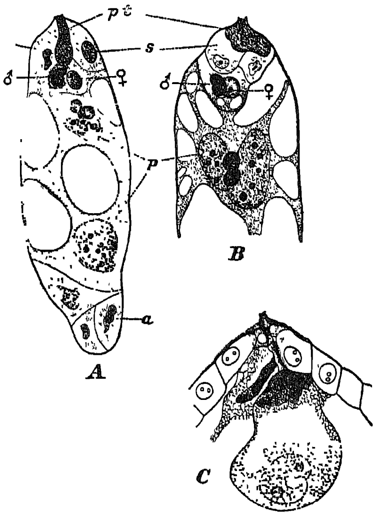



Fig. 3.—Fertilization in the Lily. (*From Wilson, after Guignard and Mottier.*) A, Two vermiform nuclei in the embryo sac; one approaching the egg-nucleus, the other uniting with the upper polar nucleus. B, Union of the vermiform nuclei with the egg-nucleus and the two polar nuclei. C, Fusion of the germ nuclei in the egg-cell; *a*, antipodal cells; *p*, polar nuclei; *pt*, pollen tube.

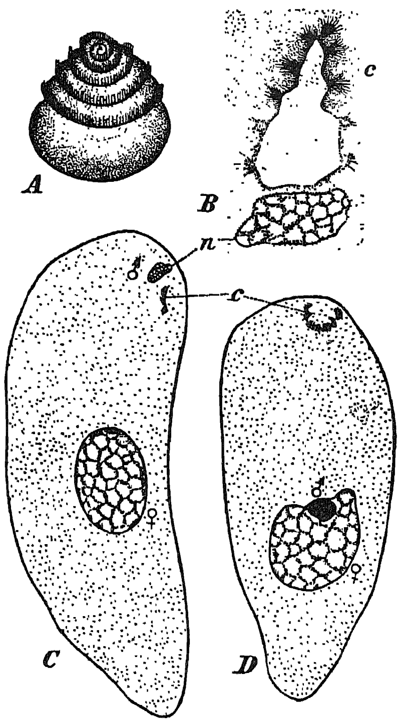



Fig. 4.—Spermatozoid and fertilization in Zamia. (*After Webber.*)

sac present a twisted appearance like a spermatozoid without cilia (Fig. 3, A, B). It has since been shown by other observers that this double fertilization occurs in many other Angiosperms, both Dicotyledons and Monocotyledons, so that it is probably of general occurrence throughout the group (see ANGIOSPERMS).

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(H. W*.)

**Czaslau** or **Časlau,** chief town of the government district of the same name in Bohemia, Austria. Population (1890), 8396, almost exclusively Czech and Catholic (655 Protestants and 247 Jews); (1900), 9145. There is a garrison of 623 men. A monument was erected in 1880 to the celebrated Hussite leader, Ziska, who was buried in the church. There are a sugar refinery, a brewery, and a distillery.

**Czech Literature** (see BOHEMIA and SLAVS, *Ency. Brit.* 9th edition). The later years of the 19th century saw a continued forward movement in the revived literature of Bohemia; but this progress may be briefly indicated, since its interest is still mainly local, except in so far as the work of Czech writers has helped to vindicate the Bohemian national movement by the reassertion of the Bohemian language as a literary vehicle. Between 1820 and 1848 a new "national school" of writers arose, led by Joseph Jungmann (1773–1847), and including the poets Jan Kollár (1793–1852), J. Kamarýt, Langer, Rubês, and Borovský (1821–56), the dramatists Turniský and Klicpera, and the novelists Jan Marek and Joseph Tyl. Jungmann introduced new models by his translations of British, French, and German literature; the new Czech drama was largely influenced by Shakespeare, and the novel by Sir Walter Scott. This "national school" gradually acquired a Panslavist character, Jungmann himself, the philologist V. Hanka (1791–1861), and the historians P. Šafařík (1795–1861), Franz Palacký (1798–1876), and Tomek (who, born in 1818, was still working at his great *History of Prague* at the end of the century) being the most prominent representatives of this tendency. After 1848 the narrower traditions of the national school gave way before a spirit of cosmopolitanism, introduced by H. Mácha (1810–76), but much encouraged by the influence of Byron; the poets H. Hálek (1835-74) and Jan Neruda (1834–91) being the leading names in this connexion. The national and cosmopolitan schools then became blended in writers of a more eclectic type, like the poets Svatopluk Cěch and "Jaroslav Vrchlický" (pseudonym for Emil Frida), the latter of whom (*b.* 1853) published some twenty volumes of poems, translations, dramas, and essays between 1893 and 1900. His epic poem *Bar-Kochba*, describing the last struggle of the Jews against Rome, is his masterpiece. Between 1890 and 1900 there was a great increase of literary production of all sorts. Julius Zeyer (*b.* 1841), besides writing poetry, has published many romantic prose stories; and Madame "Carolina Svjetla" (pseudonym for Johanna Muzák, *b.* 1830) is a novelist whose tales portray the life of the people. Among recent Czech dramatists must be mentioned Stroupéznický, the brothers Mrštik, Václav Viček, and Václav Frič (pseudonym "Brodsky," *b.* 1829), while Adolph Heyduk (*b.* 1831), has made a name as a poet, and Anton Gindely (1829–92) as a historian.

**Czernowitz** (Rumanian, *Cernâuz*), the capital of the Austrian duchy of Bukovina. Population, with suburbs (1869), 33,884; (1890), 54,171; (1900), 69,619. There is a garrison of 2965 men. There are several rather imposing modern buildings, including the Episcopal Palace in the Byzantine style, the Greek Orthodox cathedral, the Jesuit church, and a Hebrew temple in the Moorish style. The Francis Joseph University, opened in October 1875, has three faculties: theology (Greek Orthodox), law and politics, and philosophy. The language of instruction is German. In 1897 there were 41 professors and lecturers and 390 students. The industry (corn-milling and brewing) is unimportant. The trade, which is in the hands of the Jews and Armenians, is chiefly in corn, timber, cattle, hides, wool, and potash.

**Dacca,** a city of British India, giving its name to a district and division of Bengal. The city is 150 miles north-east by east of Calcutta, on an old channel of the Ganges. Railway station, 10 miles from the terminus of the river steamers at Narayanganj. Its area is about 8 square miles. The population in 1881 was 79,076, in 1891 it was 82,321, and in 1901 it was 90,679. It still shows some signs of its former magnificence. The famous manufacture of fine muslins is almost extinct, but the carving of shells, carried on from ancient times, is an important industry in the city. The Government college had 318 students in 1896, and the collegiate school 556. There is also an unaided Hindu college, with 222 students. There are 20 printing-presses, issuing 3 English and 3 vernacular newspapers. There is a large settlement of mixed Portuguese descent, known as Firinghis. Many of the public buildings, including the college, suffered severely from the earthquake of 12th June 1897.

The DISTRICT comprises an area of 2797 square miles. In 1881 it had a population of 2,113,005, and in 1891 of 2,420,656, giving an average density of 865 persons per square mile. Classified according to religion, Hindus numbered 934,063; Mahommedans, 1,450,250; Christians, 10,476, of whom 223 were Europeans; "others," 813. In 1901 the population was 2,660,631, showing an increase of 11 per cent. The land revenue and rates were Rs.6,08,761; the number of police was 697; the number of boys at school in 1896–97 was 75,836, being 42·4 per cent. of the male population of school-going age; the registered death-rate in 1897 was 27·97 per thousand. The district is now traversed by a line of the Eastern Bengal Railway, and it is further proposed to connect it by branches with the Assam-Bengal Railway; but most of the traffic is still conducted by water. It is a centre of the jute trade. There are 21 steam presses, employing 8000 hands, with an out-turn of 1,427,000 bales; and 10 hand presses, with a capital of Rs.24,00,000, employing 1130 hands, with an out-turn of 130,000 bales.

The DIVISION OF DACCA occupies the delta of the Brahmaputra, where it joins the main stream of the Ganges. It consists of the four districts of Dacca, Mymensingh, Faridpur, and Backergunge. Its area is 15,045 square miles. Its population in 1881 was 8,705,916, and in 1891 it was 9,844,127,—by far the highest rate of increase in Bengal,—with an average density of 654 persons per square mile.

**Daghestan,** a province of Russia, Transcaucasia. It occupies the triangular space between the Andi ridge, the south-east portion of the main Caucasus Range, and the Caspian Sea, and has Terek in N., Tiflis in S.W., Baku in S.E., and Caspian Sea in E. With the exception of a narrow strip of land along the seacoast and a small area in north, it is entirely covered with mountains, and presents one of the most hilly parts of the world. Area, 11,492 square miles. The snowclad Andi ridge, belonging to the system of the south-west to north-east upheavals which cross the Caucasus, branches off the later at Barbalo Peak (10,807 feet), and reaches its highest altitudes in Tebulos-mta (14,781 feet), Great Kachu (14,027 feet), and Donos-mta (13,736 feet). It is encircled on the north by a lower outer ridge, the Black Mountains, pierced by the rivers, and thickly clothed with woods, composed chiefly of beech (Ichkeria). The Bozdakh and another ridge run in the same direction between the four Koisu rivers (Avarian, Andian, Kazy-kumukh, and Kara Koisu), all flowing north-east to make the Sulak, a tributary of the Caspian. The main feature of the country is, however, according to Abich, the succession of folds of Jurassic cretaceous limestones and slates, all nearly parallel to the Caucasus, forming high and barren plateaux. Many peaks rise above 12,000 feet, and the passes are at altitudes of 11,000 feet in the interior of the country and 9000 feet in the east, towards the Caspian. The country is altogether difficult of access, and only one military route leads from Groznyi on the Terek to the military town of Botlikh on the Andi Koisu, while the eleven passes known across the Caucasus are mere bridle-paths. The climate is severe on the plateaux, hot towards the Caspian, and dry everywhere. The average temperatures are: year 51°, January 26°, July 73° at Temir-khan-shura (42° 49′ N., alt. 475 feet). The yearly rainfall varies from 21 to 17 inches.

The population of Daghestan was 590,336 in 1897, out of whom there were only 5000 Russians. It consists chiefly of mountaineers, known under the general name of Lezghians, in the west, and of a mixture of the same with Tatars and Georgians in the Caspian coast region. For a long time the highlands of Daghestan were the stronghold of the Caucasians against the Russians, especially under the leadership of Shamil. The difficulties of communication between the valleys have resulted in the formation of a great number of dialects, or even languages, which have been divided by Baron Uslar into several groups. The Avarian is a sort of inter-tribal tongue, while the Lakh or Kazi-kumukh language, the Kyurin, the Dargo-kaitakh, the Andi, and the Tabasaran are as many separate languages of common origin, subdivided in their turn into a number of dialects.

The mountaineers breed some cattle, and cultivate with great difficulty their small fields on the slopes of the mountains. In the littoral regions excellent crops are obtained with the aid of irrigation. The mountaineers excel also in a variety of petty trades.

A railway line of great importance, connecting the North Caucasian line, Rostov to Petrovsk, with the Transcaucasian line, Batum to Baku, has been built of late. It runs along the sea-coast from Petrovsk, through the Derbent "Gate," to Baku.

The province is divided into nine districts: Temir-khan-shura, Avarian, Andian, Gunib, Dargo, Kazy-kumukh, Kastago-Tabasaran, Kyurinsk, and Samur. The only towns are: Temir-khan-shura, capital of the province (9210 inh.), Derbent on the Caspian (14,821), and Petrovsk, a seaport of some importance (9810). The chief towns of the districts are mere military villages or forts, of which the fort of Gunib, the last stronghold of Shamil, has only 825 inhabitants. (P. A. K.)

**Dagupan,** the most important commercial centre in the province of Pangasinan, Luzon, Philippine Islands, and the northern terminus of the only railway in the islands. It is situated near the mouth of one of the branches of the Agno, but can be approached only by vessels of very small draught, because of a narrow bar at the river's mouth. It has a healthful climate, and is the chief point of exportation for a very rich province, which produces rice, sugar, indigo, Indian corn, and copra in abundance. It has a shipyard in which small sailing vessels and steam launches are constructed. The principal language is Pangasinan. Population, 16,000.

**Dahomey.**—An old West African kingdom, now a French colony, bounded on the S. by the Gulf of Guinea, on the E. by Lagos, on the N. and N.W. by the military territories of the French Sudan, and the W. by Togoland. With a coast-line of only 75 miles, the area after the decree of October 1899 (see below) was estimated at about 59,000 square miles, and the population at about 450,000, but nothing is as yet known with any degree of accuracy on these points. The coast is very low, sandy, and obstructed by a bar. Behind the immediate coast-line is a line of lagoons, where small steamers can ply: that of Porto Novo, on the east, that of Whidah, the longest (26 miles), and that of Grand Popo. The Ofe, the only important river (240 miles), drains the colony from the Bariba country to Porto Novo. The Zu is an affluent. The climate is very hot and moist. Four seasons are well marked: the long dry season, from December 1 to March 15; the season of the great rains, from March 15 to July 15; the short dry season, from July 15 to September 15; and the little rains, from September 15 to December 1. The negroes, of whom the population

entirely consists, belong to the Mina, Ewe, Fou, Mahi, Nago, and Bariba races. Cultivation is primitive and nine-tenths of the lands are waste. Maize, manioc, yams, and potatoes grow along the coast; millet in the interior. The forests contain the baobab, the cocoanut palm and the oil palm. Cattle are rare, and a few years ago the ox was entirely unknown. An experimental farm is carried on at Porto Novo.

France first established factories in 1851 at Whidah, after the signature of a treaty with the king. In 1868 a similar power was granted at Kotonu, and in 1878 France received authority to collect the customs at this locality. In the meantime, in 1863, the kingdom of Porto Novo had accepted the French protectorate, and the Anglo-French agreement of 1864 had fixed its boundaries. This protectorate was soon afterwards abandoned by Napoleon III., but was re-established in 1882; in 1885 a Franco-German convention assigned Grand Popo to France and Little Popo, to the west of the coast of Dahomey, to Germany. In 1890, Gleglé, king of Dahomey, claimed the right to collect the customs at Kotonu, ceded to France in 1878, and to depose the king of Porto Novo, while he also interfered with the French and with the population protected by France. The dispute ended with a treaty which secured to France her rights and to the king of Dahomey an annual pension of £800. In 1892 the attitude of King Behanzin rendered a new war necessary; Abomey, his capital, was taken by General Dodds, his states were annexed, and he himself was sent a prisoner to the Antilles. In 1894 the colony was separated from France's other West African possessions and became a separate administrative unit. Anglo-French conventions of 1889 and 1898 fixed the eastern frontier, and a Franco-German convention of 1897 settled the boundary on the west. The limits northwards were fixed on the disintegration of the French Sudan in 1899, when some of the cantons of Kwala, or Nebba, and the territory of Say, on the Niger, were added to the colony's possessions.

The colony is administered by a governor (himself under the Governor-General of French West Africa), assisted by a council composed of three official and three civil members. It has a paymaster-general and a justice of peace. It is one of the three French West African colonies which have been allowed to manage their own finances, with the result that it is entirely self-supporting. In 1899 the receipts amounted to £110,634, or £34,634 more than was anticipated in the budget. The budget for 1901 anticipated £89,000, of which the native tax was expected to produce £14,000. The principal items of expenditure provided for, apart from £31,000 for the administrative service, were: public works, &c., £21,500; the occupation of Upper Dahomey, £19,000; native troops and police, £9000. The chief towns are Porto Novo (50,000), the seat of government; Grand Popo (2000), a port; Kotonu (1000), a port; Whidah, a port; and in the interior, Abomey (15,000), the capital of Dahomey, 75 miles from the sea, Allada (10,000), and Agony (20,000).

The following table gives the value of the principal articles of import and export for 1898 and 1899, with the totals for those years:—

| Year. | Imports. | | | Exports. | | |
|---|---|---|---|---|---|---|
| | Textiles. | Intoxicants. | Total. | Palm Kernels. | Palm Oil. | Total. |
| 1898 | £83,000 | £155,000 | £400,000 | £170,000 | £109,000 | £301,500 |
| 1899 | 77,000 | 182,000 | 494,000 | ... | ... | 509,000 |

In 1898 Great Britain sent nearly all the textiles, Germany nearly all the intoxicants. The exports of kernels to Lagos was more than half the total, while France and Germany divided the remainder about equally. Lagos and France each received nearly half the oil export. France's total share of the imports in 1898 amounted to only £135,000; of the exports to only £118,300.

France can only slowly increase her sales, the convention of 1898 having guaranteed absolute equality in respect of customs. There are few roads, but a telegraph line connects Kotonu with Abomey, Gurma on the Niger, and Senegal. A railway is projected between Kohonou and the Niger. With Europe there is telegraphic communication (at Kotonu) over an English submarine cable, and steamship communication by lines from Bordeaux and Marseilles and Liverpool and Hamburg. In 1898, of 433 steamers which visited Dahomey, 111 were French, 133 British, and 156 German. French, English, and American coins circulate, and also cowrie shells. The difficulty of firmly establishing French money as the basis of exchange is one of the problems of the colony.

*Authorities.*—Bertin. *Renseignements sur Porto Novo et le Dahomey.* Paris, 1890.—Aublet. *La Guerre du Dahomey.* Paris, 1894.—Lee. *French Colonies.* Foreign Office Report, 1900. —*L'Année Coloniale.* Paris, 1900. (P. L.)

**Daiquiri,** a village 15 miles east of Santiago de Cuba. An expensive iron pier, built by the American shippers of Cuban ores, was used for the landing of the American army in the advance on Santiago in 1898. Population (1899), 1380.

# DAIRY-FARMING.

*Contents*:—



## Modern Changes.

No branch of agriculture underwent greater changes during the closing quarter of the 19th century than dairy-farming; within the period named, indeed, the dairying industry may be said to have been revolutionized. The two great factors in this modification were the introduction about the year 1880 of the centrifugal cream-separator, whereby the old slow system of raising cream in pans was dispensed with, and the invention some ten years later of a quick and easy method of ascertaining the fat content of samples of milk without having to resort to the tedious processes of chemical analysis. About the year 1875 the agriculturists of the United Kingdom, influenced by various economic causes, began to turn their thoughts more intently in the direction of dairy-farming, and to the increased production of milk and cream, butter and cheese. On 24th October 1876 was held the first London Dairy Show, under the auspices of a committee of agriculturists, and it has been followed by a similar show in every subsequent year. The official report of the pioneer show stated that "there was a much larger attendance and a greater amount of enthusiasm in the movement than even the most sanguine of its promoters anticipated." On the day named Professor J. Prince Sheldon read at the show a paper on the dairying industry, and

proposed the formation of a society to be called the British Dairy Farmers' Association. This was unanimously agreed to, and thus was founded an organization which has since been closely identified with the development of the dairying industry of the United Kingdom. In its earlier publications the Association was wont to reproduce from *Household Words* the following tribute to the cow:—

"If civilized people were ever to lapse into the worship of animals, the Cow would certainly be their chief goddess. What a fountain of blessings is the Cow! She is the mother of beef, the source of butter, the original cause of cheese, to say nothing of shoe-horns, hair-combs, and upper leather. A gentle, amiable, ever-yielding creature, who has no joy in her family affairs which she does not share with man. We rob her of her children that we may rob her of her milk, and we only care for her when the robbing may be perpetrated."

The Association has, directly or indirectly, brought about many valuable reforms and improvements in dairying. Its London shows have provided, year after year, a variety of object-lessons in cheese, in butter, and in dairy equipment. In order to demonstrate to producers what is the ideal to aim at, there is nothing more effective than a competitive exhibition of products, and the approach to uniform excellence of character in cheese and butter of whatever kinds is most obvious to those who remember what these products were like at the first two or three dairy shows. Simultaneously there has been a no less marked advance in the mechanical aids to dairying, including, in particular, the centrifugal cream-separator, the crude germ of which was first brought before the public at the International Dairy Show held at Hamburg in the spring of 1877. The Association in good time set the example, now beneficially followed in many parts of Great Britain, of providing means for technical instruction in the making of cheese and butter, by the establishment of a dairy school in the Vale of Aylesbury, subsequently removing it to new and excellent premises at Reading, where it is known as the British Dairy Institute. The initiation of butter-making contests at the annual dairy shows stimulated the competitive instinct of dairy workers, and afforded the public useful object-lessons; in more recent years milking competitions have been added. Milking trials and butter tests of cows conducted at the dairy shows have afforded results of much practical value. Many of the larger agricultural societies have found it expedient to include in their annual shows a working dairy, wherein butter-making contests are held and public demonstrations are given.

What are regarded as the dairy breeds of cattle is illustrated by the prize schedule of the annual London Dairy Show, in which sections are provided for cows and heifers of the Shorthorn, Jersey, Guernsey, Red Polled, Ayrshire, Kerry, and Dexter breeds, the characteristics of which are set forth in the article AGRICULTURE. A miscellaneous class is also provided, the entries in which are mostly cross-breds. There are likewise classes for Shorthorn bulls, Jersey bulls, and bulls of any other pure breed, but it is stipulated that all bulls must be of proved descent from dams that have won prizes in the milking trials or butter tests of the British Dairy Farmers' Association or other high-class agricultural society. The importance of securing dairy characters in the sire is thus recognized, and it is notified that, as the object of the bull classes is to encourage the breeding of bulls for dairy purposes, the prizes are to be given solely to animals exhibited in good stock-getting condition.

## MILK AND BUTTER TESTS.

The award of prizes in connexion with milking trials cannot be determined simply by the quantity of milk yielded in a given period, say twenty-four hours. Other matters must obviously be taken into consideration, such as the quality of the milk and the time that has elapsed since the birth of the last calf. With regard to the former point, for example, it is quite possible for one cow to give more milk than another, but for the milk of the second cow to include the larger quantity of butter-fat. The awards are therefore determined by the total number of points obtained according to the following scheme:—

One point for every ten days since calving (deducting the first forty days), with a maximum of fourteen points.
One point for every pound of milk, taking the average of two days' yield.
Twenty points for every pound of butter-fat produced.
Four points for every pound of "solids other than fat."
*Deductions.*—Ten points each time the fat is below 3 per cent.
Ten points each time the solids other than fat fall below 8·5 per cent.

This method of award is at present the best that can be devised, but it is possible that, as experience accumulates, some rearrangement of the points may be found to be desirable. Omitting many of the details, Table I. shows some of the results in the case of the Shorthorn and Jersey cows to which prizes were awarded in 1900. The days "in milk" denote in each case the number of days that have elapsed since calving; and if the one day's yield of milk is desired in gallons, it can be obtained approximately[1] by dividing the weight in pounds by 10: thus, the Shorthorn cow Heroine III. gave 52·4 lb, or 5·24 gallons, of milk per day. The table is incidentally of interest as showing how superior as milch kine are the unregistered or non-pedigree Shorthorns—which are typical of the great majority of dairy cows in the United Kingdom—as compared with the pedigree animals entered, or eligible for entry, in Coates's Herd-Book. The evening's milk, it should be added, is nearly always richer in fat than the morning's, but the percentages in the table relate to the entire day's milk.

TABLE I. *Prize Shorthorn and Jersey Cows in the Milking Trials, London Dairy Show,* 1900.

| Cow. | Age. | In Milk. | Milk per Day. | Fat. | Other Solids. | Total Points. |
|---|---|---|---|---|---|---|
| | Years. | Days. | lb | Per cent. | Per cent. | No. |
| SHORTHORNS eligible for Herd-Book— | | | | | | |
| Heroine III. | 6 | 61 | 52·4 | 3·7 | 8·3 | 91·5 |
| Musical | 7 | 16 | 45·2 | 3·2 | 9·3 | 90·8 |
| Lady Rosedale | 8 | 48 | 47·8 | 3·5 | 9·0 | 88·7 |
| SHORTHORNS not eligible for Herd-Book— | | | | | | |
| Granny | 9 | 33 | 70·2 | 3·5 | 8·9 | 144·1 |
| Cherry | 9 | 103 | 55·5 | 4·0 | 8·9 | 127·1 |
| Chance | 6 | 23 | 60·0 | 3·6 | 8·9 | 124·6 |
| JERSEYS— | | | | | | |
| Sultane 14th | 12 | .256 | 41·7 | 4·9 | 9·4 | 112 |
| Queen Bess | 7½ | 136 | 39·4 | 4·8 | 9·0 | 101 |
| Gloaming IV. | 7 | 156 | 30·5 | 6·7 | 9·5 | 94·9 |

The milking trials are based upon a chemical test, as it is necessary to determine the percentage of fat and of solids other than fat in each sample of milk. The butter test, on the other hand, is a churn test, as the cream has to be separated from the milk and churned. The following is the scale of points used at the London Dairy Show in making awards in butter tests:—

One point for every ounce of butter; one point for every completed ten days since calving, deducting the first forty days. Maximum allowance for period of lactation, 12 points.

[1] A gallon of milk weighs 10·3 lb, so that very little error is involved in converting pounds to gallons by dividing the number of pounds by 10.

Fractions of ounces of butter, and incomplete periods of less than ten days, to be worked out in decimals and added to the total points.

In the case of cows obtaining the same number of points, the prize to be awarded to the cow that has been the longest time in milk.

No prize or certificate to be given in the case of:—

(a) Cows under five years old failing to obtain 28 points.

(b) Cows five years old and over failing to obtain 32 points.

The manner in which butter tests are decided will be rendered clear by a study of Table II. It is seen that whilst the much larger Shorthorn cows—having a bigger frame to maintain and consuming more food—gave both more milk and more butter in the day of twenty-four hours, the Jersey milk was much the richer in fat. In the case of the first-prize Jersey the "butter ratio," as it is termed, was excellent, as only 13·83 ℔ of milk were required to yield 1 ℔ of butter; in the case of the second-prize Shorthorn, practically twice this quantity (or 27·11 ℔) was needed. Moreover, if the days in milk are taken into account, the difference in favour of the Jersey is seen to be 123 days.

TABLE II. *Prize Shorthorn and Jersey Cows in the Butter Tests, London Dairy Show*, 1900.

| Cows. | Age. | In Milk. | Milk per Day. | Butter. | Milk to 1 ℔ Butter. | Points for Butter. | Points for Lactation. | Total Points. |
|---|---|---|---|---|---|---|---|---|
| | Years. | Days. | ℔ oz. | ℔ oz. | ℔ | No. | No | No. |
| SHORTHORNS— | | | | | | | | |
| 1st | 9 | 104 | 55 2 | 2 5¼ | 23·67 | 37·25 | 6·40 | 43 65 |
| 2nd | 9 | 34 | 72 7 | 2 10½ | 27·11 | 42·75 | .. | 42·75 |
| 3rd | 7 | 33 | 58 5 | 2 7½ | 23·47 | 39·75 | .. | 39·75 |
| JERSEYS— | | | | | | | | |
| 1st | 7 | 157 | 29 10 | 2 2¼ | 13·83 | 34·25 | 11·70 | 45·95 |
| 2nd | 4 | 103 | 33 10 | 2 3 | 15·37 | 35·00 | 6·30 | 41·30 |
| 3rd | 12 | 257 | 40 13 | 1 12 | 23·32 | 28·00 | 12 00 | 40·00 |

The butter-yielding capacity of the choicest class of butter cows, the Jerseys, is amply illustrated in the results of the butter tests conducted by the English Jersey Cattle Society over the period of fourteen years 1886 to 1899 inclusive. These tests have been carried out year after year at half a dozen different shows, and the results are classified in Table III. according to the age of the animals. The average time in milk is measured by the number of days since calving, and the milk and butter yields are those for the day of twenty-four hours. The last column shows the "butter ratio." This number is lower in the case of the Jerseys than in that of the general run of dairy cows. The average results from the total of 1023 cows of the various ages are:—One day's milk, 32 ℔ 2¼ oz., equal to about 3 gallons, or 12 quarts; one day's butter, 1 ℔ 10¾ oz.; butter ratio, 19·13, or about 16 pints of milk to 1 ℔ of butter. Individual yields are sometimes extraordinarily high. Thus at the Tring show in 1899 the three leading Jersey cows gave the following results:—

TABLE III. *Summary of the English Jersey Cattle Society's Butter Tests, Fourteen Years*, 1886 *to* 1899.

| Cows' Ages. | Cows Tested. | Average Time in Milk. | Average Milk Yield. | Average Butter Yield. | Quantity Milk to 1 ℔. Butter. |
|---|---|---|---|---|---|
| Years. | No. | Days. | ℔ oz. | ℔ oz. | ℔ |
| 1 to 2 | 2 | 34 | 15 2 | 0 13 | 18·43 |
| 2 ,, 3 | 57 | 73 | 24 15¼ | 1 5¼ | 18·74 |
| 3 ,, 4 | 108 | 77 | 29 14¾ | 1 10 | 18·42 |
| 4 ,, 5 | 165 | 72 | 32 5½ | 1 11¼ | 19·01 |
| 5 ,, 6 | 188 | 80 | 32 15¼ | 1 12 | 18·76 |
| 6 ,, 7 | 189 | 89 | 34 7¾ | 1 13 | 18·92 |
| 7 ,, 8 | 139 | 84 | 33 11¼ | 1 13¼ | 18·40 |
| 8 ,, 9 | 71 | 82 | 33 6½ | 1 12 | 19·03 |
| 9 ,, 10 | 42 | 92 | 32 6½ | 1 11¼ | 18·95 |
| 10 ,, 11 | 31 | 88 | 35 4 | 1 14¼ | 18·60 |
| 11 ,, 12 | 15 | 89 | 37 1 | 1 13¾ | 19·96 |
| 12 ,, 13 | 13 | 95 | 34 1¼ | 1 10½ | 20·56 |
| 13 ,, 14 | 3 | 54 | 42 1¼ | 2 1¾ | 19·85 |

| Cow. | Age. | Live-Weight. | In Milk. | Butter. | Butter Ratio. |
|---|---|---|---|---|---|
| | Years. | ℔ | Days. | ℔ oz. | ℔ |
| Sundew 4th | 8 | 929 | 77 | 3 6¾ | 15·10 |
| Madeira 5th | 7 | 1060 | 107 | 2 15¼ | 16·14 |
| Em | 7 | 864 | 44 | 3 4¾ | 13·32 |

The eight prize-winning Jerseys on this occasion, with an average weight of 916 ℔ and an average of 117 days in milk, yielded an average of 2 ℔ 9 oz. of butter per cow in the twenty-four hours, the butter ratio working out at 16·69. At the Tring show of 1900 a Shorthorn cow Cherry gave as much as 4 ℔ 4½ oz. of butter in twenty-four hours; she had been in milk 41 days, and her butter ratio worked out at 15·79, which is unusually good for a big cow.

In the six years 1895 to 1900 inclusive 285 cows of the Shorthorn, Jersey, Guernsey, and Red Polled breeds were subjected to butter tests at the London Dairy Show, and the general results are summarized in Table IV.

TABLE IV. *Average Butter Yields and Butter Ratios at the London Dairy Show, Six Years*, 1895 *to* 1900.

| Breed. | No. of Cows. | In Milk. | Butter. | Milk to 1 ℔ Butter. |
|---|---|---|---|---|
| | | Days. | ℔ oz. | ℔ |
| Shorthorn | 106 | 50 | 1 11 | 28·81 |
| Jersey | 126 | 99 | 1 10¼ | 19·15 |
| Guernsey | 23 | 72 | 1 9½ | 21·86 |
| Red Polled | 30 | 60 | 1 4¼ | 30·29 |

Although cows in the showyard may perhaps be somewhat upset by their unusual surroundings, and thus not yield so well as at home, yet the average results of these butter-test trials over a number of years are borne out by the private trials that have taken place in various herds. The trials have, moreover, brought into prominence the peculiarities of different breeds, such as: (*a*) that the Shorthorns, Red Polls, and Kerries, being cattle whose milk contains small fat globules, are better for milk than the Jerseys and Guernseys, whose milk is richer, containing larger-sized fat globules, and is therefore more profitable for converting into butter; (*b*) that the weights of the animals, and consequently the proportionate food, must be taken into account in estimating the cost of the dairy produce; (*c*) that the influence of the stage reached in the period of lactation is much more marked in some breeds than in others.

An instructive example of the milk-yielding capacity of Jersey cows is afforded in the carefully kept records of Lord Rothschild's herd at Tring Park, Herts. The following are the figures, the gallons being calculated at the rate of 10 ℔ of milk to the gallon:—

In 1897, 30 cows averaged 6396 ℔, or 640 gallons per cow.
In 1898, 29 ,, ,, 6209 ,, 621 ,, ,,
In 1899, 37 ,, ,, 6430 ,, 643 ,, ,,
In 1900, 39 ,, ,, 6136 ,, 614 ,, ,,

The average over the four years works out at about 630 gallons per cow per annum.

Cows of larger type will give more milk than the Jerseys, but it is less rich in fat. The milk record for the year 1900 of the herd of Red Polled cattle belonging to Mr Garrett Taylor, Whitlingham, Norfolk, affords a good example. The cows in the herd, which had before

1900 produced one or more calves, and in 1900 added another to the list, being in full profit the greater part of the year, numbered 82. Their total yield was 521,950 lb of milk, or an average of 6365 lb—equivalent to about 636 gallons—per cow. In 1899 the average yield of 96 cows was 6283 lb, or 628 gallons; in 1898 the average yield of 75 cows was 6473 lb, or 647 gallons. Of cows which dropped a first calf in the autumn of 1899, one of them—Lemon—milked continuously for 462 days, yielding a total of 7166 lb of milk, being still in milk when the herd year closed on 27th December. Similar cases were those of Nora, which gave 9066 lb of milk in 455 days; Doris, 8138 lb in 462 days; Brisk, 9248 lb in 469 days; Della, 8806 lb in 434 days, drying 28 days before the year ended; and Lottie, 6327 lb in 394 days, also drying 28 days before the year ended; these were all cows with their first calf. Eight cows in the herd gave milk on every day of the 52 weeks, and 30 others had their milk recorded on 300 days or more. Three heifers which produced a first calf before 11th April 1900, averaged in the year 4569 lb of milk, or about 456 gallons. In 1900 three cows, Eyke Jessie, Kathleen, and Doss, each gave over 10,000 lb, or 1000 gallons of milk; four cows gave from 9000 lb to 10,000 lb, two from 8000 lb to 9000 lb, 17 from 7000 lb to 8000 lb, 19 from 6000 lb to 7000 lb, 30 from 5000 lb to 6000 lb, and 16 from 4000 lb to 5000 lb. The practice, long followed at Whitlingham, of developing the milk-yielding habit by milking a young cow so long as she gives even a small quantity of milk daily, is well supported by the figures denoting the results.

Though milking trials and butter tests are not usually available to the ordinary dairy farmer in the management of his herd, it is, on the other hand, a simple matter for him to keep what is known as a milk register. By a milk register is meant a record of the quantity of milk yielded by a cow. In other words, it is a quantitative estimation of the milk the cow gives. It affords no information as to the quality of the milk, or as to its butter-yielding or cheese-yielding capacity. Nevertheless, by its aid the milk-producing capacity of a cow can be ascertained exactly, and her character in this respect can be expressed by means of figures about which there need be no equivocation. A greater or less degree of exactness can be secured, according to the greater or less frequency with which the register is taken. Even a weekly register would give a fair idea as to the milk yields of a cow, and would be extremely valuable as compared with no register at all.

The practice of taking the milk register, as followed in a well-known dairy, may be briefly described. The cows are always milked in the stalls, and during summer they are brought in twice a day for this purpose. After each cow is milked, the pail containing the whole of her milk is hung on a spring balance suspended in a convenient position, and from the gross weight indicated there is deducted the already known weight of the pail.[1] The difference, which represents the weight of milk, is recorded in a book suitably ruled. This book when open presents a view of one week's records. In the left-hand column are the names of the cows; on the right of this are fourteen columns, two of which receive the morning and evening record of each cow. In a final column on the right appears the week's total yield for each cow; and space is also allowed for any remarks. Fractions of a pound are not entered, but 18 lb 12 oz. would be recorded as 19 lb, whereas 21 lb 5 oz. would appear as 21 lb, so that a fraction of over half a pound is considered as a whole pound, and a fraction of under half a pound is ignored. By dividing the pounds by 10 the yield in gallons is readily ascertained.

Every dairy farmer has some idea, as to each of his cows, whether she is a good, a bad, or an indifferent milker, but such knowledge is at best only vague. By the simple means indicated the character of each cow as a milk-producer is slowly but surely recorded in a manner which is at once exact and definite. Such a record is particularly valuable to the farmer, in that it shows to him the relative milk-yielding capacities of his cows, and thus enables him gradually to weed out the naturally poor milkers and replace them by better ones. It also guides him in regulating the supply of food according to the yield of milk. The register will, in fact, indicate unerringly which are the best milk-yielding cows in the dairy, and which therefore are, with the milking capacity in view, the best to breed from.

The simplicity and inexpensiveness of the milk register must not be overlooked. These are features which should commend it especially to the notice of small dairy farmers, for with a moderate number of cows it is particularly easy to introduce the register. But even with a large dairy it will be found that, as soon as the system has got fairly established, the additional time and trouble involved will sink into insignificance when compared with the benefits which accrue.

The importance of ascertaining not only the quantity but also the quality of milk is aptly illustrated in the case of two cows at the Tring show, 1900. The one cow gave in 24 hours $4\frac{1}{2}$ gallons of milk, which at 7d. per gallon would work out at about 2s. 7d.; she made 2 lb 12 oz. of butter, which at 1s. 4d. per lb would bring in 3s. 8d.; consequently by selling the milk the owner lost about 1s. 1d. per day. The second cow gave $5\frac{1}{3}$ gallons of milk, which would work out at 3s. 1d.; she made 1 lb 12 oz. of butter, which would only be worth 2s. 4d., so that by converting the milk into butter the owner lost 9d. per day.

The colour of milk is to some extent an indication of its quality—the deeper the colour the better the quality. The colour depends upon the size of the fat globules, a deep yellowish colour indicating large globules of fat. When the globules are of large size the milk will churn more readily, and the butter is better both in quality and in colour.

The following fifty dairy rules relating to the milking and general management of cows, and to the care of milk and dairy utensils, were drawn up on behalf of, and published by, the United States Department of Agriculture at Washington. They are given here with a few merely verbal alterations:—

THE OWNER AND HIS HELPERS.

1. Read current dairy literature and keep posted on new ideas.
2. Observe and enforce the utmost cleanliness about the cattle, their attendants, the cow house, the dairy, and all utensils.
3. A person suffering from any disease, or who has been exposed to a contagious disease, must remain away from the cows and the milk.

THE COW HOUSE.

4. Keep dairy cattle in a shed or building by themselves. It is preferable to have no cellar below and no storage loft above.
5. Cow houses should be well ventilated, lighted, and drained; should have tight floors and walls, and be plainly constructed.
6. Never use musty or dirty litter.
7. Allow no strong-smelling material in the cow house for any length of time. Store the manure under cover outside the cow house, and remove it to a distance as often as practicable.

[1] A portable milk-weighing appliance is made in which the weight of the pail is included, and an indicator shows on a dial the exact weight in pounds and ounces, and likewise the volume in gallons and pints, of the milk in the pail. When the pail is empty the indicator of course points to zero.

8. Whitewash the cow house once or twice a year; use gypsum in the manure gutters daily.
9. Use no dry, dusty feed just previous to milking; if fodder is dusty, sprinkle it before it is fed.
10. Clean and thoroughly air the cow house before milking; in hot weather sprinkle the floor.
11. Keep the cow house and dairy room in good condition, and then insist that the dairy, factory, or place where the milk goes be kept equally well.

THE COWS.

12. Have the herd examined at least twice a year by a skilled veterinarian.
13. Promptly remove from the herd any animal suspected of being in bad health, and reject her milk. Never add an animal to the herd until it is ascertained to be free from disease, especially tuberculosis.
14. Do not move cows faster than a comfortable walk while on the way to the place of milking or feeding.
15. Never allow the cows to be excited by hard driving, abuse, loud talking, or unnecessary disturbance; do not expose them to cold or storms.
16. Do not change the feed suddenly.
17. Feed liberally, and use only fresh, palatable feed-stuffs; in no case should decomposed or mouldy material be used.
18. Provide water in abundance, easy of access, and always pure; fresh, but not too cold.
19. Salt should always be accessible to the cows.
20. Do not allow any strong-flavoured food, like garlic, cabbages, and turnips, to be eaten, except immediately after milking.
21. Clean the entire skin of the cow daily. If hair in the region of the udder is not easily kept clean, it should be clipped.
22. Do not use the milk within twenty days before calving, nor for three to five days afterwards.

MILKING.

23. The milker should be clean in all respects; he should not use tobacco while milking; he should wash and dry his hands just before milking.
24. The milker should wear a clean outer garment, used only when milking and kept in a clean place at other times.
25. Brush the udder and surrounding parts just before milking, and wipe them with a clean damp cloth or sponge.
26. Milk quietly, quickly, cleanly, and thoroughly. Cows do not like unnecessary noise or delay. Commence milking at exactly the same hour every morning and evening, and milk the cows in the same order.
27. Throw away (but not on the floor—better in the gutter) the first two or three streams from each teat; this milk is very watery and of little value, but it may injure the rest.
28. If in any milking a part of the milk is bloody or stringy or unnatural in appearance, the whole should be rejected.
29. Milk with dry hands; never let the hands come in contact with the milk.
30. Do not allow dogs, cats, or loafers to be around at milking time.
31. If any accident occurs by which a pail, full or partly full, of milk becomes dirty, do not try to remedy this by straining, but reject all this milk and rinse the pail.
32. Weigh and record the milk given by each cow, and take a sample morning and night, at least once a week, for testing by the fat test.

CARE OF MILK.

33. Remove the milk of every cow at once from the cow house to a clean dry room, where the air is pure and sweet. Do not allow cans to remain in the cow house while they are being filled with milk.
34. Strain the milk through a metal gauze and a flannel cloth or layer of cotton as soon as it is drawn.
35. Cool the milk as soon as strained—to 45° F. if the milk is for shipment, or to 60° if for home use or delivery to a factory.
36. Never close a can containing warm milk.
37. If the cover is left off the can, a piece of cloth or mosquito netting should be used to keep out insects.
38. If milk is stored, it should be kept in tanks of fresh cold water (renewed as often as the temperature increases to any material extent), in a clean, dry, cold room. Unless it is desired to remove cream, it should be stirred with a tin stirrer often enough to prevent the forming of a thick cream layer.
39. Keep the night milk under shelter so that rain cannot get into the cans. In warm weather keep it in a tank of fresh cold water.
40. Never mix fresh warm milk with that which has been cooled.
41. Do not allow the milk to freeze.
42. In no circumstances should anything be added to milk to prevent its souring. Cleanliness and cold are the only preventives needed.
43. All milk should be in good condition when delivered at a creamery or a cheesery. This may make it necessary to deliver twice a day during the hottest weather.
44. When cans are hauled far they should be full, and carried in a spring waggon.
45. In hot weather cover the cans, when moved in a waggon, with a clean wet blanket or canvas.

THE UTENSILS.

46. Milk utensils for farm use should be made of metal and have all joints smoothly soldered. Never allow them to become rusty or rough inside.
47. Do not haul waste products back to the farm in the cans used for delivering milk. When this is unavoidable, insist that the skim milk or whey tank be kept clean.
48. Cans used for the return of skim milk or whey should be emptied, scalded, and cleaned as soon as they arrive at the farm.
49. Clean all dairy utensils by first thoroughly rinsing them in warm water; next clean inside and out with a brush and hot water in which a cleaning material is dissolved; then rinse and, lastly, sterilize by boiling water or steam. Use pure water only.
50. After cleaning, keep utensils inverted in pure air, and sun if possible, until wanted for use.

### Food and Milk Production.

In their comprehensive paper relating to the feeding of animals, published in 1895, Lawes and Gilbert discussed amongst other questions that of milk production, and directed attention to the great difference in the demands made on the food—on the one hand for the production of meat (that is, of animal increase), and on the other for the production of milk. Not only, however, do cows of different breeds yield different quantities of milk, and milk of characteristically different composition, but individual animals of the same breed have very different milk-yielding capacity; and whatever the capacity of a cow may be, she has a maximum yield at one period of her lactation, which is followed by a gradual decline. Hence, in comparing the amounts of constituents stored up in the fattening increase of an ox with the amounts of the same constituents removed in the milk of a cow, it is necessary to assume a wide range of difference in the yield of milk. Accordingly, Table V. shows the amounts of nitrogenous substance, of fat, of non-nitrogenous substance not fat, of mineral matter, and of total solid matter, carried off in the weekly yield of milk of a cow, on the alternative assumptions of a production of 4, 6, 8, 10, 12, 14, 16, 18, or 20 quarts per head per day. For comparison, there is given at the foot of the table the amounts of nitrogenous substance, of fat, of mineral matter, and of total solid matter, in the weekly increase in live-weight of a fattening ox of an average weight of 1000 ℔—first, on the assumption of a weekly increase of 10 ℔, and, secondly, of 15 ℔. The estimates of the amounts of constituents in the milk are based on the assumption that it will contain 12·5 per cent. of total solids—consisting of 3·65 albuminoids, 3·50 butter-fat, 4·60 sugar, and 0·75 of mineral matter. The estimates of the constituents in the fattening increase of oxen are founded on determinations made at Rothamsted.

With regard to the very wide range of yield of milk per head per day which the figures in the following table assume, it may be remarked that it is by no means impossible that the same animal might yield the largest amount, namely, 20 quarts, or 5 gallons, per day near the beginning, and only 4 quarts, or 1 gallon, or even less, towards the end of her period of lactation. At the same time, an entire herd of, for example, Shorthorns or Ayrshires, of fairly average quality, well fed, and including animals at various periods

of lactation, should not yield an average of less than 8 quarts, or 2 gallons, and would seldom exceed 10 quarts, or $2\frac{1}{2}$ gallons, per head per day the year round.

TABLE V. *Comparison of the Constituents of Food carried off in Milk, and in the Fattening Increase of Oxen.*

| [1 Gallon=10·33 ℔.] | Nitrogenous Substance. | Fat. | Non-Nitrogenous Substance not Fat (Sugar). | Mineral Matter. | Total Solid Matter. |
|---|---|---|---|---|---|
| *In Milk per Week.* | | | | | |
| If:— | ℔ | ℔ | ℔ | ℔ | ℔ |
| 4 quarts per head per day | 2·64 | 2·53 | 3·33 | 0·54 | 9·04 |
| 6 ,, ,, ,, | 3·96 | 3·80 | 4·99 | 0·81 | 13·56 |
| 8 ,, ,, ,, | 5·28 | 5·06 | 6·66 | 1·08 | 18·08 |
| 10 ,, ,, ,, | 6·60 | 6·33 | 8·32 | 1·35 | 22·60 |
| 12 ,, ,, ,, | 7·92 | 7·59 | 9·99 | 1·62 | 27·12 |
| 14 ,, ,, ,, | 9·24 | 8·86 | 11·65 | 1·89 | 31·64 |
| 16 ,, ,, ,, | 10·56 | 10·12 | 13·32 | 2·16 | 36·16 |
| 18 ,, ,, ,, | 11·88 | 11·39 | 14·98 | 2·43 | 40·68 |
| 20 ,, ,, ,, | 13·20 | 12·65 | 16·65 | 2·70 | 45·20 |
| *In Increase in Live-Weight per Week.—Oxen.* | | | | | |
| If 10 ℔ increase . . | 0·75 | 6·35 | ... | 0·15 | 7·25 |
| If 15 ℔ increase . . | 1·13 | 9·53 | ... | 0·22 | 10·88 |

For the sake of illustration, an average yield of milk of 10 quarts, equal $2\frac{1}{2}$ gallons, or between 25 and 26 ℔ per head per day, may be assumed, and the amount of constituents in the weekly yield at this rate may be compared with that in the weekly increase of the fattening ox at the higher rate assumed in the table, namely, 15 ℔ per 1000 ℔ live-weight, or 1·5 per cent. per week. It is seen that whilst of the nitrogenous substance of the food the amount stored up in the fattening increase of an ox would be only 1·13 ℔, the amount carried off as such in the milk would be 6·6 ℔, or nearly six times as much. Of mineral matter, again, whilst the fattening increase would only require about 0·22 ℔, the milk would carry off 1·35 ℔, or again about six times as much. Of fat, however, whilst the fattening increase would contain 9·53 ℔, the milk would contain only 6·33 ℔, or only about two-thirds as much. On the other hand, whilst the fattening increase contains no other non-nitrogenous substance than fat, the milk would carry off 8·32 ℔ in the form of milk-sugar. This amount of milk-sugar, reckoned as fat, would correspond approximately to the difference between the fat in the milk and that in the fattening increase.

It is evident, then, that the drain upon the food is very much greater for the production of milk than for that of meat. This is especially the case in the important item of nitrogenous substance; and if, as is frequently assumed, the butter-fat of the milk is at any rate largely derived from the nitrogenous substance of the food, so far as it is so at least about two parts of such substance would be required to produce one of fat. On such an assumption, therefore, the drain upon the nitrogenous substance of the food would be very much greater than that indicated in the table as existing as nitrogenous substance in the milk. To this point further reference will be made presently.

Attention may next be directed to the amounts of food, and of certain of its constituents, consumed for the production of a given amount of milk. This point is illustrated in Table VI., which shows the constituents consumed per 1000 ℔ live-weight per day in the case of the Rothamsted herd of 30 cows in the spring of 1884. On the left hand are shown the actual amounts of the different foods consumed per 1000 ℔ live-weight per day; and in the respective columns are recorded—first the amounts of total dry substance which the foods contained, and then the amounts of digestible nitrogenous, digestible non-nitrogenous (reckoned as starch), and digestible total organic substance which the different foods would supply; these being calculated according to Lawes and Gilbert's own estimates of the percentage composition of the foods, and to Wolff's estimates of the proportion of the several constituents which would be digestible.

The first column shows that the amount of total dry substance of food actually consumed by the herd, per 1000 ℔ live-weight per day, was scarcely 20 ℔, whilst Wolff's[1] estimated requirement, as stated at the foot of the table, is 24 ℔. But his ration would doubtless consist to a greater extent of hay and straw-chaff, containing a larger proportion of indigestible and effete woody fibre. The figures show, indeed, that the Rothamsted ration supplied, though nearly the same, even a somewhat less amount of total digestible constituents than Wolff's.

TABLE VI. *Constituents consumed per* 1000 ℔ *Live-Weight per Day, for Sustenance and for Milk-Production. The Rothamsted Herd of* 30 *Cows, Spring* 1884.

| | Total Dry Substance. | Digestible. Nitrogenous Substance. | Digestible. Non-Nitrogenous Substance (as Starch). | Digestible. Total Nitrogenous and Non-Nitrogenous Substance. |
|---|---|---|---|---|
| | ℔ | ℔ | ℔ | ℔ |
| 3·1 ℔ Cotton cake . . | 2·76 | 1·07 | 1·50 | 2·57 |
| 2·7 ℔ Bran . . . | 2·33 | 0·33 | 1·09 | 1·42 |
| 2·8 ℔ Hay-chaff . . | 2·34 | 0·15 | 1·18 | 1·33 |
| 5·6 ℔ Oat-straw-chaff . | 4·64 | 0·08 | 2·21 | 2·29 |
| 62·8 ℔ Mangel . . . | 7·85 | 1·01 | 5·73 | 6·74 |
| Total . . | 19·92 | 2·64 * | 11·71 * | 14·35 |
| Required for sustenance . | ... | 0·57 | 7·40 | 7·97 |
| Available for milk . | ... | 2·07 | 4·31 | 6·38 |
| In 23·3 ℔ milk . . . | ... | 0·85 | 3·02 | 3·87 |
| Excess in food . . | ... | 1·22 | 1·29 | 2·51 |
| *Per* 1000 ℔ *Live-Weight.* | | | | |
| | ℔ | ℔ | ℔ | ℔ |
| Wolff . . . . . | 24 | 2·5 | 12·5 † | 15·4 |

* Albuminoid ratio, 1–4·4.
† Exclusive of 0·4 fat; albuminoid ratio, 1–5·4.

Of digestible nitrogen substance, the food supplied 2·64 ℔ per day, whilst the amount estimated to be required for sustenance merely is 0·57 ℔; leaving, therefore, 2·07 ℔ available for milk-production. The 23·3 ℔ of milk yielded per 1000 ℔ live-weight per day would, however, contain only 0·85 ℔; and there would thus remain an apparent excess of 1·22 ℔ of digestible nitrogenous substance in the food supplied. But against the amount of 2·64 ℔ actually consumed, Wolff's estimate of the amount required for sustenance and for milk-production is 2·5 ℔, or but little less than the amount actually consumed at Rothamsted. On the assumption that the expenditure of nitrogenous substance in the production of milk is only in the formation of the nitrogenous substances of the milk, there would appear to have been a considerable excess given in the food. But Wolff's estimate assumes no excess of supply, and that the whole is utilized; the fact being that he supposes the butter-fat of

[1] *Landw. Fütterungslehre*, 5te Aufl., 1888, p. 249.

the milk to have been derived largely, if not wholly, from the albuminoids of the food.

It has been shown that although it is possible that some of the fat of a fattening animal may be produced from the albuminoids of the food, certainly the greater part of it, if not the whole, is derived from the carbohydrates. But the physiological conditions of the production of milk are so different from those for the production of fattening increase, that it is not admissible to judge of the sources of the fat of the one from what may be established in regard to the other. It has been assumed, however, by those who maintain that the fat of the fattening animal is formed from albuminoids, that the fat of milk must be formed in the same way. Disallowing the legitimacy of such a deduction, there do, nevertheless, seem to be reasons for supposing that the fat of milk may, at any rate in large proportion, be derived from albuminoids.

Thus, as compared with fattening increase, which may in a sense be said to be little more than an accumulation of reserve material from excess of food, milk is a special product, of a special gland, for a special normal exigency of the animal. Further, whilst common experience shows that the herbivorous animal becomes the more fat the more, within certain limits, its food is rich in carbohydrates, it points to the conclusion that both the yield of milk and its richness in butter are more connected with a liberal supply of the nitrogenous constituents in the food. Obviously, so far as this is the case, it may be only that thereby more active change in the system, and therefore greater activity of the special function, is maintained. The evidence at command is, at any rate, not inconsistent with the supposition that a good deal of the fat of milk may have its source in the breaking up of albuminoids, but direct evidence on the point is still wanting; and supposing such breaking up to take place in the gland, the question arises—What becomes of the by-products? Assuming, however, that such change does take place, the amount of nitrogenous substance supplied to the Rothamsted cows would be less in excess of the direct requirement for milk-production than the figures in the table would indicate—if, indeed, in excess at all.

The figures in the column of Table VI. relating to the estimated amount of digestible non-nitrogenous substance reckoned as starch show that the quantity actually consumed was 11·71 ℔, whilst the amount estimated by Wolff to be required was 12·5 ℔, besides 0·4 ℔ of fat. The figures further show that, deducting 7·4 ℔ for sustenance from the quantity actually consumed, there would remain 4·31 ℔ available for milk-production, whilst only about 3·02 ℔ would be required supposing that both the fat of the milk and the sugar had been derived from the carbohydrates of the food; and according to this calculation, there would still be an excess in the daily food of 1·29 ℔. It is to be borne in mind, however, that estimates of the requirement for mere sustenance are mainly founded on the results of experiments in which the animals are allowed only such a limited amount of food as will maintain them without either loss or gain when at rest. But physiological considerations point to the conclusion that the expenditure, independently of loss or gain, will be the greater the more liberal the ration; and hence it is probable that the real excess, if any, over that required for sustenance and milk-production would be less than that indicated in the table, which is calculated on the assumption of a fixed requirement for sustenance for a given live-weight of the animal. Supposing that there really was any material excess of either the nitrogenous or the non-nitrogenous constituents supplied over the requirement for sustenance and milk-production, the question arises—Whether, or to what extent, it conduced to increase in live-weight of the animals, or whether it was in part, or wholly, voided, and so wasted?

As regards the influence of the period of the year, with its characteristic changes of food, on the quantity and composition of the milk, the first column of the second division of Table VII. shows the average yield of milk per head per day of the Rothamsted herd, averaging about 42 cows, almost exclusively Shorthorns, in each month of the year, over six years, 1884 to 1889 inclusive; and the succeeding columns show the amounts of butter-fat, of solids not fat, and of total solids in the average yield per head per day in each month of the year, calculated, not according to direct analytical determinations made at Rothamsted, but according to the results of more than 14,000 analyses made, under the superintendence of Dr Vieth, in the laboratory of the Aylesbury Dairy Company in 1884;[1] the samples analysed representing the milk from a great many different farms in each month.

TABLE VII. *Percentage Composition of Milk each Month of the Year; also Average Yield of Milk, and of Constituents, per Head per Day each Month, according to Rothamsted Dairy Records.*

| | Average Composition of Milk each Month, 1884 (Dr Vieth—14,235 analyses). | | | | Rothamsted Dairy. | | | |
|---|---|---|---|---|---|---|---|---|
| | | Per cent. | | | Average Yield of Milk per Head per Day, 6 Years. | Estimated Quantity of Constituents in Milk per Head per Day each Month. | | |
| | Specific Gravity. | Butter-Fat. | Solids not Fat. | Total Solids. | | Butter-Fat. | Solids not Fat. | Total Solids. |
| | | Per cent. | Per cent. | Per cent. | ℔ | ℔ | ℔ | ℔ |
| January . | 1·0325 | 3·55 | 9·34 | 12·89 | 20·31 * | 0·72 | 1·90 | 2·62 |
| February | 1·0325 | 3·53 | 9·24 | 12·77 | 22·81 | 0·80 | 2·11 | 2·91 |
| March . | 1·0323 | 3·50 | 9·22 | 12·72 | 24·19 | 0·85 | 2·23 | 3·08 |
| April . | 1·0323 | 3·43 | 9·22 | 12·65 | 26·50 | 0·91 | 2·44 | 3·35 |
| May . | 1·0324 | 3·34 | 9·30 | 12·64 | 31·31 | 1·05 | 2·91 | 3·96 |
| June . | 1·0323 | 3·31 | 9·19 | 12·50 | 30·81 | 1·02 | 2·83 | 3·85 |
| July . | 1·0319 | 3·47 | 9·13 | 12·60 | 28·00 | 0·97 | 2·56 | 3·53 |
| August . | 1·0318 | 3·87 | 9·08 | 12·95 | 25·00 | 0·97 | 2·27 | 3·24 |
| September | 1·0321 | 4·11 | 9·17 | 13·28 | 22·94 | 0·94 | 2·11 | 3·05 |
| October . | 1·0324 | 4·26 | 9·27 | 13·53 | 21·00 | 0·89 | 1·95 | 2·84 |
| November | 1·0324 | 4·36 | 9·29 | 13·65 | 19·19 | 0·84 | 1·78 | 2·62 |
| December | 1·0326 | 4·10 | 9·29 | 13·39 | 19·31 | 0·79 | 1·79 | 2·58 |
| Mean . | 1·0323 | 3·74 | 9·22 | 12·96 | 24·28 | 0·90 | 2·24 | 3·14 |

* Average over five years only, as the records did not commence until February 1884.

It should be stated that the Rothamsted cows had cake throughout the year; at first 4 ℔ per head per day, but afterwards graduated according to the yield of milk, on the basis of 4 ℔ for a yield of 28 ℔ of milk, the result being that then the amount given averaged more per head per day during the grazing period, but less earlier and later in the year. Bran, hay and straw-chaff, and roots (generally mangel), were also given when the animals were not turned out to grass. The general plan was, therefore, to give cake alone in addition when the cows were turned out to grass, but some other dry food, and roots, when entirely in the shed during the winter and early spring months.

Referring to the column showing the average yield of milk per head per day each month over the six years, it will be seen that during the six months—January, February, September, October, November, and December—the average yield was sometimes below 20 ℔, and on the average only about 21 ℔ of milk per head per day; whilst over the other six months it averaged 27·63 ℔, and over May and June more than 31 ℔, per head

[1] *The Analyst*, April 1885, vol. x. p. 67.

per day. That is to say, the quantity of milk yielded was considerably greater during the grazing period than when the animals had more dry food, and roots instead of grass.

Next, referring to the particulars of composition, according to Dr Vieth's results, which may well be considered as typical for the different periods of the year, it is seen that the specific gravity of the milk was only average, or lower than average, during the grazing period, but rather higher in the earlier and later months of the year. The percentage of total solids was rather lower than the average at the beginning of the year, lowest during the chief grazing months, but considerably higher in the later months of the year, when the animals were kept in the shed and received more dry food. The percentage of butter-fat follows very closely that of the total solids, being the lowest during the best grazing months, but considerably higher than the average during the last four or five months of the year, when more dry food was given. The percentage of solids not fat was considerably the lowest during the later months of the grazing period, but average, or higher than average, during the earlier and later months of the year. It may be observed that, according to the average percentages given in the table, a gallon of milk will contain more of both total solids and of butter-fat in the later months of the year; that is, when there is less grass and more dry food given.

Turning to the last three columns of the table, it is seen that although, as has been shown, the percentage of the several constituents in the milk is lower during the grazing months, the actual amounts contained in the quantity of milk yielded per head are distinctly greater during those months. Thus, the amount of butter fat yielded *per head per day* is above the average of the year from April to September inclusive; the amounts of solids not fat are over average from April to August inclusive; and the amounts of total solids yielded are average, or over average, from April to August inclusive.

From the foregoing results it is evident that the quantity of milk yielded per head is very much the greater during the grazing months of the year, but that the percentage composition of the milk is lower during that period of higher yield, and considerably higher during the months of more exclusively dry-food feeding. Nevertheless, owing to the much greater quantity of milk yielded during the grazing months, the actual quantity of constituents yielded per cow is greater during those months than during the months of higher percentage composition but lower yield of milk per head. It may be added that a careful consideration of the number of newly-calved cows brought into the herd each month shows that the results as above stated were perfectly distinct, independently of any influence of the period of lactation of the different individuals of the herd.

The few results which have been brought forward in relation to *milk-production* are admittedly quite insufficient adequately to illustrate the influence of variation in the quantity and composition of the food on the quantity and composition of the milk yielded. Indeed, owing to the intrinsic difficulties of experimenting on such a subject, involving so many elements of variation, any results obtained have to be interpreted with much care and reservation. Nevertheless, it may be taken as clearly indicated that, within certain limits, high feeding, and especially high nitrogenous feeding, does increase both the yield and the richness of the milk.[1] But it is evident that when high feeding is pushed beyond a comparatively limited range, the tendency is to increase the weight of the animal—that is, to favour the development of the individual, rather than to enhance the activity of the functions connected with the reproductive system. This is, of course, a disadvantage when the object is to maintain the milk-yielding condition of the animal; but when a cow is to be fattened off it will be otherwise.

It has been stated that, early in the period of six years in which the Rothamsted results that have been quoted were obtained, the amount of oil-cake given was graduated according to the yield of milk of each individual cow; as it seemed unreasonable that an animal yielding, say, only four quarts per day, should receive, beside the home foods, as much cake as one yielding several times the quantity. The obvious inference is, that any excess of food beyond that required for sustenance and milk-production would tend to increase the weight of the animal, which, according to the circumstances, may or may not be desirable.

It may be observed that direct experiments at Rothamsted confirm the view, arrived at by common experience, that roots, and especially mangel, have a favourable effect on the flow of milk. Further, the Rothamsted experiments have shown that a higher percentage of butter-fat, of other solids, and of total solids, was obtained with mangel than with silage as the succulent food. The yield of milk was, however, in a much greater degree increased by grazing than by any other change in the food; and at Rothamsted the influence of roots comes next in order to that of grass, though far behind it, in this respect. But with grazing, as has been shown, the percentage composition of the milk is considerably reduced; though, owing to the greatly increased quantity yielded, the amount of soil-constituents removed in the milk when cows are grazing may nevertheless be greater per head per day than under any other conditions. Lastly, it has been clearly illustrated how very much greater is the demand upon the food, especially for nitrogenous and for mineral constituents, in the production of milk than in that of fattening increase.

### Manurial Value of Food consumed in the Production of Milk.

In any attempt to estimate the average value of the manure derived from the consumption of food for the production of milk, the difficulty arising from the very wide variation in the amount of milk yielded by different cows, or by the same cow at different periods of her lactation, is increased by the inadequate character of information concerning the difference in the amount of the food actually consumed by the animal coincidently with the production of such different amounts of milk. But although information is lacking for correlating, with numerical accuracy, the great differences in milk-yield of

[1] The evidence on this point taken by the Committee on Milk and Cream Regulations in 1900 is somewhat conflicting. The report states that an impression commonly prevails that the quality of milk is more or less determined by the nature and composition of the food which the cow receives. One witness said that farmers who produce milk for sale feed differently from what they do if they are producing for butter. Another stated that most of the statistics which go to show that food has no effect on milk fail, because the experiments are not carried far enough to counterbalance that peculiarity of the animal first to utilize the food for itself before utilizing it for the milk. A witness who kept a herd of 100 milking cows expressed the opinion that improvement in the quality of milk can be effected by feeding, though not to any large extent. On the other hand, it was maintained that the fat percentage in the milk of a cow cannot be raised by any manner or method of feeding. It is possible that in the case of cows very poorly fed the addition of rich food would alter the composition of their milk, but if the cows are well-fed to begin with, this would not be so. The proprietor of a herd of 500 milking cows did not think that feeding affected the quality of milk from ordinarily well-kept animals. An experimenter found that the result of resorting to rather poor feeding was that the first effect was produced upon the weight of the cow and not upon the milk; the animal began to get thin, losing its weight, though there was not very much effect upon the quality of the milk.

individual cows with the coincident differences in consumption to produce it, it may be considered as satisfactorily established that more food is consumed by a herd of cows to produce a fair yield of milk, of say 10 or 12 quarts per head per day, than by an equal live-weight of oxen fed to produce fattening increase. In the cases supposed it may, for practical purposes, be assumed that the cows would consume about one-fourth more food than the oxen. Accordingly, in the Rothamsted estimates of the value of the manure obtained on the consumption of food for the production of milk, it is assumed that one-fourth more will be consumed by 1000 ℔ live-weight of cows than by the same weight of oxen; but the estimates of the amounts of the constituents of the food removed in the milk, or remaining for manure, are nevertheless reckoned per ton of each kind of food consumed, as in the case of those relating to feeding for the production of fattening increase. It may be added that the calculations of the amounts of the constituents in the milk are based on the same average composition of milk as is adopted in the construction of Table V. Thus the nitrogen is taken at 0·579 (=3·65 nitrogenous substance) per cent., the phosphoric acid at 0·2175 per cent., and the potash at 0·1875 per cent. in the milk.

Table VIII. shows in detail the estimate of the amount of nitrogen in one ton of each food, and in the milk produced from its consumption, on the assumption of an average yield of 10 quarts per head per day; also the

TABLE VIII. *Estimates of the Total or Original Manure-Value of Cattle Foods after Consumption by Cows for the Production of Milk. Valuations on the assumption of an average production by a herd of* 10 *quarts of milk per head per day.*

| Nos. | Description of Food. | Nitrogen. | | | | | Phosphoric Acid. | | | | Potash. | | | | Total or Original Manure-Value per Ton of Food consumed. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | In 1 Ton of Food. | In Milk from 1 Ton of Food. | In Manure. | | | In 1 Ton of Food. | In Milk from 1 Ton of Food. | In Manure. | | In 1 Ton of Food. | In Milk from 1 Ton of Food. | In Manure. | | |
| | | | | Total remaining for Manure. | Nitrogen equal Ammonia | Value of Ammonia at 4d. per ℔. | | | Total remaining for Manure. | Value at 2d. per ℔. | | | Total remaining for Manure. | Value at 1½d. per ℔. | |
| | | ℔ | ℔ | ℔ | ℔ | £ s. d. | ℔ | ℔ | ℔ | s. d. | ℔ | ℔ | ℔ | s. d. | £ s d. |
| 1 | Linseed | 80·64 | 25·04 | 55·60 | 67·52 | 1 2 6 | 34·50 | 9·34 | 25·16 | 4 2 | 30·69 | 8·02 | 22·67 | 2 10 | 1 9 6 |
| 2 | Linseed cake | 106·40 | 20·86 | 85·54 | 103·87 | 1 14 7 | 44·80 | 7·79 | 37·01 | 6 2 | 31·36 | 6·71 | 24·65 | 3 1 | 2 3 10 |
| 3 | Decorticated cotton cake | 147·84 | 19·27 | 128·57 | 156·13 | 2 12 1 | 69·44 | 7·18 | 62·26 | 10 5 | 44·80 | 6·22 | 38·58 | 4 10 | 3 7 4 |
| 4 | Palm-nut cake | 56·00 | 17·86 | 38·14 | 46 31 | 0 15 5 | 26·88 | 6·68 | 20·20 | 3 4 | 11·20 | 5·73 | 5·47 | 0 8 | 0 19 5 |
| 5 | Undecorticated cotton cake | 84·00 | 15·66 | 68·34 | 82·99 | 1 7 8 | 44·80 | 5·85 | 38·95 | 6 6 | 44·80 | 5·07 | 39·73 | 5 0 | 1 19 2 |
| 6 | Cocoa-nut cake | 76·16 | 15·66 | 60·50 | 73·47 | 1 4 6 | 31·36 | 5·85 | 25·51 | 4 3 | 44·80 | 5·07 | 39·73 | 5 0 | 1 13 9 |
| 7 | Rape cake | 109·76 | 12·50 | 97·26 | 118·11 | 1 19 4 | 56·00 | 4 69 | 51·31 | 8 7 | 33·60 | 4·09 | 29·51 | 3 8 | 2 11 7 |
| 8 | Peas | 80·64 | 17·86 | 62·78 | 76·24 | 1 5 5 | 19·04 | 6·68 | 12·36 | 2 1 | 21·50 | 5·73 | 15·77 | 2 0 | 1 9 6 |
| 9 | Beans | 89·60 | 17·86 | 71·74 | 87·12 | 1 9 0 | 24·64 | 6·68 | 17·96 | 3 0 | 29·12 | 5·73 | 23·39 | 2 11 | 1 14 11 |
| 10 | Lentils | 94·08 | 17·86 | 76·22 | 92·56 | 1 10 10 | 16·80 | 6·68 | 10·12 | 1 8 | 15·68 | 5·73 | 9·95 | 1 3 | 1 13 9 |
| 11 | Tares (seed) | 94·08 | 17·86 | 76·22 | 92·56 | 1 10 10 | 17·92 | 6·68 | 11·24 | 1 10 | 17·92 | 5·73 | 12·19 | 1 6 | 1 14 2 |
| 12 | Maize | 38·08 | 17·38 | 20·70 | 25·14 | 0 8 5 | 13·44 | 6·50 | 6·94 | 1 2 | 8·29 | 5·56 | 2·73 | 0 4 | 0 9 11 |
| 13 | Wheat | 40·32 | 17·38 | 22·94 | 27·86 | 0 9 3 | 19·04 | 6·50 | 12·54 | 2 1 | 11·87 | 5·56 | 6·31 | 0 9 | 0 12 1 |
| 14 | Malt | 38·08 | 17·86 | 20·22 | 24·55 | 0 8 2 | 17·92 | 6·68 | 11·24 | 1 10 | 11·20 | 5·73 | 5·47 | 0 8 | 0 10 8 |
| 15 | Barley | 36·96 | 17·38 | 19·58 | 23·78 | 0 7 11 | 16·80 | 6·50 | 10·30 | 1 9 | 12·32 | 5·56 | 6·76 | 0 10 | 0 10 6 |
| 16 | Oats | 44·80 | 16·68 | 28·12 | 34·15 | 0 11 5 | 13·44 | 6·24 | 7·20 | 1 2 | 11·20 | 5·40 | 5·80 | 0 9 | 0 13 4 |
| 17 | Rice meal | 42·56 | 16·68 | 25·88 | 31·43 | 0 10 6 | (13·44) | 6·24 | 7·20 | 1 2 | (8·29) | 5·40 | 2·89 | 0 4 | 0 12 0 |
| 18 | Locust beans | 26·88 | 13·90 | 12·98 | 15·76 | 0 5 3 | ... | 5·19 | ... | ... | ... | 4·42 | .. | ... | ... |
| 19 | Malt coombs | 87·36 | 15·66 | 71·70 | 87·07 | 1 9 0 | 44·80 | 5·85 | 38·95 | 6 6 | 44·80 | 5·07 | 39·73 | 5 0 | 2 0 6 |
| 20 | Fine pollard | 54·88 | 16·68 | 38·20 | 46·39 | 0 15 6 | 64·96 | 6·24 | 58·72 | 9 9 | 32·70 | 5·40 | 27·30 | 3 5 | 1 8 8 |
| 21 | Coarse pollard | 56·00 | 15·66 | 40·34 | 48·99 | 0 16 4 | 78·40 | 5·85 | 72·55 | 12 1 | 33·60 | 5·07 | 28·53 | 3 7 | 1 12 0 |
| 22 | Bran | 56·00 | 13·90 | 42·10 | 51·12 | 0 17 0 | 80·64 | 5·19 | 75·45 | 12 7 | 32·48 | 4·42 | 28·06 | 3 6 | 1 13 1 |
| 23 | Clover hay | 53·76 | 8·94 | 44·82 | 54·43 | 0 18 2 | 12·77 | 3·35 | 9·42 | 1 7 | 33·60 | 2·94 | 30·66 | 3 10 | 1 3 7 |
| 24 | Meadow hay | 33·60 | 8·36 | 25·24 | 30·65 | 0 10 3 | 8·96 | 3·10 | 5·86 | 1 0 | 35·84 | 2·62 | 33·22 | 4 2 | 0 15 5 |
| 25 | Pea straw | 22·40 | 7·83 | 14·57 | 17·69 | 0 5 11 | 7·84 | 2·91 | 4·93 | 0 10 | 22·40 | 2·46 | 19·94 | 2 6 | 0 9 3 |
| 26 | Oat straw | 11·20 | 6·95 | 4·25 | 5·16 | 0 1 9 | 5·38 | 2·60 | 2·78 | 0 6 | 22·40 | 2·29 | 20·11 | 2 6 | 0 4 9 |
| 27 | Wheat straw | 10·08 | 5·98 | 4·10 | 4·98 | 0 1 8 | 5·38 | 2·23 | 3·15 | 0 6 | 17·92 | 1·96 | 15·96 | 2 0 | 0 4 2 |
| 28 | Barley straw | 8·96 | 5·46 | 3·50 | 4·25 | 0 1 5 | 4·03 | 2·04 | 1·99 | 0 4 | 22·40 | 1·80 | 20·60 | 2 7 | 0 4 4 |
| 29 | Bean straw | 20·16 | 5·68 | 14·48 | 17·58 | 0 5 10 | 6·72 | 2·14 | 4·58 | 0 9 | 22·40 | 1·80 | 20·60 | 2 7 | 0 9 2 |
| 30 | Potatoes | 5·60 | 2·07 | 3·53 | 4·29 | 0 1 5 | 3·36 | 0·78 | 2·58 | 0 5 | 12·32 | 0·66 | 11·66 | 1 5 | 0 3 3 |
| 31 | Carrots | 4·48 | 1·46 | 3·02 | 3·67 | 0 1 3 | 2·02 | 0·54 | 1·48 | 0 3 | 6·27 | 0·49 | 5·78 | 0 9 | 0 2 3 |
| 32 | Parsnips | 4·93 | 1·67 | 3·26 | 3·96 | 0 1 4 | 4·26 | 0·63 | 3·63 | 0 7 | 8·06 | 0·49 | 7·57 | 0 11 | 0 2 10 |
| 33 | Mangel wurzels | 4·93 | 1·32 | 3·61 | 4·38 | 0 1 6 | 1·57 | 0·49 | 1·08 | 0 2 | 8·96 | 0·49 | 8·47 | 1 1 | 0 2 9 |
| 34 | Swedish turnips | 5·60 | 1·14 | 4·46 | 5·42 | 0 1 10 | 1·34 | 0·44 | 0·90 | 0 2 | 4·93 | 0·33 | 4·60 | 0 7 | 0 2 7 |
| 35 | Yellow turnips | 4·48 | 0·93 | 3·55 | 4·31 | 0 1 5 | (1·34) | 0·34 | 1·00 | 0 2 | (4·93) | 0·33 | (4·60) | 0 7 | 0 2 2 |
| 36 | White turnips | 4·03 | 0·84 | 3·19 | 3·87 | 0 1 3 | 1·12 | 0·31 | 0·81 | 0 2 | 6·72 | 0·33 | 6·39 | 0 10 | 0 2 3 |

amount remaining for manure, the amount of ammonia corresponding to the nitrogen, and the value of the ammonia at 4d. per ℔. Similar particulars are also given in relation to the phosphoric acid and the potash consumed in the food, removed in the milk, and remaining for manure, &c. This table will serve as a sufficient illustration of the mode of estimating the *total or original* value of the manure, derived from the consumption of the different foods for the production of milk in the case supposed; that is, assuming an average yield of a herd of 10 quarts per head per day.

In Table IX. are given the results of similar detailed calculations of the *total or original* manure-value (as in Table VIII. for 10 quarts), on the alternative assumptions

of a yield of 6, 8, 12, and 14 quarts per head per day. For comparison there is also given, in the first column, the estimate of the *total or original* manure-value when the foods are consumed for the production of fattening increase.

So much for the plan and results of the estimations of *total or original* manure-value of the different foods, that is, deducting only the constituents removed in the milk, and reckoning the remainder at the prices at which they can be purchased in artificial manures. With a view to direct application to practice, however, it is necessary to estimate the *unexhausted manure-value* of the different foods, or what may be called their *compensation-value*, after they have been used for a series of years by the outgoing tenant and he has realized a certain portion of the manure-value in his increased crops. In the calculations for this purpose the rule is to deduct one-half of the *original manure-value* of the food used the last year, and one-third of the remainder each year to the eighth, in the case of all the more concentrated foods, and of the roots—in fact, of all the foods in the list excepting the hays and the straws. For these, which contain larger amounts of indigestible matter, and the constituents of which will be more slowly available to crops, two-thirds of the *original manure-value* is deducted for the last year, and only one-fifth from year to year to the eighth year back. The results of the estimates of *compensation-value* so made are given for the five yields of 6, 8, 10, 12, and 14 quarts of milk per head per day respectively in Lawes and Gilbert's paper[1] on the valuation of the manures obtained by the consumption of foods for the production of milk, which may be consulted for fuller details. It must, however, be borne in mind that when cows are fed in sheds or yards the manure is generally liable to greater losses than is the case with fattening oxen. The manure of the cow contains much more water in proportion to solid matter than that of the ox. Water will, besides, frequently be used for washing, and it may be that a good deal of the manure is washed into drains and lost. In the event, therefore, of a claim for compensation, the management and disposal of the manure requires the attention of the valuer. Indeed, the varying circumstances that will arise in practice must be carefully considered. Bearing these in mind, the estimates may be accepted as at any rate the best approximation to the truth that existing knowledge provides; and they should be found sufficient for the requirements of practical use. Obviously they will be more directly applicable in the case of cows feeding entirely on the foods enumerated in the list, and not depending largely on grass; but, even when the animals are partially grass-fed, the value of the manure derived from the additional dry food, or roots, may be estimated according to the scale given. The whole question is more fully dealt with under AGRICULTURE.

TABLE IX. *Comparison of the Estimates of Total or Original Manure-Value, when Foods are consumed for the Production of Fattening Increase, with those when the Food is consumed by Cows giving different Yields of Milk.*

| Nos | Description of Food | Total or Original Manure-Value per Ton of Food consumed—that is, deducting the constituents removed in the Fattening Increase or in Milk. | | | | | |
|---|---|---|---|---|---|---|---|
| | | For the Production of Fattening Increase | For the Production of Milk, supposing the Yield per Head per Day to be as under— | | | | |
| | | | 6 quarts | 8 quarts. | 10 quarts | 12 quarts | 14 quarts. |
| | | £ s. d | £ s d | £ s. d | £ s. d | £ s d. | £ s d |
| 1 | Linseed | 1 19 2 | 1 14 7 | 1 12 0 | 1 9 6 | 1 7 1 | 1 4 5 |
| 2 | Linseed cake | 2 11 11 | 2 8 1 | 2 6 0 | 2 3 10 | 2 1 9 | 1 19 8 |
| 3 | Decorticated cotton cake | 3 14 9 | 3 11 2 | 3 9 2 | 3 7 4 | 3 5 4 | 3 3 4 |
| 4 | Palm-nut cake | 1 6 4 | 1 3 2 | 1 1 4 | 0 19 5 | 0 17 9 | 0 15 11 |
| 5 | Undecorticated cotton cake | 2 5 3 | 2 2 4 | 2 0 8 | 1 19 2 | 1 17 6 | 1 15 11 |
| 6 | Cocoa-nut cake | 1 19 10 | 1 16 11 | 1 15 3 | 1 13 9 | 1 12 3 | 1 10 6 |
| 7 | Rape cake | 2 16 5 | 2 14 2 | 2 12 11 | 2 11 7 | 2 10 4 | 2 9 1 |
| 8 | Peas | 1 16 5 | 1 13 1 | 1 11 2 | 1 9 6 | 1 7 8 | 1 5 9 |
| 9 | Beans | 2 1 11 | 1 18 7 | 1 16 10 | 1 14 11 | 1 13 1 | 1 11 4 |
| 10 | Lentils | 2 0 8 | 1 17 5 | 1 15 7 | 1 13 9 | 1 12 2 | 1 10 1 |
| 11 | Tares (seed) | 2 1 1 | 1 17 11 | 1 16 0 | 1 14 2 | 1 12 6 | 1 10 7 |
| 12 | Maize | 0 16 7 | 0 13 4 | 0 11 7 | 0 9 11 | 0 8 1 | 0 6 5 |
| 13 | Wheat | 0 18 11 | 0 15 8 | 0 13 11 | 0 12 1 | 0 10 5 | 0 8 8 |
| 14 | Malt | 0 17 7 | 0 14 5 | 0 12 7 | 0 10 8 | 0 9 0 | 0 7 1 |
| 15 | Barley | 0 17 2 | 0 14 0 | 0 12 3 | 0 10 6 | 0 8 8 | 0 6 11 |
| 16 | Oats | 0 19 9 | 0 16 8 | 0 15 0 | 0 13 4 | 0 11 7 | 0 9 10 |
| 17 | Rice meal | (0 18 6) | 0 15 5 | 0 13 9 | 0 12 0 | 0 10 5 | 0 8 7 |
| 18 | Locust beans | ... | ... | ... | ... | ... | ... |
| 19 | Malt coombs | 2 6 7 | 2 3 9 | 2 2 0 | 2 0 6 | 1 18 11 | 1 17 4 |
| 20 | Fine pollard | 1 15 2 | 1 12 0 | 1 10 5 | 1 8 8 | 1 6 11 | 1 5 3 |
| 21 | Coarse pollard | 1 18 1 | 1 15 2 | 1 13 6 | 1 12 0 | 1 10 5 | 1 8 9 |
| 22 | Bran | 1 18 6 | 1 15 11 | 1 14 6 | 1 13 1 | 1 11 8 | 1 10 3 |
| 23 | Clover hay | 1 7 0 | 1 5 5 | 1 4 5 | 1 3 7 | 1 2 8 | 1 1 8 |
| 24 | Meadow hay | 0 18 7 | 0 17 0 | 0 16 3 | 0 15 5 | 0 14 5 | 0 13 7 |
| 25 | Pea straw | 0 12 2 | 0 10 9 | 0 10 0 | 0 9 3 | 0 8 5 | 0 7 8 |
| 26 | Oat straw | 0 7 5 | 0 6 2 | 0 5 5 | 0 4 9 | 0 4 0 | 0 3 3 |
| 27 | Wheat straw | 0 6 6 | 0 5 5 | 0 4 10 | 0 4 2 | 0 3 6 | 0 3 0 |
| 28 | Barley straw | 0 6 5 | 0 5 6 | 0 4 10 | 0 4 4 | 0 3 9 | 0 3 2 |
| 29 | Bean straw | 0 11 5 | 0 10 4 | 0 9 9 | 0 9 2 | 0 8 7 | 0 8 0 |
| 30 | Potatoes | 0 4 1 | 0 3 9 | 0 3 6 | 0 3 3 | 0 3 1 | 0 2 11 |
| 31 | Carrots | 0 2 9 | 0 2 6 | 0 2 4 | 0 2 3 | 0 2 1 | 0 1 11 |
| 32 | Parsnips | 0 3 6 | 0 3 3 | 0 3 1 | 0 2 10 | 0 2 8 | 0 2 7 |
| 33 | Mangel wurzels | 0 3 2 | 0 3 0 | 0 2 10 | 0 2 9 | 0 2 7 | 0 2 5 |
| 34 | Swedish turnips | 0 2 11 | 0 2 9 | 0 2 8 | 0 2 7 | 0 2 5 | 0 2 3 |
| 35 | Yellow turnips | (0 2 6) | 0 2 4 | 0 2 3 | 0 2 2 | 0 2 1 | 0 2 0 |
| 36 | White turnips | 0 2 7 | 0 2 5 | 0 2 4 | 0 2 3 | 0 2 2 | 0 2 0 |

## CHEESE AND CHEESE-MAKING.

For generations, perhaps for centuries, the question has been discussed as to why there should be so large a proportion of bad and inferior cheese and so small a proportion of really good cheese made in farmhouses throughout the land. That the result is not wholly due to skill and care, or to the absence of these qualities, on the part of the dairymaid may now be taken for granted. Instances might be quoted in which the most painstaking of dairymaids, in the cleanest of dairies, have failed to produce cheese of even second-rate quality and character, and yet others in which excellent cheese has been made under commonplace conditions as to skill and equipment, and with not much regard to cleanliness in the dairy. The explanation of what was so long a mystery has been found in the domain of ferments. It is now known that whilst various micro-organisms, which in many dairies have free access to the milk, have ruined an incalculable quantity of cheese—and of butter also—neither cheese nor butter of first-rate quality can be made without the aid of lactic acid bacilli. As an illustrative case, mention may be made of that of two most painstaking dairymaids who had tried in vain to make good cheese from the freshest of milk in the cleanest of dairies in North Lancashire. Advice to resort to the use of the ferment was acted upon, and the result was a revelation and a transformation, excellent prize-winning cheese being made from that time forward. By the addition of a "starter," in the form of a small quantity of sour milk, whey, or buttermilk, in an advanced stage of fermentation, the development of acidity in the main body of milk is accelerated. It has been ascertained that the starter is practically a culture of bacteria, which, if desired, may be obtained as a pure culture. Professor J. R. Campbell, as the result of recent experiments on pure cultures for Cheddar cheese-making, states[2] that (1) first-class Cheddar cheese can be made by using pure cultures of a lactic organism; (2) this organism abounds in all samples of sour milk and sour whey; (3) the use of a whey starter is attended with results equal in every respect to those obtained from a milk-starter. It is well within

[1] *Journ. Roy. Agric. Soc.*, 1898.
[2] *Trans. Highl. and Agric. Soc. Scot.*, 1899.

the power of any dairyman to prepare what is practically a pure culture of the same bacterium as is supplied from the laboratory. Moreover, the sour-whey starter used by some of the successful cheese-makers before the introduction of the American system is in effect a pure culture, from which it follows that these men had, by empirical methods, attained the same end as that to which bacteriological research subsequently led. Wherever a starter is necessary, the use of a culture practically pure is imperative, whether such culture be obtained from the laboratory or prepared by what may be called the "home-made starter." Pure cultures may be bought for a few shillings in the open market.

The factory-made cheese of Canada, the United States, and Australasia, which is so largely imported into the United Kingdom, is all of the Cheddar type. The factory system has made no headway in the original home of the Cheddar cheese in the West of England. The system was thus described in the *Journal* of the British Dairy Farmers' Association in 1889 by Mr R. J. Drummond:—

"In the year 1885 I was engaged as cheese instructor by the Ayrshire Dairy Association, to teach the Canadian system of Cheddar cheese-making. I commenced operations under many difficulties, being a total stranger to both the people and the country, and with this, the quantities of milk were very much less than I had been in the habit of handling. Instead of having the milk from 500 to 1000 cows, we had to operate with the milk from 25 to not over 60 cows.

"The system of cheese-making commonly practised in the county of Ayr at that time was what is commonly known as the Joseph Harding or English Cheddar system, which differs from the Canadian system in many details, and in one particular is essentially different, namely, the manner in which the necessary acidity in the milk is produced. In the old method a certain quantity of sour whey was added to the milk each day before adding the rennet, and I have no doubt in my own mind that this whey was often added when the milk was already acid enough, and the consequence was a spoiled cheese.

"Another objection to this system of adding sour whey was, should the stuff be out of condition one day, the same trouble was inoculated with the milk from day to day, and the result was sure to be great unevenness in the quality of the cheese. The utensils commonly in use were very different to anything I had ever seen before; instead of the oblong cheese vat with double casings, as is used by all the best makers at the present time, a tub, sometimes of tin and sometimes of wood, from 4 to 7 feet in diameter by about 30 inches deep, was universally in use. Instead of being able to heat the milk with warm water or steam, as is commonly done now, a large can of a capacity of from 20 to 30 gallons was filled with cold milk and placed in a common hot-water boiler, and heated sufficiently to bring the whole body of milk in the tub to the desired temperature for adding the rennet. I found that many mistakes were made in the quantity of rennet used, as scarcely any two makers used the same quantity to a given quantity of milk. Instead of having a graduated measure for measuring the rennet, a common tea-cup was used for this purpose, and I have found in some dairies as low as 3 oz. of rennet was used to 100 gallons of milk, where in others as high as 6½ oz. was used to the same quantity. This of itself would cause a difference in the quality of the cheese.

"Coagulation and breaking completed, the second heating was effected by dipping the whey from the curd into the can already mentioned, and heated to a temperature of 140° F., and returned to the curd, and thus the process was carried on till the desired temperature was reached. This mode of heating I considered very laborious and at the same time very unsatisfactory, as it is impossible to distribute the heat as evenly through the curd in this way as by heating either with hot water or steam. The other general features of the method do not differ from our own very materially, with the exception that in the old method the curd was allowed to mature in the bottom of the tub, where at the same stage we remove the curd from the vat to what we call a curd-cooler made with a sparred bottom, so as to allow the whey to separate from the curd during the maturing or ripening process. In regard to the quality of cheese on the one method compared with the other, I think that there was some cheese just as fine made in the old way as anything we can possibly make in the new, with one exception, and that is, that the cheese made according to the old method will not toast—instead of the casein melting down with the butter-fat, the two become separated, which is very much objected to by the consumer—and, with this, want of uniformity through the whole dairy. This is a very short and imperfect description of how the cheese was made at the time I came into Ayrshire; and I will now give a short description of the system that has been taught by myself for the past four years, and has been the means of bringing this county so prominently to the front as one of the best cheese-making counties in Britain.

"Our duty in this system of cheese-making begins the night before, in having the milk properly set and cooled according to the temperature of the atmosphere, so as to arrive at a given heat the next morning. Our object in this is to secure, at the time we wish to begin work in the morning, that degree of acidity or ripeness essential to the success of the whole operation. We cannot give any definite guide to makers how, or in what quantities, to set their milk, as the whole thing depends on the good judgment of the operator. If he finds that his milk works best at a temperature of 68° F. in the morning, his study the night before should tend toward such a result, and he will soon learn by experience how best to manage the milk in his own individual dairy. I have found in some dairies that the milk worked quite fast enough at a temperature of 64° in the morning, where in others the milk set in the same way would be very much out of condition by being too sweet, causing hours of delay before matured enough to add the rennet. Great care should be taken at this point, making sure that the milk is properly matured before the rennet is added, as impatience at this stage often causes hours of delay in the making of a cheese. I advise taking about six hours from the time the rennet is added till the curd is ready for salting, which means a six-hours process; if much longer than this, I have found by experience that it is impossible to obtain the best results. The cream should always be removed from the night's milk in the morning and heated to a temperature of about 84° before returning it to the vat. To do this properly and with safety, the cream should be heated by adding about two-thirds of warm milk as it comes from the cow to one-third of cream, and passed through the ordinary milk-strainers. If colouring matter is used, it should be added fifteen to twenty minutes before the rennet, so as to become thoroughly mingled with the milk before coagulation takes place.

"We use from 4 to 4½ oz. of Hansen's rennet extract to each 100 gallons of milk, at a temperature of 86° in spring and 84° in summer, or sufficient to coagulate milk firm enough to cut in about forty minutes when in a proper condition. In cutting, great care should be taken not to bruise the curd. I cut lengthwise, then across with perpendicular knife, then with horizontal knife the same way as the perpendicular, leaving the curd in small cubes about the size of ordinary peas. Stirring with the hands should begin immediately after cutting, and continue for ten to fifteen minutes prior to the application of heat. At this stage we use a rake instead of the hands for stirring the curd during the heating process, which lasts about one hour from time of beginning until the desired temperature of 100° or 102° is reached. After heating, the curd should be stirred another twenty minutes, so as to become properly firm before allowing it to settle. We like the curd to lie in the whey fully one hour after allowing it to settle before it is ready for drawing the whey, which is regulated altogether by the condition of the milk at the time the rennet is added. At the first indication of acid, the whey should be removed as quickly as possible. I think at this point lies the greatest secret of cheese-making—to know when to draw the whey.

"I depend entirely on the hot-iron test at this stage, as I consider it the most accurate and reliable guide known to determine when the proper acidity has been developed. To apply this test, take a piece of steel bar about 18 inches long by an inch wide and ¼ inch thick, and heat to a black heat: if the iron is too hot, it will burn the curd; if too cold, it will not stick; consequently it is a very simple matter to determine the proper heat. Take a small quantity of the curd from the vat and compress it tightly in the hand, so as to expel all the whey; press the curd against the iron, and when acid enough it will draw fine silky threads ¼ inch long. At this stage the curd should be removed to the curd-cooler as quickly as possible, and stirred till dry enough to allow it to mat, which generally takes from five to eight minutes. The curd is now allowed to stand in one end of the cooler for thirty minutes, when it is cut into pieces from 6 to 8 inches square and turned, and so on every half-hour until it is fit for milling. After removing the whey, a new acid makes its appearance in the body of the curd which seems to depend for its development upon the action of the air, and the presence of which experience has shown to be an essential element in the making of a cheese. This acid should be allowed to develop properly before the addition of salt. To determine when the curd is ready for salting, the hot-iron test is again resorted to; and when the curd will draw fine silky threads 1½ inch long, and at the same time have a soft velvety feel when pressed in the hand, the butter-fat will not separate with the whey from the curd. I generally advise using 1 ℔ of salt to 50 ℔ of curd, more or less, according to the condition of the curd. After salting, we let the curd lie fifteen minutes, so as to allow the salt to be thoroughly dissolved before pressing.

"In the pressing, care should be taken not to press the curd too severely at first, as you are apt to lose some of the butter-fat, and

with this I do not think that the whey will come away so freely by heavy pressing at first. We advise three days' pressing before cheese is taken to the curing-room. All cheese should have a bath in water at a temperature of 120° next morning after being made, so as to form a good skin to prevent cracking or chipping. The temperature of the curing-room should be kept as near 60° as possible at all seasons of the year, and I think it a good plan to ventilate while heating."

With regard to the hot-iron test for acidity, Mr F. J. Lloyd, in describing his investigations on behalf of the Bath and West of England Society, states that cheese-makers have long known that in both the manufacture and the ripening of cheese the acidity produced—known to the chemist as "lactic acid"—materially influences the results obtained, and that amongst other drawbacks to the test referred to is the uncertainty of the temperature of the iron itself. He gives an account,[1] however, of a chemical method involving the use of a standard solution of an alkali (soda), and of a substance termed an "indicator" (phenolphthalein), which changes colour according to whether a solution is acid or alkaline. The apparatus used with these reagents is called the acidimeter. The two stages in the manufacture of a Cheddar cheese most difficult to determine empirically are (1) when to stop stirring and to draw the whey, and (2) when to grind the curd. The introduction of the acidimeter has done away with these difficulties; and though the use of this apparatus is not actually a condition essential to the manufacture of a good cheese, it is to many makers a necessity and to all an advantage. By its use the cheese-maker can determine the acidity of the whey, and so decide when to draw the latter off, and will thus secure not only the proper development of acidity in the subsequent changes of cheese-making, but also materially diminish the time which the cheese takes to make. Furthermore, it has been proved that the acidity of the whey which drains from the curd when in the cooler is a sufficiently accurate guide to the condition of the curd before grinding; and by securing uniformity in this acidity the maker will also ensure uniformity in the quality and ripening properties of the cheese. Speaking generally, the acidity of the liquid from the press should never fall below 0·80 per cent. nor rise above 1·20 per cent., and the nearer it can be kept to 1·00 per cent. the better. Simultaneously, of course, strict attention must be paid to temperature, time, and every other factor which can be accurately determined. Analyses of large numbers of Cheddar cheeses manufactured in every month of the cheese-making season show the average composition of ripe specimens to be—water, 35·58 per cent.; fat, 31·33; casein, 29·12; mineral matter or ash, 3·97. It has been maintained that in the ripening of Cheddar cheese fat is formed out of the curd, but a comparison of analyses of ripe cheeses with analyses of the curd from which the cheeses were made affords no evidence that this is the case.

The quantity of milk required to make 1 ℔ of Cheddar cheese may be learnt from Table X., which shows the results obtained at the cheese school of the Bath and West of England Society in the two seasons of 1899 and 1900. The cheese was sold at an average age of ten to twelve weeks. In 1899 a total of 21,220 gallons of milk yielded 20,537 ℔ of saleable cheese, and in 1900, 31,808 gallons yielded 29,631 ℔. In the two years together 53,028 gallons yielded 50,168 ℔, which is equivalent to 1·05 gallon of milk to 1 ℔ of cheese. For practical purposes it may be taken that one gallon, or slightly over 10 ℔, of milk yields 1 ℔ of pressed cheese. The prices obtained are added as a matter of interest.

Cheshire cheese is largely made in the county from which it takes its name, and in adjoining districts. It is extensively consumed in Manchester and Liverpool, and other parts of the densely populated county of Lancaster.

TABLE X. *Quantities of Milk employed and of Cheese produced in the Manufacture of Cheddar Cheese.*

| When Made. | Milk. | Green Cheese. | Saleable Cheese. | Shrinkage. | Price. |
|---|---|---|---|---|---|
| 1899. | galls. | ℔ | ℔ | | per cwt |
| April . . | 3077 | 3100 | 2924 | 6 per cent. | 60s. |
| May . . | 4462 | 4502 | 4257 | $6\frac{1}{2}$ ℔ per cwt. | 63s. |
| June . . | 4316 | 4434 | 4141 | 7 ℔ 6 oz. per cwt. | 70s. |
| July . . | 3699 | 3785 | 3545 | 7 ℔ 2 oz. per cwt. | 74s. |
| August . . | 2495 | 2539 | 2353 | 8 ℔ 3 oz. per cwt. | 74s. |
| Sept. and Oct. | 3171 | 3583 | 3317 | 8 ℔ 5 oz. per cwt. | 74s. |
| 1900. | | | | | |
| April . . | 3651 | 3505 | 3292 | 6 per cent. | 63s. |
| May . . | 6027 | 6048 | 5577 | $7\frac{3}{4}$ per cent. | 64s. |
| June . . | 5960 | 5889 | 5466 | $7\frac{1}{4}$ per cent. | 68s. |
| July and Aug. | 7227 | 7177 | 6630 | $7\frac{1}{2}$ per cent. | 66s. |
| Sept. and Oct. | 8943 | 9635 | 8666 | 10 per cent. | 66s. |

The following is a description of the making of Cheshire cheese:—

The evening's milk is set apart until the following morning, when the cream is skimmed off. The latter is poured into a pan which has been heated by being placed in the boiling water of a boiler. The new milk obtained early in the morning is poured into the vessel containing the previous evening's milk with the warmed cream, and the temperature of the mixture is brought to about 75° F. Into the vessel is introduced a piece of rennet, which has been kept in warm water since the preceding evening, and in which a little Spanish annatto (a quarter of an ounce is enough for a cheese of 60 ℔) is dissolved. (Marigolds, boiled in milk, are occasionally used for colouring cheese, to which they likewise impart a pleasant flavour. In winter, carrots scraped and boiled in milk, and afterwards strained, will produce a richer colour; but they should be used with moderation, on account of their taste.) The whole is now stirred together, and covered up warm for about an hour, or until it becomes curdled; it is then turned over with a bowl and broken very small. After standing a little time, the whey is drawn from it, and as soon as the curd becomes somewhat more solid it is cut into slices and turned over repeatedly, the better to press out the whey.

The curd is then removed from the tub, broken by hand or cut by a curd-breaker into small pieces, and put into a cheese vat, where it is strongly pressed both by hand and with weights, in order to extract the remaining whey. After this it is transferred to another vat, or into the same if it has in the meantime been well scalded, where a similar process of breaking and expressing is repeated, until all the whey is forced from it. The cheese is now turned into a third vat, previously warmed, with a cloth beneath it, and a thin hoop or binder put round the upper edge of the cheese and within the sides of the vat, the cheese itself being previously enclosed in a clean cloth, and its edges placed within the vat, before transfer to the cheese-oven. These various processes occupy about six hours, and eight more are requisite for pressing the cheese, under a weight of 14 or 15 cwt. The cheese during that time should be twice turned in the vat. Holes are bored in the vat which contains the cheese, and also in the cover of it, to facilitate the extraction of every drop of whey. The pressure being continued, the cheese is at length taken from the vat as a firm and solid mass.

On the following morning and evening it must be again turned and pressed; and also on the third day, about the middle of which it should be removed to the salting chamber, where the outside is well rubbed with salt, and a cloth binder passed round it which is not turned over the upper surface. The cheese is then placed in brine extending half-way up in a salting-tub, and the upper surface is thickly covered with salt. Here it remains for nearly a week, being turned twice in the day. It is then left to dry for two or three days, during which period it is turned once—being well salted at each turning—and cleaned every day. When taken from the brine it is put on the salting benches, with a wooden girth round it of nearly the thickness of the cheese, where it stands a few days, during which time it is again salted and turned every day. It is next washed and dried; and after remaining on the drying benches about seven days, it is once more washed in warm water with a brush, and wiped dry. In a couple of hours after this it is rubbed all over with sweet whey butter, which operation is afterwards frequently repeated; and, lastly, it

[1] *Report on Cheddar Cheese-Making*, London, 1899.

is deposited in the cheese- or store-room—which should be moderately warm and sheltered from the access of air, lest the cheese should crack—and turned every day, until it has become sufficiently hard and firm. These cheeses require to be kept a considerable time.

As a matter of fact, there are three different modes of cheese-making followed in Cheshire, known as the *early* ripening, the *medium* ripening, and the *late* ripening processes. There is also a method which produces a cheese that is permeated with "green mould" when ripe, called "Stilton Cheshire"; this, however, is confined to limited districts in the county. The early ripening method is generally followed in the spring of the year, until the middle or end of April; the medium process, from that time until late autumn, or until early in June, when the late ripening process is adopted and followed until the end of September, changing again to the medium process as the season advances. The late ripening process is not found to be suitable for spring or late autumn make. There is a decided difference between these several methods of making. In the early ripening system a larger quantity of rennet is used, more acidity is developed, and less pressure employed than in the other processes. In the medium ripening process a moderate amount of acidity is developed, to cause the natural drainage of the whey from the curd when under press. In the late ripening system, on the other hand, the development of acidity is prevented as far as possible, and the whey is got out of the curd by breaking down finer, using more heat, and skewering when under press. In the Stilton Cheshire process a larger quantity of rennet is used, and less pressure is employed, than in the medium or late ripening systems.

It is hardly possible to enunciate any general rules for the making of Stilton cheese, which differs from Cheddar and Cheshire in that it is not subjected to pressure. Mr J. Marshall Dugdale, in 1899, made a visit of inspection to the chief Leicestershire dairies where this cheese is produced, but in his report[1] he stated that every Stilton cheese-maker worked on his own lines, and that at no two dairies did he find the details all carried out in the same manner. There is a fair degree of uniformity up to the point when the curd is ladled into the straining-cloths, but at this stage, and in the treatment of the curd before salting, diversity sets in, several different methods being in successful use. Most of the cheese is made from two curds, the highly acid curd from the morning's milk being mixed with the comparatively sweet curd from the evening's milk. Opinion varies widely as to the degree of tightening of the straining-cloths. No test for acidity appears to be used, the amount of acidity being judged by the taste, feel, and smell of the curd. When the desired degree of acidity has developed, the curd is broken by hand to pieces the size of small walnuts, and salt is added at the rate of about 1 oz. to 4 ℔ of dry curd, or 1 oz. to 3½ ℔ of wet curd, care being taken not to get the curd pasty. If a maker has learnt how to rennet the milk properly, and how to secure the right amount of acidity at the time of hooping—that is, when the broken and salted curd is put into the wooden hoops which give the cheese its shape—he has acquired probably two of the most important details necessary to success. It was formerly the custom to add cream to the milk used for making Stilton cheese, but the more general practice now is to employ new milk alone, which yields a product apparently as excellent and mellow as that from enriched milk.

As a cheese matures or becomes fit for consumption, not only is there produced the characteristic flavour peculiar to the type of cheese concerned, but with all varieties, independently of the quality of flavours developed, a profound physical transformation of the casein occurs. In the course of this change the firm elastic curd "breaks down"—that is, becomes plastic, whilst chemically the insoluble casein is converted into various soluble decomposition products. These ripening phenomena—the production of flavour and the breaking down of the casein (that is, the formation of proper texture) —used to be regarded as different phases of the same process. As subsequently shown, however, these changes are not necessarily so closely correlated. The theories formerly advanced as explanatory of the ripening changes in cheese were suggestive rather than based upon experimental *data*, and it is only since 1896 that careful scientific studies of the problem have been made. Of the two existing theories, the one, which is essentially European, ascribes the ripening changes wholly to the action of living organisms—the bacteria present in the cheese. The other, which had its origin in the United States, asserts that there are digestive enzymes—that is, unorganized or soluble ferments—inherent in the milk itself that render the casein soluble. The supporters of the bacterial theory are ranged in two classes. The one, led by Duclaux, regards the breaking down of the casein as due to the action of liquefying bacteria (Tyrothrix forms). On the other hand, Von Freudenreich has ascribed these changes to the lactic-acid type of bacteria, which develop so luxuriantly in hard cheese like Cheddar.

With regard to the American theory, and in view of the important practical results obtained by Babcock and Russell at the Wisconsin experiment station, the following account[2] of their work is of interest, especially as the subject is of high practical importance. In 1897 they announced the discovery of an inherent enzyme in milk, which they named *galactase*, and which has the power of digesting the casein of milk and producing chemical decomposition products similar to those that normally occur in ripened cheese. The theory has been advanced by them that this enzyme is an important factor in the ripening changes; and as in their experiments bacterial action was excluded by the use of anæsthetic agents, they conclude that, so far as the breaking down of the casein is concerned, bacteria are not essential to this process. In formulating a theory of cheese-ripening, they have further pointed out the necessity of considering the action of rennet extract as a factor concerned in the curing changes. They have shown that the addition of increased quantities of rennet extract materially hastens the rate of ripening, and that this is due to the pepsin which is present in all commercial rennet extracts. They find it easily possible to differentiate between the proteolytic action—that is, the decomposing of proteids—of pepsin and galactase, in that the first-named enzyme is incapable of producing decomposition products lower than the peptones precipitated by tannin. They have shown that the increased solubility—the ripening changes—of the casein in cheese made with rennet is attributable solely to the products peculiar to peptic digestion. The addition of rennet extract or pepsin to fresh milk does not produce this change, unless the acidity of the milk is allowed to develop to a point which experience has shown to be the best adapted to the making of Cheddar cheese. The *rationale* of the empirical process of ripening the milk before the addition of the rennet is thus explained. In studying the properties of galactase it was further found that this enzyme, as well as those present in rennet extract, is operative at very low temperatures, even below freezing-point. When cheese made in the normal manner was kept at temperatures ranging from 25° to 45° F. for periods averaging from 8 to 18 months, it was found that the texture of the product simulated that of a perfectly ripened cheese, but that such cheese developed a very mild flavour in comparison with the normally-cured product. Subsequent storage at

[1] "The Practice of Stilton Cheese-Making," *Journ. Roy. Agric. Soc.*, 1899.

[2] *Experiment Station Record*, xii. 9. Washington, 1901.

somewhat higher temperatures gives to such cheese a flavour the intensity of which is determined by the duration of storage. This indicates that the breaking down of the casein and the production of the flavour peculiar to cheese are in a way independent of each other and may be independently controlled—a point of great economic importance in commercial practice. Although it is generally believed that cheese ripened at low temperatures is apt to develop a more or less bitter flavour, the flavours in the cases described were found to be practically perfect. Under these conditions of curing, bacterial activity is inoperative, and these experiments are held to furnish an independent proof of the enzyme theory.

Not only are these investigations of interest from the scientific standpoint, as throwing light on the obscure processes of cheese-curing, but from a practical point of view they open up a new field for commercial exploitation. The inability to control the temperature in the ordinary factory curing-room results in serious losses, on account of the poor and uneven quality of the product, and the consumption of cheese has been greatly lessened thereby. These conditions may all be avoided by this low-temperature curing process, and it is not improbable that the cheese industry may undergo important changes in methods of treatment. With the introduction of cold-storage curing, and the necessity of constructing centralized plant for this purpose, the cheese industry may perhaps come to be differentiated into the manufacture of the product in factories of relatively cheap construction, and the curing or ripening of the cheese in central curing stations. In this way not only would the losses which occur under present practices be obviated, but the improvement in the quality of the cured product would be more than sufficient to cover the cost of cold-storage curing.

The characteristics of typical specimens of the different kinds of English cheese may be briefly described. Cheddar cheese possesses the aroma and flavour of a nut—the so-called "nutty" flavour. It should melt in the mouth, and taste neither sweet nor acid. It is of flaky texture, neither hard nor crumbly, and is firm to the touch. It is early-ripening and, if not too much acid is developed in the making, long-keeping. Before all others it is a cosmopolitan cheese. Some cheeses are "plain," that is, they possess the natural paleness of the curd, but many are coloured with annatto—a practice that might be dispensed with. The average weight of a Cheddar cheese is about 70 ℔. Stilton cheese is popularly but erroneously supposed to be commonly made from morning's whole milk with evening's cream added, and to be a "double-cream" cheese. The texture is waxy, and a blue-green mould permeates the mass if well ripened; the flavour is suggestive of decay. The average weight of a Stilton is 15 ℔. Cheshire cheese has a fairly firm and uniform texture, neither flaky on the one hand nor waxy on the other; is of somewhat sharp and piquant flavour when fully ripe; and is often—at eighteen months old, when a well-made Cheshire cheese is at its best—permeated with a blue-green mould, which, as in the case of Stilton cheese, contributes a characteristic flavour which is much appreciated. Cheshire cheese is, like Cheddar, sometimes highly-coloured, but the practice is quite unnecessary; the weight is about 55 ℔. Gloucester cheese has a firm, somewhat soapy, texture and sweet flavour. Double Gloucester differs from single Gloucester only in size, the former usually weighing 26 to 30 ℔, and the latter 13 to 15 ℔. Leicester cheese is somewhat loose in texture, and mellow and moist when nicely ripened. Its flavour is "clean," sweet, and mild, and its aroma pleasant. To those who prefer a mild flavour in cheese, a perfect Leicester is perhaps the most attractive of all the so-called "hard" cheese; the average weight of such a cheese is about 35 ℔. Derby cheese in its best forms is much like Leicester, being "clean" in flavour and mellow. It is sometimes rather flaky in texture, and is slow-ripening and long-keeping if made on the old lines; the average weight is 25 ℔. Lancashire cheese, when well made and ripe, is loose in texture and is mellow; it has a piquant flavour. As a rule it ripens early and does not keep long. Dorset cheese—sometimes called "blue vinny" (or veiny)—is of firm texture, blue-moulded, and rather sharp-flavoured when fully ripe; it has a local popularity, and the best makes are rather like Stilton. Wensleydale cheese, a local product in North Yorkshire, is of fairly firm texture and mild flavour, and may almost be spread with a knife when ripe; the finest makes are equal to the best Stilton. Cotherstone cheese, also a Yorkshire product, is very much like Stilton, and commonly preferable to it. The blue-green mould develops, and the cheese is fairly mellow and moist, whereas many Stiltons are hard and dry. Wiltshire cheese, in the form of "Wilts truckles," may be described as small Cheddars, the weight being usually about 16 ℔. Caerphilly cheese is a thin, flat product, having the appearance of an undersized single Gloucester and weighing about 8 ℔; it has no very marked characteristics, but enters largely into local consumption amongst the mining population of Glamorganshire and Monmouthshire. Soft cheese of various kinds is made in many localities, beyond which its reputation scarcely extends. One of the oldest and best, somewhat resembling Camembert when well ripened, is the little "Slipcote," made on a small scale in the county of Rutland; it is a soft, mellow, moist cheese, its coat slipping off readily when the cheese is at its best for eating—hence the name. Cream cheese is likewise made in many districts, but nowhere to a great extent. A good cream cheese is fairly firm but mellow, with a slightly acid yet very attractive flavour. It is the simplest of all cheese to make—cream poured into a perforated box lined with loose muslin practically makes itself into cheese in a few days' time, and is usually ripe in a week.

In France the pressed varieties of cheese with hard rinds include Gruyère, Cantal, Roquefort, and Port Salut. The first-named, a pale yellow cheese full of holes of varying size, is made in Switzerland and in the Jura Mountains district in the east of France; whilst Cantal cheese, which is of lower quality, is a product of the midland districts, and is made barrel-shape. Roquefort cheese is made from the milk of ewes, which are kept chiefly as dairy animals in the department of Aveyron, and the cheese is cured in the natural mountain caves at the village of Roquefort. It is a small, rather soft, white cheese, abundantly veined with a greenish-blue mould, and weighs between 4 and 5 ℔. The Port-Salut is quite a modern cheese, which originated in the abbey of that name in Mayenne; it is a thin, flat cheese, of characteristic and not unattractive odour and flavour. The best known of the soft unpressed cheeses are Brie, Camembert, and Coulommiers, whilst Pont l'Evêque, Livarot, and other varieties are also made. After being shaped in moulds of various forms, these cheeses are laid on straw mats to cure, and when fit to eat they possess about the same consistency as butter. The Neufchâtel, Gervais, and Bondon cheeses are soft varieties intended to be eaten quite fresh, like cream cheese.

Of the varieties of cheese made in Switzerland, the best known is the Emmenthaler, which is about the size of a cart-wheel, and has a weight varying from 150 to 300 ℔. It is full of small holes of almost uniform size and very regularly distributed. In colour and flavour it is the same as Gruyère. The Edam and Gouda are the common cheeses of Holland. The Edam is spherical in shape, weighs from 3 to 4 ℔, and is usually dyed crimson on

the outside. The Gouda is a flat cheese with convex edges, and is of any weight up to 20 ℔. Of the two, the Edam has the finer flavour. Limburger is the leading German cheese, whilst other varieties are the Backstein and Munster; all are strong-smelling. Parmesan cheese is an Italian product, round and flat, about 5 inches thick, weighing from 60 to 80 ℔, and possessed of fine flavour. Gorgonzola cheese, so called from the Italian town of that name near Milan, is made in the Cheddar shape, and weighs from 20 to 40 ℔. When ripe it is permeated by a blue mould, and resembles in flavour, appearance, and consistency a rich old Stilton.

### Butter and Butter-Making.

As with cheese, so with butter, large quantities of the latter have been inferior not because the cream was poor in quality, but because the wrong kinds of bacteria had taken possession of the atmosphere in hundreds of dairies. The greatest if not the latest novelty in dairying in the last decade of the 19th century was the isolation of lactic acid bacilli, their cultivation in a suitable medium, and their employment in cream preparatory to churning. Used thus in butter-making, an excellent product results, provided cleanliness be scrupulously maintained. The culture repeats itself in the buttermilk, which in turn may be used again with marked success. Much fine butter, indeed, was made long before the bearing of bacteriological science upon the practice of dairying was recognized—made by using acid buttermilk from a previous churning.

In Denmark, which is, for its size, the greatest butter-producing country in the world, most of the butter is made with the aid of "starters," or artificial cultures which are employed in ripening the cream. Though the butter made by such cultures shows little if any superiority over a good sample made from cream ripened in the ordinary way,—that is, by keeping the cream at a fairly high temperature until it is ready for churning, when it must be cooled—it is claimed that the use of these cultures enables the butter-makers of Denmark to secure a much greater uniformity in the quality of their produce than would be possible if they depended upon the ripening of the cream through the influence of bacteria taken up in the usual way from the air.

Butter-making is an altogether simpler process than cheese-making, but success demands strict attention to sound principles, the observance of thorough cleanliness in every stage of the work, and the intelligent use of the thermometer. The following rules for butter-making, issued by the Royal Agricultural Society, sufficiently indicate the nature of the operation:—

Prepare churn, butter-worker, wooden hands, and sieve as follows:—(1) Rinse with cold water. (2) Scald with boiling water. (3) Rub thoroughly with salt. (4) Rinse with cold water.

*Always use a correct thermometer.*

The cream, when in the churn, to be at a temperature of 56° to 58° F. in summer and 60° to 62° F. in winter. The churn should never be more than half full. Churn at number of revolutions suggested by maker of churn. If none are given, *churn at* 40 *to* 45 *revolutions per minute.* Always churn slowly at first.

*Ventilate* the churn *freely* and frequently during churning, until no air rushes out when the vent is opened.

*Stop churning immediately* the butter comes. This can be ascertained by the sound; if in doubt, *look.*

The butter should now be like grains of mustard seed. Pour in a small quantity of cold water (1 pint of water to 2 quarts of cream) to harden the grains, and give a few more turns to the churn gently.

Draw off the buttermilk, giving plenty of time for draining. Use a straining-cloth placed over a hair-sieve, so as to prevent any loss, and wash the butter in the churn with plenty of cold water; then draw off the water, and repeat the process until the water comes off quite clear.

*To brine butter,* make a strong brine, 2 to 3 ℔ of salt to 1 gallon of water. Place straining-cloth over mouth of churn, pour in brine, put lid on churn, turn sharply half a dozen times, and leave for 10 to 15 minutes. Then lift the butter out of churn into sieve, turn butter out on worker, leave it a few minutes to drain, and work gently till all superfluous moisture is pressed out.

*To drysalt butter,* place butter on worker, let it drain 10 to 15 minutes, then work gently till all the butter comes together. Place it on the scales and weigh; then weigh salt, for slight salting, $\frac{1}{4}$ oz.; medium, $\frac{1}{2}$ oz.; heavy salting, $\frac{3}{4}$ oz. to the ℔ of butter. Roll butter out on worker and carefully sprinkle salt over the surface, a little at a time; roll up and repeat till all the salt is used.

*Never touch the butter with your hands.*

Well-made butter is firm and not greasy. It possesses a characteristic texture or "grain," in virtue of which it cuts clean with a knife and breaks with a granular fracture, like that of cast-iron. Theoretically, butter should consist of little else than fat, but in practice this degree of perfection is never attained. Usually the fat ranges from 83 to 88 per cent., whilst water is present to the extent of from 10 to 15 per cent.[1] There will also be from 0·2 to 0·8 per cent. of milk-sugar, and from 0·5 to 0·8 per cent. of casein. It is the casein which is the objectionable ingredient, and the presence of which is usually the cause of rancidity. In badly washed or badly worked butter, from which the buttermilk has not been properly removed, the proportion of casein, or curd, left in the product may be considerable, and such butter has only inferior keeping qualities. At the same time, the mistake may be made of overworking or of overwashing the butter, thereby depriving it of the delicacy of flavour which is one of its chief attractions as an article of consumption if eaten fresh. The object of washing with brine is that the small quantity of salt thus introduced shall act as a preservative and develop the flavour. Streaky butter may be due either to curd left in by imperfect washing, or to an uneven distribution of the salt.

### Equipment of the Dairy.

The improved form of milking-pail shown in Fig. 1 has rests or brackets, which the milker when seated on

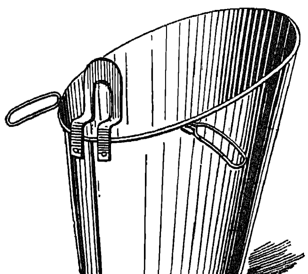


Fig. 1.—Milking Pail.

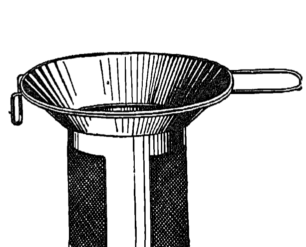


Fig. 2.—Milk Sieve.

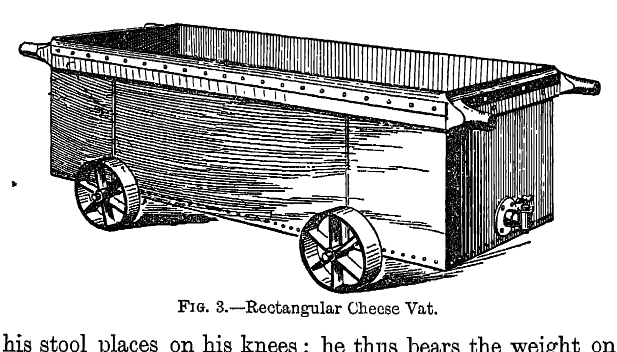


Fig. 3.—Rectangular Cheese Vat.

his stool places on his knees; he thus bears the weight on his thighs, and is entirely relieved of the strain involved

[1] Market butter is sometimes deliberately over-weighted with water, and a fraudulent profit is obtained by selling this extra moisture at the price of butter. In July 1901, therefore, a departmental committee was appointed to inquire into the matter (*vide infra*).

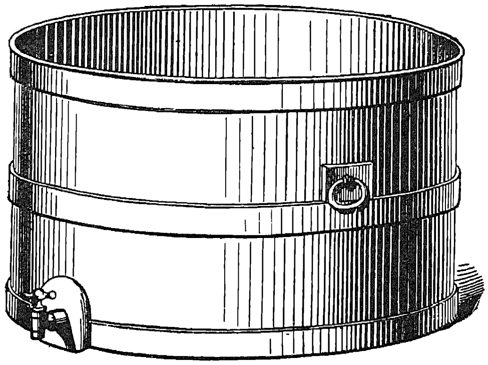


FIG. 4.—Cheese Tub

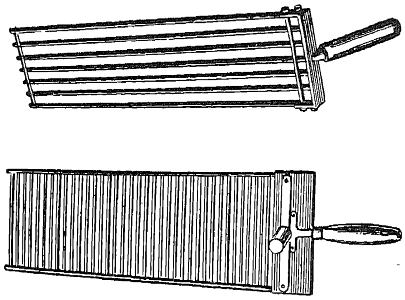


FIG. 5.—Curd Knives.

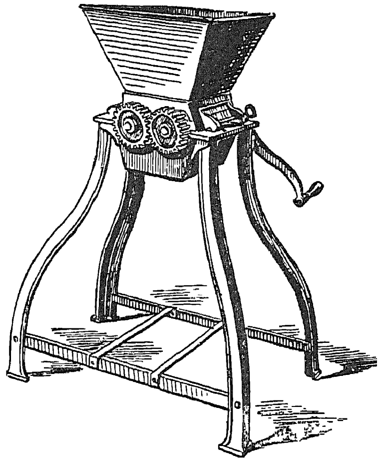


FIG. 6.—Curd Mill.

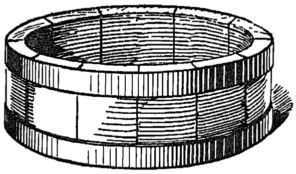


FIG. 7 —Hoop for Flat Cheese

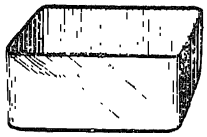


FIG. 10 —Cheese Mould (Pont l'Évêque).

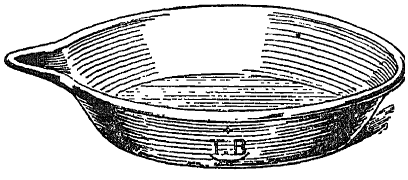


FIG. 11.—Milk Pan.

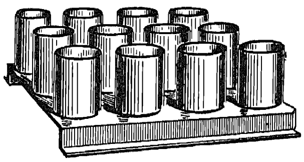


FIG. 9.—Cheese Mould (Gervais).

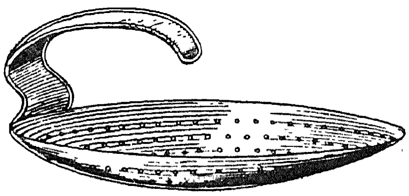


FIG. 12.—Skimmer.

FIG. 13.—Cream Crock.

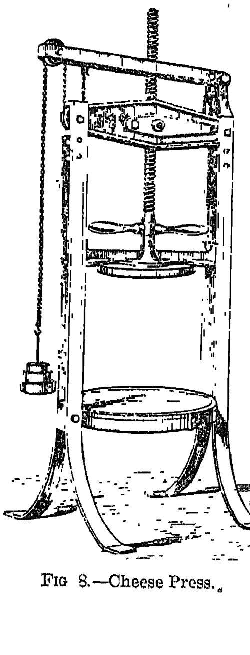


FIG 8.—Cheese Press.

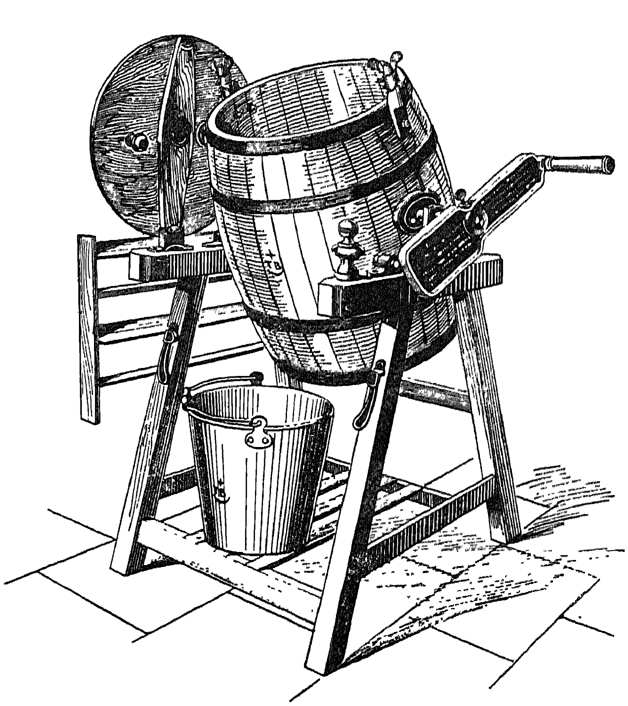


FIG. 14.—Churn.

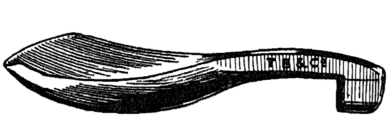


FIG. 15.—Butter Scoop.

in gripping the can between the knees. The milk sieve or strainer (Fig. 2) is used to remove cow-hairs and any other mechanical impurity that may have fallen into the milk. A double straining surface is provided, the second being of very fine gauze placed vertically, so that the pressure of the milk does not force the dirt through; the strainer is easily washed. The cheese tub or vat receives the milk for cheese-making. The rectangular form shown in Fig. 3 is a Cheshire cheese-vat, for steam. The inner vat is of tinned steel, and the outer is of iron and is fitted with pipes for steam supply. Round cheese-tubs (Fig. 4) are made of strong sheets of steel, doubled tinned to render them lasting. They are fitted with a strong bottom hoop and bands round the sides, and can be double-jacketed for steam-heating if required. Curd-knives (Fig. 5) are used for cutting the coagulated mass into cubes in order to liberate the whey. They are made of fine steel, with sharp edges; there are also wire curd-breakers. The object of the curd-mill (Fig. 6) is to grind consolidated curd into small pieces, preparatory to salting and vatting; two spiked rollers work up to spiked breasts. Hoops, into which the curd is placed in order to acquire the shape of the cheese, are of wood or steel, the former being made of well-seasoned oak with iron bands (Fig. 7), the latter of tinned steel. The cheese is more easily removed

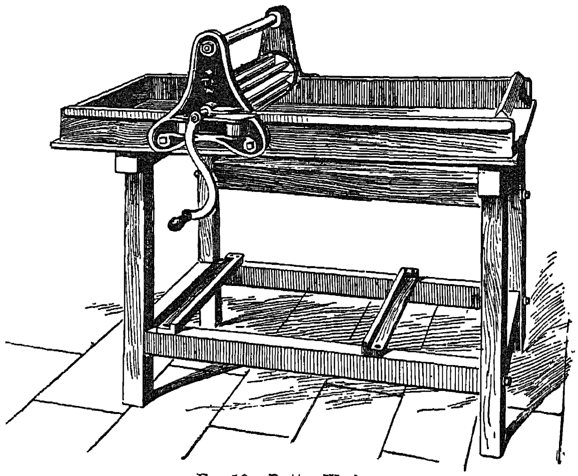


FIG. 16.—Butter Worker.

from the steel hoops, and they are readily cleaned. The cheese-press (Fig. 8) is used only for hard or "pressed" cheese, such as Cheddar. The arrangement is such that the pressure is continuous; in the case of soft cheese the curd is merely placed in moulds (Figs. 9 and 10) of the required shape, and then taken out to ripen, no pressure being applied. The cheese-room is fitted with easily-turned shelves, on which newly-made "pressed" cheeses are laid to ripen.

In the butter dairy, when the centrifugal separator is not used, milk is "set" for cream-raising in the milk-pan (Fig. 11), a shallow vessel of white porcelain, tinned steel, or enamelled iron. The skimming-dish or skimmer (Fig. 12), made of tin, is for collecting the cream from the surface of the milk, whence it is transferred to the cream-crock (Fig. 13), in which vessel the cream remains from one to three days, till it is required for churning. Many different kinds of churns are in use, and vary much in size, shape, and fittings; the one illustrated in Fig. 14 is a very good type of diaphragm churn. The butter-scoop (Fig. 15) is of wood, and is sometimes perforated; it is used for taking the butter out of the churn. The butter-worker (Fig. 16) is employed for consolidating newly-churned butter, pressing out superfluous water, and mixing in salt. More extended use, however, is now being made of the "Délaiteuse" butter-dryer, a centrifugal machine that rapidly extracts the moisture from the butter, and renders the butter-worker unnecessary, whilst the butter produced has a better grain. Scotch hands (Fig. 17), made of boxwood, are used for the lifting, moulding, and pressing of butter.

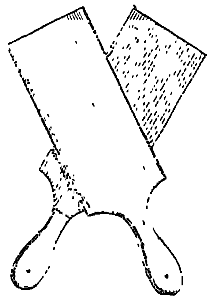


FIG. 17.—Scotch Hands.

In the centrifugal cream-separator the new milk is allowed to flow into a bowl, which is caused to rotate on its own axis several thousand times per minute. The heavier portion which makes up the watery part of the milk flies to the outer circumference of the bowl, whilst the lighter particles of butter-fat are forced to travel in an inner zone. By a simple mechanical arrangement the separated milk is forced out at one tube and the cream at another, and they are collected in distinct vessels. Separators are made of all sizes, from small machines dealing with 10 or 20 up to 100 gallons an hour, and worked by hand (Fig. 18), to large machines separating 150 to 440 gallons an hour, and worked by horse, steam, or other power (Fig. 19). Separation is found to be most effective at temperatures ranging in different machines from 80° to 98° F., though as high a temperature as 150° is sometimes employed. The most efficient separators remove nearly the whole of the butter-fat, the quantity of fat left in the separated milk falling in some cases to as low as 0·1 per cent. When cream is raised by the deep-setting method, from 0·2 to 0·4 per cent. of fat is left in the skim-milk; by the shallow-setting method from 0·3 to 0·5 per cent. of the fat is left behind. As a rule, therefore, "separated" milk is much poorer in fat than ordinary "skim" milk left by the cream-raising method in deep or shallow vessels.

The first continuous working separator was the invention of Dr de Laval. The more recent invention by Baron von Bechtolsheim of what are known as the Alfa discs, which are placed along the centre of the bowl of the separator, has much increased the separating capacity of the machines without adding to the power required. This has been of great assistance to dairy farmers by lessening the cost of the manufacture of butter, and thus enabling a large additional number of factories to be established in different parts of the world, particularly in Ireland, where these disc machines are very extensively used.

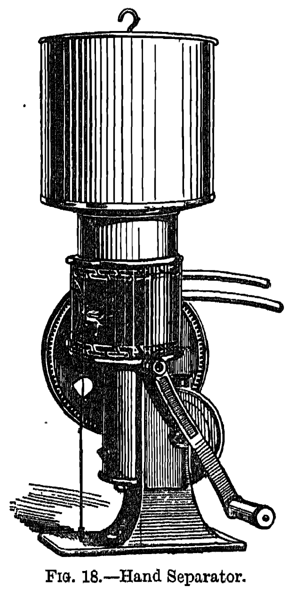


FIG. 18.—Hand Separator.

The pasteurizer—so named after the French chemist Pasteur — affords a means whereby at the outset the milk is maintained at a temperature of 170° to 180° F. for a period of eight or ten minutes. The object of this is to destroy the tubercle bacillus, if it should happen to exist in the milk, whilst incidentally the bacilli associated with several other diseases communicable through the medium of milk would also be killed if they were present. Discordant results have been recorded by experimenters who have attempted to kill tubercle bacilli in milk by heating the latter in open vessels, thereby permitting the formation of a scum

or "scalded layer" capable of protecting the tubercle bacilli, and enabling them to resist a higher temperature

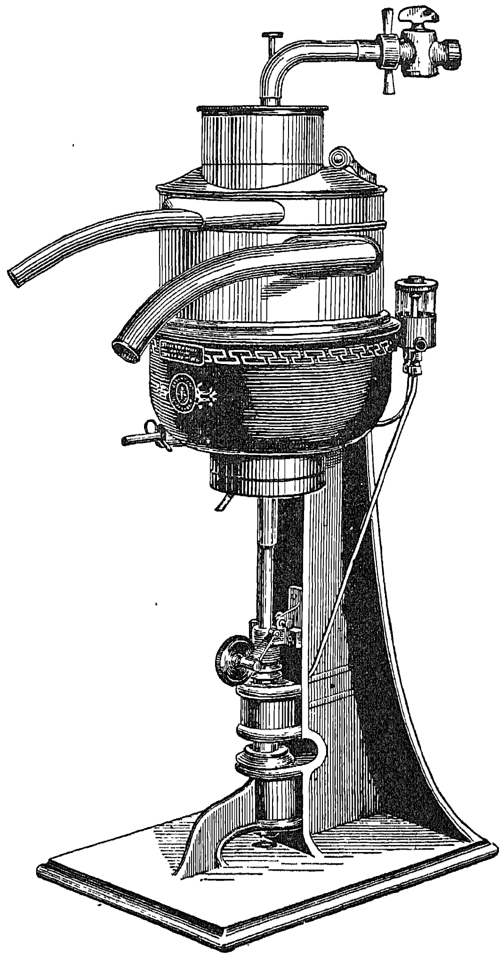


FIG. 19.—Power Separator.

than otherwise would be fatal to them. At a temperature not much above 150° F. milk begins to acquire the cooked flavour which is objectionable to many palates, whilst its "body" is so modified as to lessen its suitability for creaming purposes. Three factors really enter into effective pasteurization of milk, namely, (1) the temperature to which the milk is raised, (2) the length of time it is kept at that temperature, (3) the maintenance of a condition of mechanical agitation to prevent the formation of "scalded layer." Within limits, what a higher temperature will accomplish if maintained for a very short time may be effected by a lower temperature continued over a longer period. The investigation of the problem forms the subject of a paper[1] in the *17th Annual Report of the Wisconsin Agricultural Experiment Station*, 1900. The following are the results of the experiments:—

1. An exposure of tuberculous milk in a tightly closed commercial pasteurizer for a period of ten minutes destroyed in every case the tubercle bacillus, as determined by the inoculation of such heated milk into susceptible animals like guinea-pigs.
2. Where milk is exposed under conditions that would enable a pellicle or membrane to form on the surface, the tubercle organism is able to resist the action of heat at 140° F. (60° C.) for considerably longer periods of time.
3. Efficient pasteurization can be more readily accomplished in a closed receptacle such as is most frequently used in the commercial treatment of milk, than where the milk is heated in open bottles or open vats.
4. It is recommended, in order thoroughly to pasteurize milk so as to destroy any tubercle bacilli which it may contain, without in any way injuring its creaming properties or consistency, to heat the same in closed pasteurizers for a period of not less than twenty minutes at 140° F.

Under these conditions one may be certain that disease bacteria such as the tubercle bacillus will be destroyed without the milk or cream being injured in any way. For over a year this new standard has been in constant use in the Wisconsin University Creamery, and the results, from a purely practical point of view, reported a year earlier by Farrington and Russell,[2] have been abundantly confirmed.

Dairy engineers have solved the problem as to how large bodies of milk may be pasteurized, the difficulty of raising many hundreds or thousands of gallons of milk up to the required temperature, and maintaining it at that heat for a period of twenty minutes, having been successfully dealt with. The plant usually employed provides for the thorough filtration of the milk as it comes in from the farms, its rapid heating in a closed receiver and under mechanical agitation up to the desired temperature, its maintenance thereat for the requisite time, and finally its sudden reduction to the temperature of cold water through the agency of a refrigerator, to be next noticed.

Refrigerators are used for reducing the temperature of milk to that of cold water, whereby its keeping properties

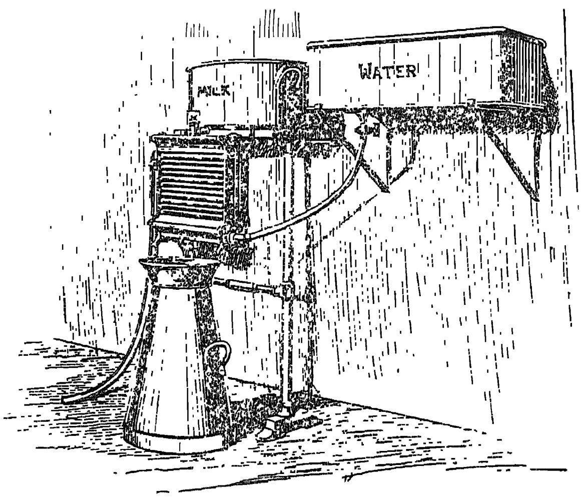



FIG. 20.—Refrigerator and Can.

are enhanced. The milk flows down the outside of the metal refrigerator (Fig. 20), which is corrugated in order to provide a larger cooling surface, whilst cold water circulates through the interior of the refrigerator. The conical vessel into which the milk is represented as flowing from the refrigerator in Fig. 20 is absurdly called a "milk-churn," whereas milk-can is a much more appropriate name. For very large quantities of milk, such as flow from a pasteurizing plant, cylindrical refrigerators (Fig. 21), made of tinned copper, are available; the cold water circulates inside, and the milk, flowing down the outside in a very thin sheet, is rapidly cooled from a temperature of

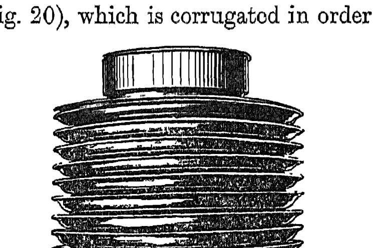


FIG. 21.—Cylindrical Cooler or Refrigerator.

[1] "Thermal Death-Point of Tubercle Bacilli, and Relation of same to Commercial Pasteurization of Milk." By H. L. Russell and E. G. Hastings.

[2] *16th Rept. Wis. Agric. Expt. Station*, 1899, p. 129.

140° F. or higher to 1° above the temperature of the water.

The fat test for milk was originally devised by Dr S. M. Babcock, of the Wisconsin Experiment Station, U.S.A. It combines the principle of centrifugal force with simple chemical action. Besides the machine itself and its graduated glass vessels, the only requirements are sulphuric acid of standard strength and warm water. The machines—often termed butyrometers—are commonly made to hold from two up to two dozen testers. After the tubes or testers have been charged, they are put in the apparatus, which is rapidly rotated as shown (Fig. 22); in a few minutes the test is complete, and with properly graduated vessels the percentage of fat can be read off at a glance. The butyrometer is extremely useful, alike for measuring periodically the fat-producing capacity of individual cows in a herd, for rapidly ascertaining the percentage of fat in milk delivered to factories and paying for such milk on the basis of quality, and for determining the richness in fat of milk supplied for the urban milk trade. Any intelligent person can soon learn to work the apparatus, but its efficiency is of course dependent upon the accuracy of the measuring vessels. To ensure this the Board of Agriculture have made arrangements with the National Physical Laboratory, Old Deer Park, Richmond, Surrey, to verify at a small fee the pipettes, measuring-glasses, and test-bottles used in connexion with the centrifugal butyrometer, which in recent years has been improved by Dr N. Gerber of Zurich.

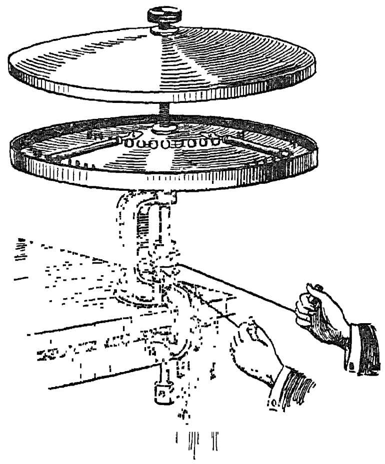


Fig. 22.—Butyrometer.

### Dairy Factories.

In connexion with co-operative cheese-making the merit of having founded the first "cheesery" or cheese factory is generally credited to Jesse Williams, who lived near Rome, in Oneida county, New York State. The system, therefore, was of American origin. Williams was a skilled cheese-maker, and the produce of his dairy sold so freely, at prices over the average, that he increased his output of cheese by adding to his own supply of milk other quantities which he obtained from his neighbours. His example was so widely followed that by the year 1866 there had been established close upon 500 cheese factories in New York State alone. In 1870 two co-operative cheeseries were at work in England, one in the town of Derby and one at Longford in the same county. There are now thousands of cheeseries in the United States and Canada, and also many "creameries," or butter factories, for the making of high-class butter.

The first creamery was that of Alanson Slaughter, and it was built near Wallkill, Orange county, New York State, in 1861, or ten years later than the first cheese factory; it dealt daily with the milk of 375 cows. Cheeseries and creameries would almost certainly have become more numerous than they are in England but for the rapidly-expanding urban trade in country milk. The development of each, indeed, has been contemporaneous since 1871, and they are found to work well in conjunction one with the other—that is to say, a factory is useful for converting surplus milk into cheese or butter when the milk trade is overstocked, whilst the trade affords a convenient avenue for the sale of milk whenever this may happen to be preferable to the making of cheese or butter. Extensive dealers in milk arrange for its conversion into cheese or butter, as the case may be, at such times as the milk market needs relief, and in this way a cheesery serves as a sort of economic safety-valve to the milk trade. The same cannot always be said of creameries, because the machine-skimmed milk of some of these establishments has been far too much used to the prejudice of the legitimate milk trade in urban districts. Be this as it may, the operations of cheeseries and creameries in conjunction with the milk trade have led to the diminution of home dairying. A rapidly-increasing population has maintained, and probably increased, its consumption of milk, which has obviously diminished the farmhouse production of cheese, and also of butter. The foreign competitor has been less successful with cheese than with butter, for he is unable to produce an article qualified to compete with the best that is made in Great Britain. In the case of butter, on the other hand, the imported article, though not ever surpassing the best home-made, is on the average much better, especially as regards uniformity of quality. Colonial and foreign producers, however, send into the British markets as a rule only the best of their butter, as they are aware that their inferior grades would but injure the reputation their products have acquired.

There are no official statistics concerning dairy factories in Great Britain, and such figures relating to Ireland were issued for the first time in 1901. The number of dairy factories in Ireland in 1900 was returned at 506, comprising 333 in Munster, 92 in Ulster, 52 in Leinster, and 29 in Connaught. Of the total number of factories, 495 received milk only, 9 milk and cream, and 2 cream only. As to ownership, 219 were joint-stock concerns, 190 were maintained by co-operative farmers, and 97 were proprietary. In the year ended 30th September 1900 these factories used up nearly 121 million gallons of milk, namely, 94 in Munster, 14 in Ulster, 7 in Leinster, and 6 in Connaught. The number of centrifugal cream-separators in the factories was 985, of which 889 were worked by steam, 79 by water, 9 by horse-power, and 8 by hand-power. The number of hands permanently employed was 3653, made up of 2976 in Munster, 279 in Leinster, 278 in Ulster, and 120 in Connaught. The year's output was returned at 401,490 cwt. of butter, 439 cwt. of cheese (made from whole milk), and 46,253 gallons of cream. In most cases the skim-milk is returned to the farmers. A return of the number of separators used in private establishments gave a total of 899, comprising 693 in Munster, 157 in Leinster, 39 in Ulster, and 10 in Connaught. In factories and private establishments together as many as 1884 separators were thus accounted for. Much of the factory butter would be sent into the markets of Great Britain, though some would no doubt be retained for local consumption. A great improvement in the quality of Irish butter has recently been noticeable in the exhibits entered at the London Dairy Show.

### Adulteration of Dairy Produce.

The Sale of Food and Drugs Act, 1899, which came into operation on January 1, 1900, contains several sections relating to the trade in dairy produce in the United Kingdom. Section 1 imposes penalties in the case of the importation of produce insufficiently marked, such as (a) margarine or margarine-cheese, except in packages conspicuously marked "Margarine" or "Margarine-cheese";

(*b*) adulterated or impoverished butter (other than margarine) or adulterated or impoverished milk or cream, except in packages or cans conspicuously marked with a name or description indicating that the butter or milk or cream has been so treated; (*c*) condensed separated or skimmed milk, except in tins or other receptacles which bear a label whereon the words "Machine-skimmed Milk" or "Skimmed Milk" are printed in large and legible type. For the purposes of this section an article of food is deemed to be adulterated or impoverished if it has been mixed with any other substance, or if any part of it has been abstracted, so as in either case to affect injuriously its quality, substance, or nature; provided that an article of food shall not be deemed to be adulterated by reason only of the addition of any preservative or colouring matter of such a nature and in such quantity as not to render the article injurious to health. Section 7 provides that every occupier of a manufactory of margarine or margarine-cheese, and every wholesale dealer in such substances, shall keep a register showing the quantity and destination of each consignment of such substances sent out from his manufactory or place of business, and this register shall be open to the inspection of any officer of the Board of Agriculture. Any such officer shall have power to enter at all reasonable times any such manufactory, and to inspect any process of manufacture therein, and to take samples for analysis. Section 8 is of much practical importance, as it limits the quantity of butter-fat which may be contained in margarine; it states that it shall be unlawful to manufacture, sell, expose for sale, or import any margarine the fat of which contains more than 10 per cent. of butter-fat, and every person who manufactures, sells, exposes for sale, or imports any margarine which contains more than that percentage shall be guilty of an offence under the Margarine Act, 1887. For the purposes of the Act *margarine-cheese* is defined as "any substance, whether compound or otherwise, which is prepared in imitation of cheese, and which contains fat not derived from milk"; whilst *cheese* is defined as "the substance usually known as cheese, containing no fat derived otherwise than from milk." The so-called "filled" cheese of American origin, in which the butter-fat of the milk is partially or wholly replaced by some other fat, would come under the head of "margarine-cheese." In making such cheese a cheap form of fat, usually of animal origin, but sometimes vegetable, is added to and incorporated with the skim-milk, and thus takes the place previously occupied by the genuine butter-fat. The Act is regarded by some as defective in that it does not prohibit the artificial colouring of margarine to imitate butter.

In connexion with this Act a departmental committee was appointed in 1900 "to inquire and report as to what regulations, if any, may with advantage be made by the Board of Agriculture under section 4 of the Sale of Food and Drugs Act, 1899, for determining what deficiency in any of the normal constituents of genuine milk or cream, or what addition of extraneous matter or proportion of water, in any sample of milk (including condensed milk) or cream, shall for the purposes of the Sale of Food and Drugs Acts, 1875 to 1899, raise a presumption, until the contrary is proved, that the milk or cream is not genuine." Much evidence of the highest interest to dairy farmers was taken, and subsequently published as a Blue-Book (Cd. 484). The report of the committee (Cd. 491) included the following "recommendations," which were signed by all the members excepting one:—

I. That regulations under section 4 of the Food and Drugs Act, 1899, be made by the Board of Agriculture with respect to milk (including condensed milk) and cream.

II. (*a*) That in the case of any milk (other than skimmed, separated, or condensed milk) the total milk-solids in which on being dried at 100° C. do not amount to 12 per cent. a presumption shall be raised, until the contrary is proved, that the milk is deficient in the normal constituents of genuine milk.

(*b*) That any milk (other than skimmed, separated, or condensed milk) the total milk-solids in which are less than 12 per cent., and in which the amount of milk-fat is less than 3·25 per cent., shall be deemed to be so deficient in milk-fat as to raise a presumption, until the contrary is proved, that it has been mixed with separated milk or water, or that some portion of its normal content of milk-fat has been removed. In calculating the percentage amount of deficiency of fat the analyst shall have regard to the above-named limit of 3·25 per cent. of milk-fat.

(*c*) That any milk (other than skimmed, separated, or condensed milk) the total milk-solids in which are less than 12 per cent., and in which the amount of non-fatty milk-solids is less than 8·5 per cent., shall be deemed to be so deficient in normal constituents as to raise a presumption, until the contrary is proved, that it has been mixed with water. In calculating the percentage amount of admixed water the analyst shall have regard to the above-named limit of 8·5 per cent. of non-fatty milk-solids, and shall further take into account the extent to which the milk-fat may exceed 3·25 per cent.

III. That the artificial thickening of cream by any addition of gelatin or other substance shall raise a presumption that the cream is not genuine.

IV. That any skimmed or separated milk in which the total milk-solids are less than 9 per cent. shall be deemed to be so deficient in normal constituents as to raise a presumption, until the contrary is proved, that it has been mixed with water.

V. That any condensed milk (other than that labelled "machine-skimmed milk" or "skimmed milk," in conformity with section 11 of the Food and Drugs Act, 1899) in which either the amount of milk-fat is less than 10 per cent., or the amount of non-fatty milk-solids is less than 25 per cent., shall be deemed to be so deficient in some of the normal constituents of milk as to raise a presumption, until the contrary is proved, that it is not genuine.

The committee further submitted the following expressions of opinion on points raised before them in evidence:—

(*a*) That it is desirable to call the attention of those engaged in the administration of the Food and Drugs Acts to the necessity of adopting effective measures to prevent any addition of water, separated or condensed milk, or other extraneous matter, for the purpose of reducing the quality of genuine milk to any limits fixed by regulation of the Board of Agriculture.

(*b*) That it is desirable that steps should be taken with the view of identifying or "ear-marking" separated milk by the addition of some suitable and innocuous substance, and by the adoption of procedure similar to that provided by section 7 of the Food and Drugs Act, 1899, in regard to margarine.

(*c*) That it is desirable that, so far as may be found practicable, the procedure adopted in collecting, forwarding, and retaining pending examination, samples of milk (including condensed milk) and cream under the Food and Drugs Acts should be uniform.

(*d*) That it is desirable that, so far as may be found practicable, the methods of analysis used in the examination of samples of milk (including condensed milk) or cream taken under the Food and Drugs Acts should be uniform.

(*e*) That it is desirable in the case of condensed milk (other than that labelled "machine-skimmed milk" or "skimmed milk," in conformity with section 11 of the Food and Drugs Act, 1899) that the label should state the amount of dilution required to make the proportion of milk-fat equal to that found in uncondensed milk containing not less than 3·25 per cent. of milk-fat.

(*f*) That it is desirable in the case of condensed whole milk to limit, and in the case of condensed machine-skimmed milk to exclude, the addition of sugar.

(*g*) That the official standardizing of the measuring vessels commercially used in the testing of milk is desirable.

In the minority report, signed by Mr Geo. Barham, the most important clauses are the following:—

(*a*) That in the case of any milk (other than skimmed, separated, or condensed milk) the total milk-solids in which are less

than 11·75 per cent., and in which, during the months of July to February inclusive, the amount of milk-fat is less than 3 per cent., and in the case of any milk which during the months of March to June inclusive shall fall below the above-named limit for total solids, and at the same time shall contain less than 2·75 per cent. of fat, it shall be deemed that such milk is so deficient in its normal constituent of fat as to raise a presumption, for the purposes of the Sale of Food and Drugs Acts, 1875 to 1899, until the contrary is proved, that the milk is not genuine.

(b) That any milk (other than skimmed, separated, or condensed milk) the total milk-solids in which are less than 11·75 per cent., and in which the amount of non-fatty solids is less than 8·5 per cent., shall be deemed to be so deficient in its normal constituents as to raise a presumption, for the purposes of the Sale of Food and Drugs Acts, 1875 to 1899, until the contrary is proved, that the milk is not genuine. In calculating the amount of the deficiency the analyst shall take into account the extent to which the milk-fat exceeds the limits above named.

(c) That any skimmed or separated milk in which the total milk-solids are less than 8·75 per cent. shall be deemed to be so deficient in its normal constituents as to raise a presumption, for the purpose of the Sale of Food and Drugs Acts, 1875 to 1899, until the contrary is proved, that the milk is not genuine.

Much controversy arose out of the publication of these reports, the opinion most freely expressed being that the standard recommended in the majority report was too high. The difficulty of the problem is illustrated by, for example, the diverse legal standards for milk that prevail in the United States, where the prescribed percentage of fat in fresh cows' milk ranges from 2·5 in Rhode Island to 3·5 in Georgia and Minnesota, and 3·7 (in the winter months) in Massachusetts, and the prescribed total solids range from 12 in several states (11·5 in Ohio during May and June) up to 13 in others. Standards are recognized in 21 of the states, but the remaining states have no laws prescribing standards for dairy products. That the public discussion of the reports of the committee was effective is shown by the following regulations which appeared in the *London Gazette* on 6th August 1901, and fixed the limit of fat at 3 per cent:—

The Board of Agriculture, in exercise of the powers conferred on them by section 4 of the Sale of Food and Drugs Act, 1899, do hereby make the following regulations:—

1. Where a sample of milk (not being milk sold as skimmed, or separated, or condensed milk) contains less than 3 per cent. of milk-fat, it shall be presumed for the purposes of the Sale of Food and Drugs Acts, 1875 to 1899, until the contrary is proved, that the milk is not genuine, by reason of the abstraction therefrom of milk-fat, or the addition thereto of water.
2. Where a sample of milk (not being milk sold as skimmed, or separated, or condensed milk) contains less than 8·5 per cent. of milk-solids other than milk-fat, it shall be presumed for the purposes of the Sale of Food and Drugs Acts, 1875 to 1899, until the contrary is proved, that the milk is not genuine, by reason of the abstraction therefrom of milk-solids other than milk-fat, or the addition thereto of water.
3. Where a sample of skimmed or separated milk (not being condensed milk) contains less than 9 per cent. of milk-solids, it shall be presumed for the purposes of the Sale of Food and Drugs Acts, 1875 to 1899, until the contrary is proved, that the milk is not genuine, by reason of the abstraction therefrom of milk-solids other than milk-fat, or the addition thereto of water.
4. These regulations shall extend to Great Britain.
5. These regulations shall come into operation on 1st September 1901.
6. These regulations may be cited as the Sale of Milk Regulations, 1901.

In July 1901 another departmental committee was appointed by the Board of Agriculture to inquire and report as to what regulations, if any, may with advantage be made under section 4 of the Sale of Food and Drugs Act, 1899, for determining what deficiency in any of the normal constituents of butter, or what addition of extraneous matter, or proportion of water in any sample of butter shall, for the purpose of the Sale of Food and Drugs Acts, raise a presumption, until the contrary is proved, that the butter is not genuine. As bearing upon this point reference may be made to a report of the Dairy Division of the United States Department of Agriculture on experimental exports of butter, in the appendix to which are recorded the results of the analyses of many samples of butter of varied origin. First, as to American butters, 19 samples were analysed in Wisconsin, 17 in Iowa, 5 in Minnesota, and 2 in Vermont, at the respective experiment stations of the states named. The amount of moisture throughout was low, and the quantity of fat correspondingly high. In no case was there more than 15 per cent. of water, and only 4 samples contained more than 14 per cent. On the other hand, 11 samples had less than 10 per cent., the lowest being a pasteurized butter from Ames, Iowa, with only 6·72 per cent. of water. The average amount of water in the total 43 samples was 11·24 per cent. The fat varies almost inversely as the water, small quantities of curd and ash having to be allowed for. The largest quantity of fat was 91·23 per cent. in the sample containing only 6·72 per cent. of water. The lowest proportion of fat was 80·18 per cent., whilst the average of all the samples shows 85·9 per cent., which is regarded as a good market standard. The curd varied from 0·55 to 1·7 per cent., with an average of 0·98. This small amount indicates superior keeping qualities. Theoretically there should be no curd present, but this degree of perfection is never attained in practice. It was desired to have the butter contain about 2½ per cent. of salt, but the quantity of ash in the 43 samples ranged from 0·83 to 4·79 per cent., the average being 1·88. Analyses made at Washington of butters other than American showed a general average of 13·22 per cent. of water over 28 samples representing 14 countries. The lowest were 10·25 per cent. in a Canadian butter and 10·38 in an Australian sample. The highest was 19·1 per cent. in an Irish butter, which also contained the remarkably large quantity of 8·28 per cent. of salt. Three samples of Danish butter contained 12·65, 14·27, and 15·14 per cent. respectively of water. French and Italian unsalted butter included, the former 15·46 and the latter 14·41 per cent. of water, and yet appeared to be unusually dry. In 7 samples of Irish butters the percentages of water ranged from 11·48 to 19·1. Of the 28 foreign butters 15 were found to contain preservatives. All 5 samples from Australia, the 2 from France, the single ones from Italy, New Zealand, Argentina, and England, and 4 out of the 7 from Ireland, contained boric acid.

### The Milk Trade.

The term "milk trade" has come to signify the great traffic in country milk for the supply of dwellers in urban districts. Prior to 1860 this traffic was comparatively small, or in its infancy. Thirty years earlier it could not have been brought into existence, for it is an outcome of the great network of railways which was spread over the face of the country in the latter half of the 19th century. It affords an instructive illustration of the process of commercial evolution which has been fostered by the vast increase of urban population within the period indicated. It is a tribute to the spirit of sanitary reform which—as an example in one special direction—has brought about the disestablishment of urban cow sheds and the consequent demand for milk produced in the shires. London, in fact, is now being regularly supplied with fresh milk from places anywhere within 150 miles, and the milk traffic on the railways, not only to London but to other great centres, is an important item. A factor in the development of the milk trade must no doubt be sought in the outbreak of cattle plague in 1865, for it was then that the dairymen of the metropolis were compelled to seek milk all over England, and the capillary refrigerator being invented

soon after, the production of milk has remained ever since in the hands of dairymen living mainly at a distance from the towns supplied.

This great change in country dairying, involving the continuous export of enormous quantities of milk from the farms, has been accompanied by subsidiary changes in the management of dairy farms, and has necessitated the extensive purchase of feeding-stuffs for the production of milk, especially in winter time. It is probable that, in this way, a gradual improvement of the soil on such farms has been effected, and the corn-growing soils of distant countries are adding to the store of fertility of soils in the British Isles. Country roads, exposed to the wear and tear of a comparatively new traffic, are lively at morn and eve with the rattle of vehicles conveying fresh milk from the farms to the railway stations. Most of these changes were brought about within the limits of the last third of the 19th century.

In the case of London, the daily supply of a perishable article such as milk, which must be delivered to the consumer within a few hours of its production, to a population of five millions, is an undertaking of very great magnitude, especially when it is considered that only a comparatively minute proportion of the supply is produced in the metropolitan area itself. To meet the demand of the London consumer some 5000 dairies proper exist, as well as a large number of businesses where milk is sold in conjunction with other commodities. It has been computed that some 12,000 traders are engaged in the business of milk-selling in the metropolis, and the number of persons employed in its distribution, &c., cannot be fewer than 25,000. The amount of capital involved is very great, and it may be mentioned that the paid-up capital of six of the principal distributing and retail dairy companies amounts to upwards of one million sterling. The most significant feature in connexion with the milk supply of the metropolis at the beginning of the 20th century is the gradual extinction of the town "cowkeeper"—the retailer who produces the milk he sells. The facilities afforded by the railway companies, the favourable rates which have been secured for the transport of milk, and the more enlightened methods of its treatment after production, have made it possible for milk produced under more favourable conditions to be brought from considerable distances and delivered to the retailer at a price lower than that at which it has been possible to produce it in the metropolis itself. As a result, the number of milk cows in the county of London diminished from 10,000 in 1889 to 5144 in 1900, the latter, on an estimated production of 700 gallons per cow—the average production of stall-fed town cows—representing a yearly milk yield of 3,600,000 gallons. How small a proportion this is of the total supply will be gathered from the fact that the annual quantity of milk delivered in London on the Great Western line amounts to some 11,000,000 gallons, whilst the London and North-Western Railway delivers 9,000,000, and the Midland Railway at St Pancras 5,000,000, and at others of its London stations about 1,000,000, making 6,000,000 in all. The London and South-Western Railway brings upwards of 8,000,000 gallons to London, a quantity of 7,500,000 gallons is carried by the Great Northern Railway, and the Great Eastern Railway is responsible for 7,000,000. The London, Brighton, and South Coast Railway delivers 1,000,000 gallons, and the South-Eastern and Chatham and the London and Tilbury Railways carry approximately 1,000,000 gallons between them. A large quantity of milk is also carried in by local lines from farms in the vicinity of London and delivered at the local stations, and some is now brought by the Great Central Railway, which has recently obtained an entry into London. In addition to this, milk is taken into London by carts from farms in the neighbourhood of the metropolis. A computation of the total milk supply of the metropolis reveals a quantity approximating to 60,000,000 gallons per annum, or rather more than a million gallons per week, which, taking 500 gallons as the average yearly production of the cows contributing to this supply, represents the yield of at least 120,000 cows. The growth of the supply of country milk to London is seen from the figures given by Mr George Barham, chairman of the Express Dairy Co. Limited, in an article on "The Milk Trade" contributed to Professor Sheldon's work on *The Farm and Dairy*. The quantities carried by the respective railways in 1889 are therein stated in gallons as :—Great Western, 9,000,000; London and North-Western, 7,000,000; Midland, 7,000,000; London and South-Western, 6,000,000; Great Northern, 3,000,000; Great Eastern, 3,000,000; the southern lines, 2,000,000. The increase, therefore, during the past twelve years on these lines amounts to no less than 13,500,000 gallons per annum, or 36 per cent. The diminished production in the metropolis itself amounts approximately to only 3,000,000 gallons, and it follows, therefore, that the consumption has largely increased.

Previous to 1864 it was only possible to bring milk into London from short distances, but the introduction of the refrigerator has enabled milk to be brought from places as far removed from the metropolis as North Staffordshire, and it has even been received from Scotland. Practically the whole of the milk supplied to the metropolis is produced in England. Attempts have been made to introduce foreign milk during recent years, and in 1898 a company was formed to promote the sale of fresh milk from Normandy, but the enterprise did not succeed. The trade has shown signs of reviving since, owing probably to the increased cost of the home produced article, and during the winter season of 1900–1901 the largest quantity received into the kingdom in one week amounted to 10,000 gallons. Of recent years a large demand has sprung up for sterilized milk in bottles, and a considerable trade is also done in humanized milk, which is a milk preparation approximating in its chemical composition to human milk.

Estimating the average yield of milk of each country cow at 500 gallons per annum, and assuming an average of 28 cows to each farm, as many as 4300 farmers are engaged in supplying London with milk; allotting ten cows to each milker, it needs 12 battalions of 1000 men each for this work alone. Some 3500 horses are required to convey the milk from the farms to the country railway stations. The chief sources of supply are in the counties of Derby, Stafford, Leicester, Northampton, Notts, Warwick, Bucks, Oxford, Gloucester, Berks, Wilts, Hants, Dorset, Essex, and Cambridge. It is not entirely owing to the railways that London's enormous supply of milk has been rendered possible, for the milk must still have been produced in the immediate neighbourhood of the metropolis had not the method of reducing the temperature of the product by means of the refrigerator been devised. There are probably 5700 horses engaged in the delivery of milk in London, and more people are employed in this work than in milking the cows. One of the great difficulties the London dairyman has to contend with, and a cause of frequent anxiety to him, is associated with the rise and fall of the thermometer, for a movement to the extent of ten degrees one way or the other may diminish or increase the supply in an inverse ratio to the demand. Thus, at periods of extreme cold, the cows shrink in their yield of milk, while from the same cause the Londoner is demanding more, in an extra cup of coffee, &c. Again, at periods of extreme heat, which has the same effect on the

cow's production as extreme cold, the customer also demands an increased quantity of milk. Ten degrees fall of temperature in the summer will result in a lessened demand and an enlarged supply—to such an extent, indeed, that a single firm has been known to have had returned by its carriers some 600 gallons in one day. In such cases the cream separator is capable of rendering invaluable assistance. To make cheese in London in large quantities and at uncertain intervals has been found to be impracticable, whilst to set for cream a great bulk of milk is almost equally so. But now a considerable portion of what would otherwise be lost is saved by passing the milk through separators, and churning the cream into butter.

Previous to the enormous development of the urban trade in country milk, dairy farms were in the main self-sustaining in the matter of manures and feeding-stuffs, and the cropping of arable land was governed by routine. To-day, on the contrary, many dairy farms are run at high pressure by the help of purchased materials,—corn, cake, and manure,—and the land is cropped regardless of routine and independent of courses. Such crops, moreover, are grown—white straw crops, green crops, root crops—as are deemed likely to be most needed at the time when they are ready. Green crops,—"soiling" crops, as they are termed in North America,—consisting largely of vetches or tares (held up by stalks of oat plants grown amongst them), cabbages, and in some districts green maize, are used to supplement the failing grass-lands at the fall of the year, and root crops, especially mangel, are advantageously grown for the same purpose. For winter feeding the farm is made to yield what it will in the shape of meadow and clover hay, and of course root crops of the several kinds. This provision is supplemented by the purchase of, for example, brewers' grains as a bulky food, and of oilcake and corn of many sorts as concentrated food.

## Home Output, Imports, and Exports of Dairy Produce.

Whilst the quantity of imported butter and cheese consumed in the United Kingdom from year to year can be arrived at with a tolerable degree of accuracy, it is more difficult to form an estimate of the amounts of these articles annually produced at home. Various attempts have, however, from time to time been made by competent authorities to arrive approximately at the annual output of milk, butter, and cheese in the United Kingdom, and the results have been brought down to date by Messrs W. Weddel & Co. in their annual *Dairy Produce Review* (1899–1900), from which Table XI. is quoted. It shows the estimates for each of the ten years 1890 to 1899, the numbers in the second column of "cows and heifers in milk or in calf" being identical with those officially recorded in the agricultural returns. In thus estimating the quantity of milk, butter, and cheese produced within the United Kingdom, the "average milking life" of a cow is taken to be four years, from which it follows that on the average one-fourth of the total herd has to be renewed every year by heifers with their first calf. This leaves 75 per cent. of the total herd giving milk throughout the year. Each cow of this 75 per cent. is estimated as yielding 49 cwt., or 531 gallons of milk annually. It is assumed that 15 per cent. of the total milk yield is used for the calf, 32 per cent. utilized for butter-making, 20 per cent. for cheese-making, and the remaining 33 per cent. consumed in the household as fresh milk. A ton of milk is estimated to produce 80 ℔ of butter or 220 ℔ of cheese. A gallon of milk weighs 10·33 ℔ ($10\frac{1}{3}$ ℔). The probable effects of each season upon the production have been taken into consideration in making these estimates, and it will be noticed that owing to the terrible drought of 1893 a reduction of 9 per cent. is made from the average. Accept-

Table XI. *Estimated Annual Production of Milk, Butter, and Cheese in the United Kingdom for the Ten Years ended* 31st *December* 1899.

| Year ended December 31. | Cows and Heifers in Milk or in Calf on June 4. | Cows per 1000 of Population. | Cows and Heifers giving Milk all the Year round; say 75 per cent of Total. | Influence of Season. Percentage above or below the Average of previous 10 Years | Estimated Total Quantity of Milk produced in the 52 Weeks by 75 per cent of the Total Herd, at 49 Cwt or 531 Gallons per Cow. | Estimated Total Quantity of Butter produced in the 52 Weeks, taking 32 per cent of the Total Milk to yield 80 ℔ of Butter per Ton of Milk | Estimated Total Quantity of Cheese produced in the 52 Weeks, taking 20 per cent. of the Total Milk to yield 220 ℔ of Cheese per Ton of Milk. |
|---|---|---|---|---|---|---|---|
| | No. | No. | No. | Per cent. | Tons. | Tons | Tons. |
| 1890 | 3,956,220 | 105 5 | 2,967,165 | +3 0 | 7,487,640 | 85,572 | 147,078 |
| 1891 | 4,117,707 | 108 9 | 3,088,281 | Average. | 7,566,288 | 86,472 | 148,624 |
| 1892 | 4,120,451 | 108 1 | 3,090,339 | -5 6 | 7,147,337 | 81,684 | 140,394 |
| 1893 | 4,014,055 | 104 4 | 3,010,542 | -9·0 | 6,712,004 | 76,709 | 131,843 |
| 1894 | 3,925,486 | 101·2 | 2,944,115 | +6·3 | 7,667,505 | 87,628 | 150,611 |
| 1895 | 3,937,590 | 100·5 | 2,953,193 | -3·5 | 6,982,087 | 79,652 | 137,148 |
| 1896 | 3,958,762 | 100 0 | 2,969,387 | -4 0 | 6,983,999 | 79,817 | 130,000 |
| 1897 | 3,984,167 | 99·7 | 2,988,126 | +3 1 | 7,547,856 | 86,261 | 148,200 |
| 1898 | 4,035,501 | 100 0 | 3,025,526 | +3·2 | 7,645,105 | 87,372 | 150,171 |
| 1899 | 4,133,249 | 101 9 | 3,099,937 | -3·5 | 7,329,027 | 83,760 | 130,020 |
| 10 *Years' Average* | 4,018,318 | 103·0 | 3,013,660 | -0·7 | 7,906,874 | 83,992 | 141,412 |

ing these estimates with due reservation,[1] it is seen that the annual production of milk varied in the decade to the extent of nearly a million tons, the exact difference between the maximum of 7,667,505 tons in 1895 and the minimum of 6,712,004 tons in 1894 being 955,501 tons. The decennial averages are 7,906,874 tons of milk, 83,992 tons of butter, and 141,412 tons of cheese.

Table XII. furnishes an estimate of the total consumption of butter in the United Kingdom in each of the years 1891 to 1900. Whilst the estimated home production did not vary greatly from year to year, the imports from colonial and foreign sources underwent almost continuous increase. The ten years' average indicates 37·6 per cent. home-made, 7·3 per cent imported colonial, and 55·1 per cent. imported foreign butter. But whereas at the beginning of the decade the proportions were 45·4 per cent. home-made, 1·5 per cent. colonial, and 53·2 per cent. foreign, at the end the percentages were 32·8, 14·7, and 52·5 respectively. It thus appears that whilst the United Kingdom was able in 1891 to furnish nearly half of its requirements (45·4 per cent.), by 1900 it was unable to supply more than one-third (32·8 per cent.).

Table XII. *Estimated Home Production and Imports of Butter into the United Kingdom for the Ten Years ended* 30*th June* 1900.

| Year ended 30th June. | Home Production, *estimated.* | Imported Colonial. | Imported Foreign. | Total. |
|---|---|---|---|---|
| | Tons. | Tons. | Tons. | Tons. |
| 1891 . . | 84,961 | 2,883 | 99,598 | 187,442 |
| 1892 . . | 86,022 | 6,323 | 101,796 | 194,141 |
| 1893 . . | 84,078 | 9,408 | 105,712 | 199,198 |
| 1894 . . | 79,196 | 15,550 | 107,534 | 202,280 |
| 1895 . . | 82,168 | 17,807 | 116,730 | 216,705 |
| 1896 . . | 83,640 | 12,949 | 133,249 | 229,838 |
| 1897 . . | 79,734 | 18,111 | 138,800 | 236,645 |
| 1898 . . | 83,039 | 17,732 | 141,426 | 242,197 |
| 1899 . . | 87,326 | 22,443 | 142,193 | 251,962 |
| 1900 . . | 83,760 | 37,534 | 133,957 | 255,251 |
| 10 *Years' Average* | 83,392 | 16,074 | 122,099 | 221,565 |

The rapid headway which colonial butter is making in

[1] A special committee appointed by the council of the Royal Statistical Society commenced in 1901 an inquiry into the home production of milk and meat in the United Kingdom.

British markets is shown by the fact that for the five years ended 30th June 1900 the import had grown from 12,949 tons to 37,534 tons per annum, or an increase of 24,585 tons. It is during the mid-winter months that the colonial butter from Australasia arrives on the British markets, while that from Canada begins to arrive in July, and virtually ceases in the following January. The bulk of the Canadian butter reaches British markets during August, September, and October; the bulk of the Australasian in December, January, and February.

It appears to be demonstrated by the experience of the last decade of the 19th century that the United Kingdom is quite unable to turn out sufficient dairy produce to supply its own population. In the year ended 30th June 1891 the total import of butter was 102,500 tons, and for the year ended 30th June 1900 it was 170,700 tons, which shows an annual average increase in the decade of 6800 tons. This growth was on the whole very uniform, any disturbance in its regularity being attributable more to the deficient seasons in the colonies and foreign countries than to the bountiful seasons at home. Twice in the decade the import of butter from colonial sources fell off slightly from the previous year, namely, in 1896 and 1898, while only once was there any decrease in the foreign supply, and this occurred in 1900. In 1896 the colonial supply fell off by 5000 tons, principally owing to drought in Australia, but from foreign countries this deficiency was more than made good, as the increased import from these sources exceeded 16,500 tons. In 1900 the position was reversed, for while the foreign import fell away to the extent of over 8000 tons, the supply from the colonies exceeded that of 1899 by 15,000 tons, thus leaving a gain in the quantity of imported butter of nearly 7000 tons on the year. Table XII. shows that over the ten years 1891 to 1900 the import of colonial butter was augmented by 34,600 tons, and that of foreign by 33,600 tons, so that the increased import is fairly divided between colonial and foreign sources. If, however, the last five years of the period be taken, it will be seen that the increases in the arrivals of colonial butter have far exceeded those from foreign countries. Between 1891 and 1900 the Australasian colonies increased their quota by 13,400 tons, and Canada by 11,100 tons. Of foreign countries, Denmark showed the greatest development in the supply of imported butter, which increased in the ten years by 28,678 tons. Next came Russia and Holland, with increases respectively of 7207 tons and 6589 tons. Sweden, which made steady progress from 1891 to 1896, subsequently declined, and in 1900 sent 1400 tons less than in 1891. France and Germany are rapidly falling away, and the latter country will soon cease its supply altogether. Up to 1896 it was 6000 tons annually; by 1900 it had fallen to 1850 tons. France, which in 1892 sent to the United Kingdom 29,000 tons, regularly declined, and in 1900 sent only 16,800. Among the countries sending the smaller quantities, Argentina, Belgium, and Norway are all gradually increasing their supplies; but their totals are comparatively insignificant, as they together contributed in 1900 only 6400 tons out of a total foreign supply of 134,000 tons. The United States was erratic in its supplies during the decade, and up to 1900 had not made butter specially for export to the United Kingdom, as all the other foreign countries had done. Consequently it is only when supplies from elsewhere fail that American butter is sought for by British buyers. The large amount of salt in this butter, although suitable for the American palate, prevents its becoming popular in the United Kingdom.

The sources whence the United Kingdom receives butter from abroad are sufficiently indicated in Table XIII., which shows the absolute quantities and the relative proportions sent by the chief contributory countries in each of the four years 1897 to 1900, the order of precedence of the several countries being in accord with the figures for 1900. Denmark, as a result of the efforts made by that little kingdom to supply a sound product of uniform quality, possesses over 40 per cent. of the trade, and in the year 1900 received from the United Kingdom upwards of eight million pounds sterling for butter and over three million pounds sterling for bacon, the raising of pigs for the consumption of separated milk being an important adjunct of the dairying industry in Denmark, where butter factories are extensively maintained on the co-operative principle. It is worthy of note that some at least of the butter received in the United Kingdom from Russia is made in Siberia, whence it is sent at the outset on a long land journey in refrigerated railway cars for shipment at a Baltic port, usually Riga. The countries not specifically enumerated in Table XIII. from which butter is sent to the United Kingdom

TABLE XIII. *Annual Imports of Butter into the United Kingdom, 1897 to 1900.*

| From | 1897. | 1898. | 1899. | 1900. |
|---|---|---|---|---|
| | Cwt. | Cwt. | Cwt. | Cwt. |
| Denmark | 1,334,726 | 1,465,030 | 1,430,052 | 1,486,342 |
| Australasia | 269,432 | 228,563 | 366,944 | 509,910 |
| France | 448,128 | 416,821 | 353,942 | 322,048 |
| Holland | 278,631 | 269,324 | 284,810 | 282,805 |
| Russia [1] | ... | ... | ... | 209,738 |
| Sweden | 299,214 | 294,962 | 245,599 | 196,041 |
| Canada | 109,402 | 156,865 | 250,083 | 138,313 |
| United States | 154,196 | 66,712 | 159,137 | 56,046 |
| Germany | 51,761 | 41,231 | 36,953 | 36,042 |
| Other countries | 272,312 | 269,645 | 262,331 | 141,231 |
| Total | 3,217,802 | 3,209,153 | 3,389,851 | 3,378,516 |
| | Per cent. | Per cent. | Per cent. | Per cent. |
| Denmark | 41·5 | 45·6 | 42·2 | 44·0 |
| Australasia | 8·4 | 7·1 | 10·8 | 15·1 |
| France | 13·9 | 13·0 | 10·5 | 9·5 |
| Holland | 8·7 | 8·4 | 8·4 | 8·4 |
| Russia [1] | ... | ... | ... | 6·2 |
| Sweden | 9·3 | 9·2 | 7·2 | 5·8 |
| Canada | 3·4 | 4·9 | 7·4 | 4·1 |
| United States | 4·8 | 2·1 | 4·7 | 1·6 |
| Germany | 1·6 | 1·3 | 1·1 | 1·1 |
| Other countries | 8·4 | 8·4 | 7·7 | 4·2 |
| Total | 100·0 | 100·0 | 100·0 | 100·0 |

[1] Not shown separately in the Trade and Navigation Returns prior to 1900.

are Argentina, Belgium, Norway, and Spain—these are included in "other countries."

In Table XIV., relating to the estimated home production of cheese and the imports of that article, the ten years' average indicates a home-made supply of 55·3 per cent., imports of colonial cheese 24·2 per cent., and imports of foreign cheese 20·5 per cent. Comparing, however, the first with the last year of the period 1891 to 1900, it appears that in 1891 the proportions were 58·6 per cent. home-made, 17·2 per cent. colonial, and 24·2 per cent. foreign, whereas in 1900 the percentages were 50·3, 28·9, and 20·8 respectively. Hence the colonial contribution (chiefly Canadian) has gained ground at the expense both of the home-made and of the foreign. Again, comparing 1891 with 1900, the import of cheese into the United Kingdom increased to the extent of only 24,500 tons, so that it shows no expansion comparable with that of butter, which increased by about 70,000 tons. Simultaneously the estimated home production diminished by 17,000 tons.

In imported colonial cheese Canada virtually has the field to itself, for the only other colonial cheese which

TABLE XIV. *Estimated Home Production and Imports of Cheese into the United Kingdom for the Ten Years ended 30th June 1900.*

| Year ended 30th June. | Home Production, *estimated.* | Imported Colonial. | Imported Foreign. | Total. |
|---|---|---|---|---|
| | Tons. | Tons. | Tons. | Tons. |
| 1891 . . | 147,078 | 43,228 | 60,816 | 251,122 |
| 1892 . . | 148,624 | 45,781 | 59,452 | 253,857 |
| 1893 . . | 140,394 | 55,549 | 56,767 | 252,710 |
| 1894 . . | 131,843 | 57,322 | 52,498 | 241,663 |
| 1895 . . | 150,611 | 61,622 | 52,570 | 264,803 |
| 1896 . . | 137,148 | 62,478 | 44,569 | 244,195 |
| 1897 . . | 130,000 | 67,028 | 46,317 | 243,345 |
| 1898 . . | 148,260 | 77,620 | 49,114 | 274,994 |
| 1899 . . | 150,000 | 73,752 | 46,985 | 270,737 |
| 1900 . . | 130,000 | 74,702 | 53,903 | 258,605 |
| 10 *Years' Average* | 141,396 | 61,908 | 52,299 | 255,603 |

finds its way into the United Kingdom is from New Zealand, but the amount of this kind is comparatively insignificant, having been in 1900 only 4000 tons out of a total import of 128,600 tons. Australia, in several seasons since 1891, sent small quantities, but they are not worth quoting.

From foreign countries the decline in the export of cheese is mainly in the case of the United States, which shipped to British ports 10,000 tons less in 1900 than in 1891. France also is losing its cheese trade in British markets, and is being supplanted by Belgium. In 1891 France supplied over 3000 tons, in 1900 the import was below 2000 tons. Belgium in 1891 supplied less than 1000 tons, but in 1900 contributed 2600 tons. The import trade in Dutch cheese remains almost stationary. In 1891 it amounted to 15,300 tons, in 1899 it was 15,600 tons, whilst in 1900, owing to exceptionally high prices, which stimulated the manufacture, it reached 17,000 tons.

Over 80 per cent. of the cheese imported into the United Kingdom is derived from North America, but the bulk of the trade belongs to Canada, which supplies nearly 60 per cent. of the entire import. The value of the

TABLE XV. *Annual Imports of Cheese into the United Kingdom,* 1897 *to* 1900.

| From | 1897. | 1898. | 1899. | 1900. |
|---|---|---|---|---|
| | Cwt. | Cwt. | Cwt. | Cwt. |
| Canada . . | 1,526,664 | 1,432,181 | 1,337,198 | 1,511,872 |
| United States . | 631,616 | 485,995 | 590,737 | 680,583 |
| Holland . . | 297,604 | 292,925 | 328,541 | 327,817 |
| Australasia . . | 68,615 | 44,608 | 32,294 | 86,513 |
| France . . . | 36,358 | 33,086 | 34,307 | 35,110 |
| Other countries . | 42,321 | 50,657 | 60,992 | 69,910 |
| Total . . | 2,603,178 | 2,339,452 | 2,384,069 | 2,711,805 |
| | Per cent. | Per cent. | Per cent. | Per cent. |
| Canada . . | 58·6 | 61·2 | 56·1 | 55·8 |
| United States . | 24·3 | 20 8 | 24·8 | 25·1 |
| Holland . . | 11·4 | 12·5 | 13·8 | 12·0 |
| Australasia . . | 2·7 | 1·9 | 1·3 | 3·2 |
| France . . . | 1·4 | 1·4 | 1·4 | 1·3 |
| Other countries . | 1·6 | 2·2 | 2·6 | 2·6 |
| Total . . | 100·0 | 100·0 | 100·0 | 100·0 |

cheese exported from Canada to the United Kingdom in the calendar year 1900 was close upon £3,800,000. As is shown in Table XV. above, Holland, Australasia, and France participate in this trade, whilst amongst the "other countries" are Germany, Italy, and Russia. The cheese sent from North America and Australasia is mostly of the substantial Cheddar type, whereas soft or "fancy" cheese is the dominant feature of the French shipments. Thus, in the calendar year 1900 the average price of the cheese imported into the United Kingdom from France was 61s. per cwt., whilst the average value of the cheese from all other sources was 50s. per cwt., there being a difference of 11s. in favour of the "soft" cheese of France.

The imports of butter and margarine into the United Kingdom were not separately distinguished before the year 1886. Previous to that date they amounted, at five year intervals, to the following aggregate quantities:—

| | 1870. | 1875. | 1880. | 1885. |
|---|---|---|---|---|
| Cwt. . . | 1,159,210 | 1,467,870 | 2,326,305 | 2,401,373 |

For the same years the imports of cheese registered the subjoined totals:—

| | 1870. | 1875. | 1880. | 1885. |
|---|---|---|---|---|
| Cwt. . . | 1,041,281 | 1,627,748 | 1,775,997 | 1,833,832 |

The imports of butter and margarine, both separately and together, and also the imports of cheese in each year from 1886 to 1900 inclusive, are set out in Table XVI., the most significant feature of which is the rapid expansion it shows in the imports of butter. In the space of nine

TABLE XVI. *Imports of Butter, Margarine, and Cheese into the United Kingdom,* 1886–1900.

| Year. | Butter. | Margarine. | Total Butter and Margarine. | Cheese. |
|---|---|---|---|---|
| | Cwt. | Cwt | Cwt. | Cwt. |
| 1886 . . | 1,543,566 | 887,974 | 2,431,540 | 1,734,890 |
| 1887 . . | 1,513,134 | 1,276,140 | 2,789,274 | 1,836,789 |
| 1888 . . | 1,671,433 | 1,139,743 | 2,811,176 | 1,917,616 |
| 1889 . . | 1,927,842 | 1,241,690 | 3,169,532 | 1,907,999 |
| 1890 . . | 2,027,717 | 1,079,856 | 3,107,573 | 2,144,074 |
| 1891 . . | 2,135,607 | 1,235,430 | 3,371,037 | 2,041,325 |
| 1892 . . | 2,183,009 | 1,305,350 | 3,488,359 | 2,232,817 |
| 1893 . . | 2,327,474 | 1,299,970 | 3,627,444 | 2,077,462 |
| 1894 . . | 2,574,835 | 1,109,325 | 3,684,160 | 2,266,145 |
| 1895 . . | 2,825,662 | 940,168 | 3,765,830 | 2,133,819 |
| 1896 . . | 3,037,718 | 925,934 | 3,963,652 | 2,244,525 |
| 1897 . . | 3,217,802 | 936,543 | 4,154,345 | 2,603,178 |
| 1898 . . | 3,209,153 | 900,615 | 4,109,768 | 2,339,452 |
| 1899 . . | 3,389,851 | 953,175 | 4,343,026 | 2,384,069 |
| 1900 . . | 3,378,516 | 920,416 | 4,298,932 | 2,711,805 |

years, between 1887 and 1896, the quantity was doubled. On the other hand, the general tendency of the imports of margarine, which have been much more uniform than those of butter, has been in the direction of decline since 1892. It is necessary, however, to point out that there has been an increase in the number of margarine factories in the United Kingdom, and in the quantity of margarine manufactured in them, during the last few years. Taking the imports of butter and margarine together, the aggregate in 1899 and also in 1900 was practically three times as large as a quarter of a century earlier, in 1875. The imports of cheese have increased at a less rapid rate than those of butter, and the quantity imported in 1900, which was a maximum, fell considerably short of twice the quantity in 1875. In 1886, 1887, 1888, 1890, and 1892 the imports of cheese exceeded those of butter, but since the last-named year those of butter have always been the larger, and in 1899 were fully a million cwt. more than the cheese imports. The cheapness of imported fresh meat has probably had the effect of checking the growth of the demand for cheese amongst the industrial classes.

The imports of condensed milk into the United Kingdom

were not separately distinguished before 1888. In that year they amounted to 352,332 cwt. The quantities imported in subsequent years were the following:—

| Year. | Cwt. | Year. | Cwt. | Year. | Cwt. |
|---|---|---|---|---|---|
| 1889 | 339,892 | 1893 | 501,005 | 1897 | 756,243 |
| 1890 | 407,426 | 1894 | 529,465 | 1898 | 817,274 |
| 1891 | 444,666 | 1895 | 545,394 | 1899 | 824,599 |
| 1892 | 481,374 | 1896 | 611,335 | 1900 | 986,741 |

The quantity thus increased continuously in each year after 1889, with the result that in 1900 the imports had grown to nearly three times the amount of those in 1889. Simultaneously, over the period 1889–1900 the annual value of the imports steadily advanced from £704,849 to £1,405,033. Thus, while the imports of condensed milk trebled in quantity, they doubled in value. A fair proportion is, however, exported, as is shown in the following statement of exports of imported condensed milk for the four years 1897 to 1900:—

| | 1897. | 1898. | 1899. | 1900. |
|---|---|---|---|---|
| Quantity, cwt. | 143,932 | 133,596 | 118,394 | 164,602 |
| Value | £274,578 | £256,525 | £228,446 | £309,460 |

There is also an export trade in condensed milk made in the United Kingdom. Thus, in 1892 the exports of home-made condensed milk amounted to 61,442 cwt., valued at £133,556. By 1896 the quantity had almost doubled, and reached 111,959 cwt., of the value of £224,831. In subsequent years the exports were:—

| | 1897. | 1898. | 1899. | 1900. |
|---|---|---|---|---|
| Quantity, cwt. | 154,901 | 178,055 | 185,749 | 209,447 |
| Value | £302,748 | £343,070 | £353,819 | £390,559 |

Milk and cream (fresh or preserved other than condensed) received no separate classification in the imports until 1894, in which year the quantity imported was 161,633 gallons, followed by 126,995 gallons in 1895, and 22,776 gallons in 1896. The quantities have since been returned by weight—10,006 cwt. in 1897, 10,691 cwt. in 1898, 7859 cwt. in 1899, and 15,638 cwt. in 1900. The values of these imports in the successive years 1894 to 1900 were £21,371, £19,991, £5489, £9848, £11,293, £16,068, and £26,837.

The total values of the imports of dairy produce of all kinds—butter, margarine, cheese, &c.—into the United Kingdom were, at five-year intervals between 1875 and 1890, the following:—

| | 1875. | 1880. | 1885. | 1890. |
|---|---|---|---|---|
| Value | £13,211,592 | £17,232,548 | £15,632,852 | £19,505,798 |

The values in each year of the closing decade of the 19th century are set forth in Table XVII., where the totals in the last column include small sums for margarine-cheese and, since 1893, for fresh milk and cream. The aggregate value more than doubled during the last quarter of the century. The earliest year for which the value of imported butter is separately available is 1886, when it amounted to £8,141,438. Thirteen years later this sum had more than doubled, and it is an impressive fact that in the closing year of the century the United Kingdom should have expended on imported butter alone a sum closely approximating to 17½ million pounds sterling, equivalent to about three-fourths of the total amount disbursed on imported wheat grain.[1]

TABLE XVII. *Values of Dairy Products imported into the United Kingdom from* 1891 *to* 1900, *in Thousands of Pounds Sterling.*

| Year. | Butter. | Margarine. | Cheese. | Condensed Milk. | Total. |
|---|---|---|---|---|---|
| | £1000. | £1000. | £1000. | £1000. | £1000. |
| 1891 | 11,591 | 3558 | 4813 | 900 | 20,863 |
| 1892 | 11,965 | 3713 | 5417 | 930 | 22,025 |
| 1893 | 12,754 | 3655 | 5161 | 1010 | 22,580 |
| 1894 | 13,457 | 3045 | 5475 | 1079 | 23,077 |
| 1895 | 14,245 | 2557 | 4675 | 1084 | 22,581 |
| 1896 | 15,344 | 2498 | 4900 | 1170 | 23,920 |
| 1897 | 15,917 | 2485 | 5886 | 1398 | 25,715 |
| 1898 | 15,962 | 2384 | 4970 | 1436 | 24,779 |
| 1899 | 17,214 | 2549 | 5503 | 1455 | 26,747 |
| 1900 | 17,450 | 2465 | 6838 | 1743 | 28,544 |

The imports of margarine—that is, of margarine specifically declared to be such—into the United Kingdom are derived almost entirely from Holland. Out of a total of 920,416 cwt. imported in 1900 Holland supplied 862,154 cwt., and out of £2,464,839 expended on imported margarine in the same year Holland received £2,295,174. To the imports in the year named Holland contributed 93·7 per cent.; France, 2·9; Norway, 0·9; all other countries, 2·5; so that Holland possesses almost a monopoly of this trade. The quantities of imported butter, margarine, and cheese that are again exported from the United Kingdom are trivial when compared with the imports, as will be seen from the following quantities and values in the three years 1898 to 1900:—

| | 1898. | 1899. | 1900. | 1898. | 1899. | 1900. |
|---|---|---|---|---|---|---|
| | Cwt. | Cwt. | Cwt. | £ | £ | £ |
| Butter | 63,491 | 50,453 | 51,583 | 319,806 | 257,999 | 258,931 |
| Margarine | 10,023 | 13,139 | 11,326 | 24,721 | 33,319 | 27,882 |
| Cheese | 56,694 | 56,390 | 55,982 | 159,210 | 163,991 | 168,369 |

There is also a very small export trade in butter and cheese made in the United Kingdom, but its insignificant character is evident from the subjoined details as to quantities and values for the years named:—

| | 1898. | 1899. | 1900. | 1898. | 1899. | 1900. |
|---|---|---|---|---|---|---|
| | Cwt. | Cwt. | Cwt. | £ | £ | £ |
| Butter | 11,359 | 9936 | 10,127 | 59,731 | 53,195 | 53,701 |
| Cheese | 10,126 | 9758 | 9,356 | 36,803 | 35,890 | 36,691 |

## AMERICAN DAIRYING.

The development of the dairying industry in the vast region of the United States of America has been described in the official *Year-Book* by Major Henry E. Alvord, chief of the dairy division of the Bureau of Animal Industry in the Department of Agriculture at Washington. The beginning of the 20th century found the industry upon an altogether higher level than seemed possible a few decades earlier. The milch cow herself, upon which the whole business rests, has become almost as much a machine as a natural product, and a very different creature from the average animal of bygone days. The few homely and inconvenient implements for use in the laborious duties of the dairy have been replaced by perfected appliances, skilfully devised to accomplished their object and to lighten labour. Long rows of shining metal pans no longer adorn rural dooryards. The factory system of co-operative or concentrated manufacture has so far taken the place of home dairying that in entire states the cheese vat or press is as rare as the handloom, and in many counties it

[1] In 1901 the United Kingdom imported 3,702,810 cwt. of butter, valued at £19,297,005, both totals being the largest on record.

is as difficult to find a farm churn as a spinning-wheel. An illustration of the nature of the changes is afforded in the butter-making district of Northern Vermont, at St Albans, the business centre of Franklin county. In 1880 the first creamery was built in this county; ten years later there were 15. Now a creamery company at St Albans has upwards of 50 skimming or separating stations distributed through Franklin and adjoining counties. To these is carried the milk from more than 30,000 cows. Farmers who possess separators at home may deliver cream which, after being inspected and tested, is accepted and credited at its actual butter value, just as other raw material is sold to mills and factories. The separated cream is conveyed by rail and waggon to the central factory, where in one room from 10 to 12 tons of butter are made every working day—a single churning place for a whole county! The butter is all of standard quality, "extra creamery," and is sold on its reputation upon orders received in advance of its manufacture. The price is relatively higher than the average for the product of the same farms fifty years earlier. This is mainly due to better average quality and greater uniformity—two important advantages of the creamery system.

In one important detail dairy labour is the same as a century ago. Cows still have to be milked by hand. Although many attempts have been made, and patent after patent has been issued, no mechanical contrivance has yet proved a practical success as a substitute for the human hand in milking. Consequently, twice (or thrice) daily every day in the year, the dairy cows must be milked by manual labour. This is one of the main items of labour in dairying, and is a delicate and important duty. Assuming 10 cows per hour to a milker, which implies quick work, it requires the continuous service of an army of 300,000 men, working 10 or 12 hours a day throughout the year, to milk the cows kept in the United States.

The business of producing milk for urban consumption, with the accompanying agencies for transportation and distribution, has grown to immense proportions. In many places the milk trade is regulated and supervised by excellent municipal ordinances, which have done much to prevent adulteration and to improve the average quality of the supply. Quite as much is, however, being done by private enterprise through large milk companies, well organized and equipped, and establishments which make a speciality of serving milk and cream of fixed quality and exceptional purity. Such efforts to furnish "certified" and "guaranteed" milk, together with general competition for the best class of trade, are doing more to raise the standard of quality and improve the service than all the legal measures. The buildings and equipment of some of these modern dairies are beyond precedent. This branch of dairying is advancing fast, upon the safe basis of care, cleanliness, and better sanitary conditions.

Cheese-making has been transferred bodily from the domain of domestic arts to that of manufactures. In the middle of the 19th century about 100,000,000 ℔ of cheese was made yearly in the United States, and all of it in farm dairies. At the beginning of the 20th century the annual production is about 300,000,000 ℔, and 96 or 97 per cent. of this is made in factories. Of these there are nearly 3000, but they vary greatly in capacity, and some are very small. New York and Wisconsin possess a thousand each, but the former state makes nearly twice as much cheese as the latter, whilst the two together produce three-fourths of the entire output of the country. A change is taking place in the direction of bringing a number of factories previously independent into a "combination" or under the same management. This tends to improve the quality and secure greater uniformity in the product, and often reduces cost of manufacture. More than nine-tenths of all the cheese made is of the familiar standard type, copied after the English Cheddar, but new kinds and imitations of foreign varieties are increasing. The annual export of cheese from the United States ranges between 30,000,000 and 50,000,000 ℔. The consumption *per capita* does not exceed 3½ ℔ per annum, which is much less than in most European countries.

Butter differs from cheese in that it is still made much more largely on farms in the United States than in creameries. Creamery butter controls all the large markets, but this represents little more than one-third of the entire business. Estimating the annual butter product of the entire country at 1,400,000,000 ℔, not much over 500,000,000 ℔ of this is made at the 7500 or 8000 creameries in operation. Iowa is the greatest butter-producing state, and the one in which the greater proportion is made on the factory plan. The total output of butter in this state is one-tenth of all made in the Union. The average quality of butter has materially improved since the introduction of the creamery system and the use of modern appliances. Nevertheless, a vast quantity of poor butter is made—enough to afford a large and profitable business in collecting it at country stores at grease prices or a little more, and then rendering or renovating it by patent processes. This renovated butter has been fraudulently sold to a considerable extent as the true creamery article, of which it is a fair imitation while fresh, and several states have made laws for the identification of the product and to prevent buyers from being imposed upon. No butter is imported, and the quantity exported is insignificant, although there is beginning to be a foreign demand for American butter. The home consumption is estimated at the yearly rate of 20 ℔ per person, which, if correct, would indicate Americans to be the greatest butter-eating people in the world. The people of the United States also consume millions of pounds every year of butter substitutes and imitations, such as oleomargarine and butterine. Most of this is believed to be butter by those who use it, and the State Dairy Commissioners are busily employed in carrying out the laws intended to protect purchasers from these butter frauds.

The by-products of dairying have, within recent years, been put to economical uses, in an increasing degree. For every pound of butter made there are 15 to 20 ℔ of skim-milk and about 3 ℔ of butter-milk, and for every pound of cheese nearly 9 ℔ of whey. Up to 1889 or 1890 enormous quantities of skim-milk and butter-milk from the creameries and of whey from the cheese factories were entirely wasted. At farm dairies these by-products are generally used to advantage in feeding animals, but at the factories —especially at the seasons of greatest milk supply—this most desirable method of utilization is to a great extent impracticable. In many places new branches have been instituted for the making of sugar-of-milk and other commercial products from whey, and for the utilization of skim-milk in various ways. The albumin of the latter is extracted for use with food products and in the arts. The casein is desiccated and prepared as a substitute for eggs in baking, as the basis of an enamel paint, and as a substitute for glue in paper-sizing. It has also been proposed to solidify it to make buttons, combs, brush-backs, electrical insulators, and similar articles.

No census of cows in the United States was taken until the year 1840, but they have been enumerated in each subsequent decennial census. From 23 to 27 cows to every 100 of the population were required to keep the country supplied with milk, butter, and cheese, and provide for the export of dairy products. The export trade, though it has fluctuated considerably, has never exceeded the produce of 500,000 cows. At the close of the 19th century it was estimated that there was one milch cow in the United States for every four persons, making the number of cows about 17,500,000. They are, however, very unevenly distributed, being largely concentrated in the great dairy states, Iowa leading with 1,500,000 cows, and being followed closely by New York. In the middle and eastern states the milk product goes very largely to the supply of the numerous large towns and cities. In the central, west, and north-west butter is the leading dairy product.

Table XVIII. shows approximately the quantity and value of the dairy products of the United States in 1899, the grand total representing a value of $451,600,000. Adding to this the skim-milk, butter-milk, and whey, at their proper feeding value, and the calves dropped yearly, the annual aggregate value of the produce of the dairy cows exceeds $500,000,000, or is more than one hundred million pounds sterling. Accepting these estimates as conservative, they show that the commercial importance of the dairy industry of the United States is such as to justify all reasonable provisions for guarding its interests.

TABLE XVIII. *Estimated Number of Cows and Quantity and Value of Dairy Products in the United States in* 1899.

| Cows. | Product. | Rate of Product per Cow. | Total Product. | Rate of Value. | Total Value. |
|---|---|---|---|---|---|
| | | | | Cents. | Dollars. |
| 11,000,000 | Butter | 130 ℔ | 1,430,000,000 ℔ | 18 | 257,400,000 |
| 1,000,000 | Cheese | 300 ℔ | 300,000,000 ℔ | 9 | 27,000,000 |
| 5,500,000 | Milk | 380 gals. | 2,090,000,000 gals. | 8 | 167,200,000 |

(W. FR)

**Dalaguete,** a town on the east coast of the island of Cebú, Philippine Islands, in 9° 52′ N. It has a hot but healthful climate. The growing of Indian corn, sibucao, cacao, copra, and sugar, and the weaving of rough fabrics, are the sole occupations of its inhabitants. The language is Cebú-Visayan. Population, 21,000.

**Dalbeattie,** a police burgh of south-east Kirkcudbrightshire, Scotland, 14½ miles south-west of Dumfries by rail. There are important quarries in the neighbourhood, and steam granite-polishing works in the town. There is a prospect of ironstone being worked. There is a town-hall, a mechanics' institute, and a church hall. Population (1891), 3149; (1901), 3462.

**Dale, Robert William** (1829–1895), Congregationalist divine, was born in London, 1st December 1829, and was educated for the Congregational ministry. In 1853 he became co-pastor of Carr's Lane Chapel, Birmingham, with the veteran John Angell James. At first the liberality of his theology occasioned much suspicion and offence, over which, partly owing to the support of the senior minister, he so completely triumphed as to become sole pastor on the latter's death in 1859. He was for many years one of the most influential personalities in Birmingham, and took the most active part in the remarkable municipal development of that city. He was especially conspicuous in the controversies arising out of the Education Act of 1870, which, so far as Birmingham was concerned, were terminated in 1879 by a compromise, of which Dale disapproved. His adherence to Mr Chamberlain on the Irish Home Rule question did not diminish his influence. His sympathies were broad, and he had many warm friends in the Church of England. He died on 13th March 1895.

**Dalecarlia,** in Swedish *Dalarne* ("the Dales"), in popular usage the name of a very characteristic region in the middle of Sweden, characteristic in respect of its productions, but even more so in respect of its people. It is virtually the same as the county of Kopparberg, of which Falun is the chief town. The Dalecarlians or Dalesmen speak their own peculiar dialect (see a paper by A. Noreen in *De Svenska Landsmålen*, vol. iv., 1881), wear their own peculiar costumes, and are famed for their brave spirit and sturdy love of independence. More than once they have played a decisive *rôle* in the history of Sweden. In 1434, led by Engelbrecht, the miner, they rose against the oppressive tyranny of the officers of Erik XIV. of Denmark, and in 1519-23 it was amongst them that Gustavus Vasa found his staunchest supporters in his patriotic task of freeing Sweden from the yoke of the Danes. The districts around Lakes Runn and Siljan ("the Eye of the Dales"), the principal sheets of water in the valleys of the Dal rivers, are consequently classic ground. The people are for the most part small peasant proprietors. In 1894, out of 27,848 estates, no less than 27,287 were under 50 acres in extent. They eke out their scanty returns from tilling the soil by a variety of home industries, such as making scythes, saws, bells, wooden wares, hair goods, and so forth. The larger portion of the area is, however, covered with forest (75·4 per cent. in 1897), only 7·1 per cent. being under cultivation. Besides the wealth of the forests, the Dales contain some of the largest and most prolific iron mines in Sweden, especially Grängesberg. In 1898 the iron mines of Dalecarlia yielded 751,038 tons of iron ore, or 32·6 per cent. of the entire output of the kingdom. Nor is iron the only mineral. In Dalecarlia, too, are the far-famed copper mines of Falun, as well as mines of silver and lead, zinc and sulphur. In consequence of this the district has numerous smelting furnaces, blasting and rolling mills, iron and metallurgical works, as well as sawmills, wood-pulp factories, chemical works, and so forth.

See G. H. MELLIN, *Skildringar af den Skandinaviska Nordens Folklif og Natur*, vol. iii. (1865), and FREDERIKA BREMER, *I Dalarne* (1845), of which there is an English translation by Wm. and Mary Howitt (1852).

**Dalias,** a town of Spain in the province of Almeria, 8 miles from the Mediterranean. Population in 1897, 6341. In its neighbourhood are the ruins of an older town, walls, tombs, aqueducts. Between Dalias and the sea are small lagoons and an old castle turned into a guardhouse for the carabiniers. The streets are narrow and irregular, and there is no public building worth mentioning, except a parish church and the town-hall, both comparatively modern. An earthquake on 25th August 1804 destroyed most of the houses and churches, and 162 inhabitants were killed. The trade of Dalias consists of wheat, wine, oil, oranges, esparto-grass, and fruit.

**Dalkeith,** a police burgh and market-town in the county of Edinburgh, situated between the North and South Esk, 6¾ miles south-east from Edinburgh P.O. and about 5 miles from the city boundary. In 1899 the parish contained 7704 inhabitants (W. parish, 4323; E. parish, 3381), and in 1901 the police burgh had 6753. The rental of lands in the parish for 1899-1900 amounted to £40,156. In recent years Eskbank (within the parish and burgh) has been made a handsome residential quarter. The only changes of note in the industries of the town are the closing of the iron-foundry and the opening of a colliery near Eskbank. A pipe supply of water has been introduced from the Edinburgh district works, and has been supplemented by a local water scheme.

**Dallas,** capital of Dallas county, Texas, U.S.A., in 32° 45′ N. lat. and 96° 46′ W. long., on the eastern bank of Trinity river, which here is not navigable. It is at an altitude of 422 feet. It has a level site, a fairly regular plan, is sewered, and has a good water supply. It is the third city in population and the most important railway centre in Texas, being entered by five railways, four of which are trunk lines. It is in a rich agricultural region, which produces cotton, wheat, and Indian corn, and it has large trade and extensive manufactures. In 1890 its manufacturing capital was $5,250,000, employing 4082 hands, and the products were worth over $9,000,000. Prominent among these were flour and leather goods. In 1900 the assessed valuation of real and personal property, on a basis of about one-half of the full value, was $23,016,600, the net debt $1,759,458, and the tax rate from $24.02 to $24.50 per $1000. Dallas was founded in 1841, but most of its growth has come in recent years. Population (1880), 10,358; (1890), 38,067; (1900), 42,638, of whom 9035 were negroes.

**Dalmatia** (German, *Dalmatien*; Serbo-Croatian, *Dalmacija*), a crownland and kingdom of the Cisleithan part of the Austro-Hungarian monarchy. It is separated from the rest of Austria by Croatia, which belongs to the Hungarian half of the monarchy. Ethnographically and geographically it is part of the lands of the Hungarian crown, and is still included in the official title of the Kingdom of Croatia. Its reincorporation is one of the objects aimed at by a considerable section of the Croatian people. Population in 1869, 456,961; in 1880, 476,101; in 1890, including garrison of 5400 men, 527,426, the equivalent of 106·83 inhabitants per square mile; in 1900, 591,597. Proportion of females to males (1890), 993 to 1000. The Serbo-Croatians constitute 96·2 per cent. and the Italians 3 per cent. of the population, the former increasing, the latter declining. The remainder is made up of

Germans, Czechs, Slovenes, &c. 83·3 per cent. are of the Roman Catholic and 16·5 per cent. of the Greek Orthodox faith. There are 329 Jews. In 1896 the marriage-rate was 7·34, the birth-rate 40·01, or excluding still-births, 39·65, and the death-rate 29 per thousand. Of the births, 3·84 per cent. were illegitimate, with the exception of Görz and Gradisca the lowest proportion in Austria. Dalmatia sends 11 members to the Reichsrath. In the provincial Diet there are 28 Croatians, 9 Servians, and 6 Italians. The distinction drawn between Croatians and Servians in Dalmatia, as also in Croatia and Slavonia, is political and religious, and not one of race. The Croatians and Servians of those parts speak the same language, but the former are Roman Catholic and use the Latin characters in writing, and the latter are Orthodox and employ the Cyrillic characters. Notwithstanding the progress during the period 1860–1900, Dalmatia remained the most backward of the Austrian crownlands in the matter of education. In 1890, 82·8 per cent. of the population were returned as illiterate, that proportion being an improvement of 4 per cent. on the census of 1880. It possessed, in 1893, 5 intermediate and 337 elementary schools, attended by 88·4 per cent. of the children, 6 theological seminaries, 6 gymnasia, and some 40 technical and continuation schools. Of the 28 periodicals, 21 are in the Serbo-Croatian language, 5 in Italian, 1 in Latin, and 1 in polyglot. But a small proportion of the population (4·58 per cent.) is engaged in industry and mining, and 4·8 per cent. in trade and transport. Viticulture, which has latterly made great progress, cattle-breeding, and the cultivation of the olive tree, vegetables, and fruit are among the principal resources, a large number of the inhabitants also finding employment as sailors and in sea-fishing. A small quantity of sea salt is recovered by evaporation. Other industries are ship-building (which is of considerable importance), the manufacture of liqueurs (Maraschino), spirits, soap, oil, &c. Its commerce consists mainly of a lucrative transit trade with Bosnia and Herzegovina, Montenegro, Turkey, and the ports of the Adriatic and the Mediterranean. In 1890 the Dalmatian mercantile marine numbered 8 steamers and nearly 6000 sailing vessels of all sizes. Communications are in a backward state. In 1897 there were 125 kilometres of railway, 2857 kilometres of roads, and 55 kilometres of navigable waterway. There were 151 post and 98 telegraph offices.

See T. G. Jackson, *Dalmatia, the Quarnero, and Istria* (Oxford, 1887); and works by Goracucchi, Schatzmayer, Ruthner, Cons, Nolhac, Schweiger-Lerchenfeld, Eitelberger, and Pisrni.

(Æ. O'N.)

**Dalny,** a new Russian free port, opened to foreign trade in 1901, situated on the Central Manchurian Railway, and thus one of the Pacific termini of the Trans-Siberian Railway. It stands at the head of Talien-wan Bay, on the east side of Liao-tung peninsula, in Manchuria, about 20 miles north-east from Port Arthur and twenty-one days' journey by rail from St Petersburg. The harbour is roomy, easy of entrance, and free from ice all the year round. Population (1901), 50,000, of whom about one-half were workmen, mostly Chinese.

**Dalry,** a mining and manufacturing town of Ayrshire, Scotland, on the river Garnock, 17½ miles north by west of Ayr. There is a public hall, library, and a public park (1893). Ironstone is extensively worked, and the town contains woollen factories and a large worsted spinning mill. The other industries embrace cabinet-making, coke-making, brick-making, machine-knitting, box-making, currying, and the manufacture of aërated waters. The churches are two Established, two United Free, Episcopal, and Roman Catholic, and there are two memorial mission halls. Three public schools had an average attendance of 698 in 1898–99, a female industrial school 184, and a church school 129. Population (1881), 5010; (1891), 4572; (1901), 5314.

**Dalton-in-Furness,** a market-town and railway station in the North Lonsdale parliamentary division of Lancashire, England, 4 miles north-east by north of Barrow-in-Furness. The ruins of Furness Abbey are near, and Dalton Castle stands on an eminence in the town. There are Established, Roman Catholic, and various Nonconformist churches. There are numerous iron-ore mines in the parish, and ironworks at Askam, in the northern part of the district. Area (an urban district), 7223 acres. Population (1881), 13,339; (1901), 13,020.

**Damanhur,** a town and important railway station of Lower Egypt, 10 miles from Alexandria, capital of the richly cultivated province of Behera. The town stands on the site of the ancient Egyptian *Pa-Tahoth*, the *Hermopolis Parva* of the Romans. A much frequented fair is held here three times a year, and there are several cotton manufactories. Population (1900), 19,600.

**Damão** or **Damaun,** a town of Portuguese India, capital of district Damão, is situated on the east side of the entrance of the Bay of Cambay. Area of district, 148 sq. miles. Population (1894), 64,248. Salt is produced by 500 to 600 men to the extent of nearly 3000 tons annually. The cajuri palm is cultivated.

**Damaraland.** See South-West Africa, German.

**Damascus** (Hebrew, *Dammesek*, or *Darmesek;* Egyptian, *Timasku;* Assyrian, *Dimaski;* Arabic, *Dimishk esh-Shám*, or simply *esh-Shám*), the largest town in Syria, and the capital of the esh-Shám (Syria) viláyet, situated near the northern edge of the Ghúta, a fertile plain at the foot of Anti-Lebanon, at an altitude of 2250 ft. above the sea. It is the seat of the governor-general, of the Mushir commanding the 5th Army Corps, and of British and other consuls, and is connected by rail with its port, Beirút, and with el-Mezeiríb in the Haurán. The Ghúta is irrigated by the Baradá (see Abanah) and the 'Awaj, which flow eastward in several channels, and lose themselves, about 18 miles from the city, in small marshes at the edge of the Syrian desert. The plain is covered nearly everywhere with luxuriant vegetation, out of which, where the foliage is densest and most beautiful, rise the minarets and domes of the "white smokeless city." The delicious verdure and the all-pervading presence of running water constitute an abiding charm, which is heightened by the barren hills that almost surround the great oasis. Damascus stands on both banks of the main stream of the Baradá, about two miles from the mouth of the gorge through which the river runs to the plain. Most of the city, including the oldest portion, which was enclosed by a wall, lies on the right bank, and from it a long suburb, el-Meidán, stretches southwards for more than a mile along the Haj road to Mecca. On the left bank is a large suburb, el-'Amára, of later date, and north of this, at the foot of the hills, lies the beautiful suburb es-Salihíyeh. The old wall, Arab and Turkish, on Roman or perhaps earlier foundations, was pierced by several gates, and the city was traversed from east to west by a colonnaded street, "the street which was called Straight," still named Derb el-Mustakím. In the north-west corner, near the Baradá, which filled its moat, is the castle built, A.D. 1219, by el-Melik el-Ashraf. It stands on the site of an earlier building, possibly a palace, which was connected with a temple to the east, now represented by the Great Mosque of the Omeiyads. This mosque, destroyed by fire on the 14th of October 1893, and now being rebuilt, was a reconstruction, by the Khalíf el-Walíd (705–715), of the Church of St

John, built by Arcadius (395–408), on a site previously occupied by Roman, Greek, and earlier temples. Traces of the church and of the two later temples are still visible, and recent research has shown that they, and their courts, stood near the centre of a great enclosure measuring 1300 feet from east to west and 1000 feet from north to south. The streets are still narrow, crooked, and in great part unpaved. The best is the Derb el-Mustakím, which separates the Christian and Jewish quarters. The water of the Baradá is led through every quarter; but the supply is not well regulated, and in autumn the water is often unwholesome. In the gardens which surround the city grow walnut, apricot, pomegranate, almond, &c.; and beyond them are fields of wheat, barley, and maize. The climate is good: in winter there is often hard frost and much snow, and even in summer, with a day temperature of 100° F., the nights are always cool. Fever, dysentery, and ophthalmia, chiefly due to exposure to heavy dews and cold nights, are prevalent.

In 1894–95 the Damascus-Mezeiríb and Damascus-Beirút Railways were opened, and they are now worked at a loss by a French company. Damascus appears to have been an important manufacturing, agricultural, and commercial centre from an early time. Its position in a fertile oasis on the edge of the desert, with roads leading to Northern Syria, the Euphrates and Persian Gulf, Arabia, Egypt, and Acre, its natural port, enabled it to recover after every disaster, and until the opening of the Suez Canal it retained its importance. It is still the market of the nomads, but the surer and cheaper sea route has almost destroyed the transit trade to which it owed its wealth, and has even diminished the importance of the annual pilgrim caravan (Haj) to Mecca. The Damascene, however, still retains his skill as a craftsman and tiller of the soil. The furniture of mosaic wood-work, the iron, copper, and brass work, and the woven goods in cotton, silk, and wool, show great artistic taste. The principal exports are silk and cotton fabrics, wool, apricot paste, wooden and brass goods, starch, rope, &c.; and the imports are cloths, prints, muslins, raw silk, sugar, rice, &c.

The value of exports and imports in certain specified years is shown in the following table:—

| | 1890 | 1894. | 1898. |
|---|---|---|---|
| Exports . . . | £325,660 | £400,830 | £302,050 |
| Imports . . . | 525,710 | 614,490 | 675,080 |

The estimates of population vary from 154,000 (including Christians and Jews, 55,000) to 225,000 (including Christians and Jews, 35,000). Most of the Christians belong to the Orthodox and Roman Catholic (United) Greek Churches; and there are also communities of Melchites, Jacobites, Maronites, Nestorians, Armenians, and Protestants. There are British and American Missions, and a British hospital.

AUTHORITIES.—LORTET. *La Syrie d'aujourd'hui*, p. 567 f. Paris, 1884.—VON OPPENHEIM. *Vom Mittelmeer zum Persischen Golf*, i. 49 f. Berlin, 1899.—G. A. SMITH. *Historical Geography of the Holy Land. Encyclopædia Biblica*, art. "Damascus." *Consular Reports.*—BAEDEKER-SOCIN. *Handbook to Syria and Palestine.*—For the Great Mosque see Dickie, Spiers, and Wilson in *Palestine Exploration Fund Quarterly Statement*, October 1897.

(C. W. W.)

**Damghán,** a town in the province of Samnán va Damghán of Persia, situated 216 miles from Teherán, on the high-road thence to Khorasan, at an elevation of 3770 feet, and in 36° 10′ N. lat. and 54° 20′ E. long. It has a population of less than 10,000. There are post and telegraph offices, and a great export trade is done in pistachios and almonds. The Damghán almonds of the kind called "Kághazí" (papery), with very thin shells, are famous throughout the country. Damghán was an important city in the Middle Ages, but only a ruined mosque, with a number of columns and some fine wood-carvings, and two minarets remain of that period. Near the city, a few miles south and south-west, are the remains of *Hecatompylos*, extending from Frát, 16 miles south of Damghán, to near Gúsheh, 20 miles west.

**Damien** [properly VEUSTER, JOSEPH DE] (1840–1889), Belgian missionary, was born at Tremeloo, near Louvain, on 3rd January 1840. He was educated for a business career, but in his eighteenth year entered the Church, joining the Society of the Sacred Heart of Jesus and Mary (also known as the Picpus Congregation), and taking Damien as his name in religion. In October 1863, while he was still in minor orders, he went out as a missionary to the Pacific Islands, taking the place of his brother, who had been prevented by an illness. Reaching Honolulu in March 1864 he was ordained priest in Whitsuntide of that year, and took up his duties as a missionary. Having observed the ravages of leprosy among the natives, and the painful scenes attending the departure of the lepers, whom it was the practice of the Hawaian Government to deport to the island of Molokai, he conceived an earnest desire to mitigate their lot, and in 1873 volunteered to take spiritual charge of the settlement at Molokai. Here he remained for the rest of his life, with occasional visits to Honolulu, until he became stricken with leprosy in 1885. Besides attending to the spiritual needs of the lepers, he managed, by the labour of his own hands and by appeals to the Hawaian Government, to improve materially the water-supply, the dwellings, and the victualling of the settlement. For five years he worked alone; subsequently other resident priests from time to time assisted him. He succumbed to leprosy on 15th April 1889. Some ill-considered imputations upon Father Damien by a Protestant clergyman produced a memorable tract by Robert Louis Stevenson, which has made Damien's self-sacrifice famous throughout the world. (J. M'F.)

**Damietta,** a town of Lower Egypt, near the mouth of the eastern branch of the Delta, terminus of the railway from Cairo, from which it is distant 125 miles by the Tanta route. The population in 1900 was 43,000, showing an increase of 9000 since 1882. Damietta gives its name to *dimity*, a kind of striped cloth, for which the place was at one time famous. Now it is chiefly important for its rice and fisheries, with which it does a brisk trade with the interior.

**Damoh,** a town and district of British India, in the Jubbulpore division of the Central Provinces. The town is a railway station, 48 miles east of Saugor. The population in 1881 was 8665; in 1891 it was 11,753.

The DISTRICT OF DAMOH has an area of 2831 square miles. The population in 1881 was 312,957, and in 1891 was 325,613, giving an average density of 115 persons per square mile. In 1901 the population was 285,138, showing a decrease of 12 per cent., due to famine. The land revenue was Rs.3,85,000, the incidence of assessment being R.0–5–3 per acre; the cultivated area in 1897–98 was 433,283 acres, of which 1858 were irrigated; the number of police was 326; the boys at school numbered 3394, being 13·6 per cent. of the male population of school-going age; the registered death-rate in 1897 was 60·84 per thousand. A branch of the Indian Midland Railway was opened throughout from Saugor to Katni (104 miles) in January 1899. Damoh suffered severely from the famine of 1896–97. Fortunately the famine of 1900 was little felt.

**Dana, Charles Anderson** (1819–1897), American journalist, was born in Hinsdale, New Hampshire, 8th August 1819; studied at Harvard University, and became a member of the Brook Farm literary, philosophical, socialistic, and agricultural community, near West Roxbury, Massachusetts, in 1842, where he had among his associates Hawthorne, George W. Curtis, George Ripley, and Margaret Fuller, the three last named being afterwards, like himself, editors in New York. As a young

man he entered ardently into the hopes of the founders of this famous enterprise, lecturing on "Friendship," &c., and remaining at Brook Farm until its abandonment in 1844; but in his later years, in the words of the historian of the community, "he departed farthest from its aspirations." After some newspaper work in Boston, Dana joined the editorial staff of Horace Greeley's New York *Tribune*, becoming its managing editor, and actively promoting the anti-slavery cause, but he left the paper in 1862, because of a sharp disagreement with Greeley regarding the conduct of the war by President Lincoln's administration. As Dana himself said: "Greeley was for peace and I was for war." Having served as a special investigating agent of the war department at the front,—informing Secretary Stanton of the capacity and methods of various generals in the field,—Dana became assistant-secretary of war in 1863, so remaining until the close of the conflict. After a brief editorial connexion in Chicago, in 1868 he became editor and chief owner of the New York *Sun*, and remained in control until his death, giving to it a flavour and character of its own, in accordance with his personal preferences and aversions. The *Sun*, under the same editorial control, was at one time a spokesman of Tammany Hall, the local democratic organization in New York City; and at another of the Republican party and its managers in city and state. In his later years, after his abandonment of the Democratic party at the time of the nomination of William J. Bryan for the Presidency, Dana was the principal advocate, in the New York press, of an aggressively "American" or national policy. Dana was also a connoisseur in art, and edited a *Household Book of Poetry* (1857) and (with George Ripley) the *New American Cyclopædia*, 15 vols. (1857-63). His reminiscences of the war, having been published in a monthly magazine, were issued in a volume in 1898. Dana died at his home at Glen Cove, Long Island, near New York, 18th October 1897.

**Dana, James Dwight** (1813-1895), American geologist, was born in Utica, New York, 12th February 1813. He early displayed a taste for science, and entered Yale College that he might study under the elder Benjamin Silliman. Graduating in 1833, for the next two years he was teacher of mathematics to midshipmen in the navy, and sailed to the Mediterranean while engaged in his duties. From 1835 to 1837 he was assistant to Professor Silliman at Yale, and then, for five years, acted as mineralogist and geologist of a United States exploring expedition, commanded by Commodore Wilkes, in the Southern and Pacific oceans. His labours in preparing the reports of such explorations as he had shared, occupied parts of thirteen years after his return to America in 1842. In 1844 he again became a resident of New Haven, married Professor Silliman's daughter, and on the resignation of Silliman was appointed Silliman Professor of Natural History and Geology in Yale College, a position which he only resigned in 1892. He was for many years, and until his death, editor of the *American Journal of Science and Arts* (founded in 1819 by Benjamin Silliman), to which he was a constant contributor, principally of articles on geology and mineralogy. A bibliographical list of his writings shows 214 titles of books and papers, beginning in 1835 with a paper on the conditions of Vesuvius in 1834, and ending with the fourth revised edition (finished in February 1895) of his *Manual of Geology*. His reports on *Zoophytes*, on the *Geology of the Pacific*, and on *Crustacea*, summarizing his work on the Wilkes expedition, appeared in 1846, 1849, and 1852-54, in quarto volumes, with copiously illustrated atlases; but as these were issued in small numbers, his general reputation more largely rests upon his *System of Mineralogy* (1837), *Manual of Geology* (1862), and *Corals and Coral Islands* (1872), the first two having repeatedly been revised in successive editions, and widely used as text-books in American colleges. In 1887 Dana visited the Hawaiian Islands to study volcanoes. He died in New Haven, 14th April 1895.

**Danao,** a town on the east coast of the island of Cebú, Philippine Islands, in 10° 28′ N. It has a comparatively cool and healthful climate, and is the centre of a rich agricultural region producing rice, Indian corn, sugar, copra, and cacao. The language is Cebú-Visayan. Population, 16,000.

**Danbury,** capital of Fairfield county, Connecticut, U.S.A., in 41° 24′ N. lat. and 73° 26′ W. long., at an altitude of 371 feet. It is entered by the New England and the New York, New Haven, and Hartford Railways. It has for a century been known for its manufacture of hats, which is still its principal industry. Besides these, it makes boots and shoes, shirts, and other articles of clothing. Population of the town (1880), 11,666; (1890), 19,473; (1900), 19,474; population of the city (1890), 16,552; (1900), 16,537.

**Dancing** is the universal human expression, by movements of the limbs and body, of a sense of rhythm which is implanted among the primitive instincts of the animal world. The rhythmic principle of motion extends throughout the universe, governing the lapse of waves, the flow of tides, the reverberations of light and sound, and the movements of celestial bodies; and in the human organism it manifests itself in the automatic pulses and flexions of the blood and tissues. Dancing is merely the voluntary application of the rhythmic principle, when excitement has induced an abnormally rapid oxidization of brain tissue, to the physical exertion by which the overcharged brain is relieved. This is primitive dancing; and it embraces all movements of the limbs and body expressive of joy or grief, all pantomimic representations of incidents in the lives of the dancers, all performances in which movements of the body are employed to excite the passions of hatred or love, pity or revenge, or to arouse the warlike instincts, and all ceremonies in which such movements express homage or worship, or are used as religious exercises. Although music is not an essential part of dancing, it almost invariably accompanies it, even in the crudest form of a rhythm beaten out on a drum. For an account of savage dances and of such customs of savage or civilized peoples as are included in this description of dancing the reader is referred to the article on Dancing in the ninth edition of this work. The present article is confined to a discussion of Modern Dancing, by which is meant dancing employed as an entertainment either for the dancers or for spectators—this being the direction in which dancing has been developed as an art in civilized countries. In its evolution, its direct application to arouse emotion or religious feeling tends to be obscured, and, although attempts are occasionally made to revive it, finally dropped out; and it is in the sense of an art or pastime that the term dancing is used in this article.

Italy, in the 15th century, saw the renaissance of dancing, and France may be said to have been the nursery of the modern art, though comparatively few modern dances are really French in origin. The national dances of other countries were brought to France, studied systematically, and made perfect there. An English or a Bohemian dance, practised only amongst peasants, would be taken to France, polished and perfected, and would at last find its way back to its own country, no more recognizable than a piece of elegant cloth when it returns from the printer to the place from which as "grey" material it was

sent. The fact that the terminology of dancing is almost entirely French is a sufficient indication of the origin of the rules that govern it. The earliest dances that bear any relation to the modern art are probably the *danses basses* and *danses hautes* of the 16th century. The *danse basse* was the dance of the court of Charles IX. and of good society, the steps being very grave and dignified, not to say solemn, and the accompaniment a psalm tune. The *danses hautes*, or *baladines*, had a skipping step, and were practised only by clowns and country people. More lively dances, such as the *Gaillarde* and *Volta* were introduced into France from Italy by Catherine de' Medici, but even in these the interest was chiefly spectacular. Other dances of the same period were the *Branle* (afterwards corrupted to *Braule*, and known in England as the Brawle)—a kind of generic dance which was capable of an almost infinite amount of variety. Thus there were imitative dances—*Branles mimés*, such as the *Branles des Ermites, Branles des flambeaux*, and the *Branles des lavandières*. The *Branle* in its original form had steps like the *Allemande*. Perhaps the most famous and stately dance of this period was the *Pavane* (of Spanish origin), which is very fully described in Tabouret's *Orchésographie*, the earliest work in which a dance is found minutely described. The *Pavane*, which was really more a procession than a dance, must have been a very gorgeous and noble sight, and it was perfectly suited to the dress of the period, the stiff brocades of the ladies and the swords and heavily plumed hats of the gentlemen being displayed in its simple and dignified measures to great advantage. The dancers in the time of Henry III. of France usually sang, while performing the *Pavane*, a *chanson*, of which this is one of the verses:

> "Approche donc, ma belle,
> Approche—toi, mon bien;
> Ne me sois plus rebelle,
> Puisque mon cœur est tien;
> Pour mon âme apaiser,
> Donne-moi un baiser."

In the *Pavane* and *Branle*, and in nearly all the dances of the 17th and 18th centuries, the practice of kissing formed a not unimportant part, and seems to have added greatly to the popularity of the pastime. Another extremely popular dance was the *Saraband*, which, however, died out after the 17th century. It was originally a Spanish dance, but enjoyed an enormous success for a time in France. Every dance at that time had its own tune or tunes, which were called by its own name, and of the *Saraband* the Chevalier de Grammont wrote that "it either charmed or annoyed everyone, for all the guitarists of the court began to learn it, and God only knows the universal twanging that followed." Vauquelin des Yveteaux in his eightieth year desired to die to the tune of the *Saraband*, "so that his soul might pass away sweetly." After the *Pavane* came the *Courante*, a court dance performed on tiptoe with slightly jumping steps and many bows and curtseys. The *Courante* is one of the most important of the strictly modern dances. The Minuet and the Waltz were both in some degree derived from it, and it had much in common with the famous *Seguidilla* of Spain. It was a favourite dance of Louis XIV., who was an adept in the art, and it was regarded in his time as of such importance that a nobleman's education could hardly have been said to be begun until he had mastered the *Courante*.

The dance which the French brought to the greatest perfection—which many, indeed, regard as the fine flower of the art—was the *Minuet*. Its origin, as a rustic dance, is not less antique than that of the other dances from which the modern art has been evolved. It was originally a *branle* of Poitou, derived from the *Courante*. It came to Paris in 1650, and was first set to music by Lully. It was at first a gay and lively dance, but on being brought to court it soon lost its sportive character and became grave and dignified. It is mentioned by Beauchamps, the father of dancing-masters, who flourished in Louis XIV.'s reign, and also by Blondy, his pupil; but it was Pécour who really gave the Minuet its popularity, and although it was improved and made perfect by Dauberval, Gardel, Marcel, and Gaétan Vestris, it was in Louis XV.'s reign that it saw its golden age. It was then a dance for two in moderate triple time, and was generally followed by the Gavotte. Afterwards the Minuet was considerably developed, and with the Gavotte became chiefly a stage dance and a means of display; but it should be remembered that the minuets which are now danced on the stage are generally highly elaborated with a view to their spectacular effect, and have imported into them steps and figures which do not belong to the Minuet at all, but are borrowed from all kinds of other dances. The original Court Minuet was a grave and simple dance, although it did not retain its simplicity for long. But when it became elaborated it was glorified and moulded into a perfect expression of an age in which deportment was most sedulously cultivated and most brilliantly polished. The "languishing eye and smiling mouth" had their due effect in the minuet; it was a school for chivalry, courtesy, and ceremony; the hundred slow graceful movements and courtesies, the pauses which had to be filled by neatly turned compliments, the beauty and bravery of attire—all were eloquent of graces and outward refinements which we cannot boast now. The fact that the measure of the Minuet has become incorporated in the structure of the Symphony shows how important was its place in the polite world. The *Gavotte*, which was often danced as a pendant to the Minuet, was also originally a peasant's dance, a *danse des Gavots*, and consisted chiefly of kissing and capering. It also became stiff and artificial, and in the later and more prudish half of the 18th century the ladies received bouquets instead of kisses in dancing the Gavotte. It rapidly became a stage dance, and it has never been restored to the ballroom. Grétry attempted to revive it, but his arrangement never became popular. Other dances which were naturalized in France were the *Ecossaise*, popular in 1760; the *Cotillon*, fashionable under Charles X., derived from the peasant *branles* and danced by ladies in short skirts; the *Galop*, imported from Germany; the *Lancers*, invented by Laborde in 1836; the *Polka*, brought by a dancing-master from Prague in 1840; the *Schottisch*, also Bohemian, first introduced in 1844; the *Bourée*, or French clog-dance; the *Quadrille*, known in the 18th century as the *Contredanse*; and the *Waltz*, which was danced as a *volte* by Henry III. of France, but only became popular in the beginning of the 19th century. We shall return to the history of some of these later dances in discussing the dances at present in use.

If France has been the nursery and school of the art of dancing, Spain is its true home. There it is part of the national life, the inevitable expression of the gay, contented, irresponsible, sunburnt nature of the people. The form of Spanish dances has hardly changed; some of them are of great antiquity, and may be traced back with hardly a break to the performances in ancient Rome of the famous dancing-girls of Cadiz. The connexion is lost during the period of the Arab invasion, but the art was not neglected, and Jovellanos suggests that it took refuge in the Asturias. At any rate, dances of the 10th and 12th centuries have been preserved uncorrupted. The earliest dances known were the *Turdion*, the *Gibidana*,

the *Pié-de-gibao*, and (later) the *Madama Orleans*, the *Alemana*, and the *Pavana*. Under Philip IV. theatrical dancing was in high popularity, and ballets were organized with extraordinary magnificence of decoration and costume. They supplanted the national dances, and the *Zarabanda* and *Chacona* were practically extinct in the 18th century. It is at this period that the famous modern Spanish dances the *Bolero*, *Seguidilla*, and the *Fandango* first appear. Of these the *Fandango* is the most important. It is danced by two people in 6–8 time, beginning slowly and tenderly, the rhythm marked by the click of castanets, the snapping of the fingers, and the stamping of feet, and the speed gradually increasing until a whirl of exaltation is reached. A feature of the *Fandango* and also of the *Seguidilla* is a sudden pause of the music towards the end of each measure, upon which the dancers stand rigid in the attitudes in which the stopping of the music found them, and only move again when the music is resumed. M. Vuillier, in his *History of Dancing*, gives the following description of the *Fandango*:—"Like an electric shock, the notes of the Fandango animate all hearts. Men and women, young and old, acknowledge the power of this air over the ears and soul of every Spaniard. The young men spring to their places, rattling castanets, or imitating their sound by snapping their fingers. The girls are remarkable for the willowy languor and lightness of their movements, the voluptuousness of their attitudes—beating the exactest time with tapping heels. Partners tease and entreat and pursue each other by turns. Suddenly the music stops, and each dancer shows his skill by remaining absolutely motionless, bounding again into the full life of the Fandango as the orchestra strikes up. The sound of the guitar, the violin, the rapid tic-tac of heels (*taconeos*), the crack of fingers and castanets, the supple swaying of the dancers, fill the spectator with ecstasy. The measure whirls along in a rapid triple time. Spangles glitter; the sharp clank of ivory and ebony castanets beats out the cadence of strange, throbbing, deepening notes—assonances unknown to music, but curiously characteristic, effective, and intoxicating. Amidst the rustle of silks, smiles gleam over white teeth, dark eyes sparkle and droop, and flash up again in flame. All is flutter and glitter, grace and animation—quivering, sonorous, passionate, seductive."

The *Bolero* is a comparatively modern dance, having been invented by Sebastian Cerezo, a celebrated dancer of the time of King Charles III. It is remarkable for the free use made in it of the arms, and is said to be derived from the ancient *Zarabanda*, a violent and licentious dance, which has entirely disappeared, and with which the later Saraband has practically nothing in common. The step of the *Bolero* is low and gliding, but well marked. It is danced by one or more couples. The *Seguidilla* is hardly less ancient than the *Fandango*, which it resembles. Every province in Spain has its own *Seguidilla*, and the dance is accompanied by *coplas*, or verses, which are sung either to traditional melodies or to the tunes of local composers; indeed, the national music of Spain consists largely of these coplas. Baron Davillier, among several specimens of *Seguidillas*, gives this one

"Mi corazon volando
Se fué á tu pecho;
Le cortaste las alas,
Y quédo dentro.
Por atrevido
Se quedará por siempre
En el metido."[1]

[1] "My heart flew to thy breast. Thou didst cut its wings, so that it remained there. And now it has waxed daring, and will stay with thee for evermore."

M. Vuillier quotes a *copla* which he heard at Polenza, in the Balearic Islands. This verse is formed on the rhythm of the *Malagueña*:

"Una estrella se ha pardida
En el ciel y no parece;
En tu cara se ha metido;
Y en tu frente resplandece."[2]

The *Jota* is the national dance of Aragon, a lively and splendid, but withal dignified and reticent, dance derived from the 16th century *Passacaille*. It is still used as a religious dance. The *Cachuca* is a light and graceful dance in triple time. It is performed by a single dancer of either sex. The head and shoulders play an important part in the movements of this dance. Other provincial dances now in existence are the *Jaleo de Jerez*, a whirling measure performed by gipsies, the *Palotéa*, the *Polo*, the *Gallegada*, the *Muyneria*, the *Habas Verdes*, the *Zapateado*, the *Zorongo*, the *Vito*, the *Tirano*, and the *Tripola Trapola*. Most of these dances are named either after the places where they are danced or after the composers who have invented tunes for them. Many of them are but slight variations from the *Fandango* and *Seguidilla*.

The history of court dancing in Great Britain is practically the same as that of France, and need not occupy much of our attention here. But there are strictly national dances still in existence which are quite peculiar to the country, and may be traced back to the dances and games of the Saxon gleemen. The Egg dance and the Carole were both Saxon dances, the Carole being a Yule-tide festivity, of which the present-day Christmas carol is a remnant. The oldest dances which remain unchanged in England are the Morris dances, which were introduced in the time of Edward III. The name Morris or Moorish refers to the origin of these dances, which are said to have been brought back by John of Gaunt from his travels in Spain. The Morris dances are associated with May-day, and are danced round a Maypole to a lively and capering step, some of the performers having bells fastened to their knees in the Moorish manner. They are dressed as characters of old English tradition, such as Robin Hood, Maid Marian, Friar Tuck, Little John, and Tom the Piper. All the true country dances of Great Britain are of an active and lively measure; they may all, indeed, be said to be founded on the jig; and the hornpipe, which is a kind of jig, is the national dance of England. Captain Cook on his voyages made his sailors dance hornpipes in calm weather to keep them in good health. A characteristic of English dances was that they partook to a great extent of the nature of games; there was little variety in the steps, which were nearly all those of the jig or hornpipe, but these were incorporated into various games or plays, of which the Morris dances were the most elaborate. Richard Baxter wrote that "sometimes the Morris dancers would come into the church in all their linen and scarves and antic dresses, with Morris bells jingling at their legs; and as soon as Common Prayer was read, did haste and presently to their play again." May-day has always been celebrated in England with rustic dances and festivities. Before the Reformation there were no really national dances in use at court; but in the reign of Elizabeth the homely, domestic style of dancing reached the height of its popularity. Remnants of many of these dances remain to-day in the games played by children and country people; "Hunt the Slipper," "Kiss in the Ring," "Here we go round the Mulberry Bush," are examples. All the Tudor dances were kissing dances, and must have been the occasion of a great deal of merriment. Mrs Groves

[2] "A star is lost and appears not in the sky; in thy face it has set itself; on thy brow it shines."

gives the following description of the Cushion Dance:—"The dance is begun by a single person, man or woman, who, taking a cushion in hand, dances about the room, and at the end of a short time stops and sings: 'This dance it will no farther go,' to which the musician answers: 'I pray you, good sir, why say so?' 'Because Joan Sanderson will not come to.' 'She must come to whether she will or no,' returns the musician, and then the dancer lays the cushion before a woman; she kneels and he kisses her, singing 'Welcome, Joan Sanderson.' Then she rises, takes up the cushion, and both dance and sing 'Prinkum prankum is a fine dance, and shall we go dance it over again?' Afterwards the woman takes the cushion and does as the man did." Other popular dances—generally adapted to the tunes of popular songs, the nature of some of which may be guessed from their titles—were the Trenchmore, Omnium-gatherum, Tolly-polly, Hoite cum toite, Dull Sir John, Faine I would, Sillinger, All in a Garden Green, An Old Man's a Bed Full of Bones, If All the World were Paper, John, Come Kiss Me Now, Cuckholds All Awry, Green Sleeves and Pudding Pies, Lumps of Pudding, Under and Over, Up Tails All, The Slaughter House, Rub her Down with Straw, Have at thy Coat Old Woman, The Happy Marriage, Dissembling Love, Sweet Kate, Once I Loved a Maiden Fair. Dancing practically disappeared during the Puritan *régime*, but with the Restoration it again became popular. It underwent no considerable developments, however, until the reign of Queen Anne, when the glories of Bath were revived in the beginning of the 18th century, and Beau Nash drew up his famous codes of rules for the regulation of dress and manners, and founded the balls in which the polite French dances completely eclipsed the simpler English ones. An account of a dancing lesson witnessed by a fond parent at this time is worth quoting, as it shows how far the writer (but not his daughter) had departed from the jolly, romping traditions of the old English dances:—"As the best institutions are liable to corruption, so, sir, I must acquaint you that very great abuses are crept into this entertainment. I was amazed to see my girl handed by and handing young fellows with so much familiarity, and I could not have thought it had been my child. They very often made use of a most impudent and lascivious step called *setting* to partners, which I know not how to describe to you but by telling you that it is the very reverse of *back to back.* At last an impudent young dog bid the fiddlers play a dance called *Moll Patley*, and, after having made two or three capers, ran to his partner, locked his arms in hers, and whisked her round cleverly above ground in such a manner that I, who sat upon one of the lowest benches, saw farther above her shoe than I can think fit to acquaint you with. I could no longer endure these enormities, wherefore, just as my girl was going to be made a whirligig, I ran in, seized my child, and carried her home." What we may call polite dancing, when it became fashionable, soon invaded London, its first home being Madame Cornely's famous Carlisle House in Soho Square. Ranelagh and Vauxhall and Almack's were all extensively patronized, and the rage for magnificent entertainment and dancing culminated in the erection of the palatial Pantheon in Oxford Street—a place so universally patronized that even Dr Johnson was to be found there. White's and Boodle's were also famous assembly rooms, but the most exclusive of all these establishments was Almack's, the original of Brooks's Club.

The only true national dances of Scotland are reels, strathspeys, and flings, while in Ireland there is but one dance—the jig, which is there, however, found in many varieties and expressive of many shades of emotion, from the maddest gaiety to the wildest lament. Curiously enough, although the Welsh dance often, they have no strictly national dances.

Dancing in present-day society is a comparatively simple affair, as five-sixths of almost all ball programmes consists of WALTZES. The origin of the Waltz is a much-debated subject, the French, Italians, and Bavarians each claiming for their respective countries the honour of having given birth to it. As a matter of fact the Waltz, as it is now danced, comes from Germany; but it is equally true that its real origin is French, since it is a development of the *Volte*, which in its turn came from the *Lavolta* of Provence, one of the most ancient of French dances. The *Lavolta* was fashionable in the 16th century, and was the delight of the Valois court. The *Volte* danced by Henry III. was really a *Valse à deux pas*; and Castil-Blaze says that "the waltz which we took again from the Germans in 1795 had been a French dance for four hundred years." The change, it is true, came upon it during its visit to Germany, hence the theory of its German origin. The first German waltz tune is dated 1770—"Ach! du lieber Augustin." It was first danced at the Paris opera in 1793, in Gardel's ballet *La Dansomanie.* It was introduced to English ballrooms in 1812, when it roused a storm of ridicule and opposition, but it became popular when danced at Almack's by the Emperor Alexander in 1816. The Waltz *à trois temps* has a sliding step in which the movements of the knees play an important part. The *tempo* is moderate, so as to allow three distinct movements on the three beats of each bar; and the Waltz is written in 3–4 time and in eight bar sentences. Walking up and down the room and occasionally breaking into the step of the dance is not true waltzing, and the habit of pushing one's partner backwards along the room is an entirely English one. But the dancer must be able to waltz equally well in all directions, pivoting and crossing the feet when necessary in the reverse turn. It need hardly be said that the feet should never leave the floor in the true Waltz. Gungl, Waldteufel, and the Strauss family may be said to have moulded the modern Waltz to its present form by their rhythmical and agreeable compositions. There are variations—chiefly American—which include hopping and lurching steps; these are degradations, and foreign to the spirit of the true Waltz.

The QUADRILLE is a *Contredanse* of some antiquity. The *Contredanse* was first brought to England from Normandy by William the Conqueror, and was common all over Europe in the 16th and 17th centuries. The term Quadrille means a kind of card game, and the dance is supposed to be in some way connected with the game. A species of Quadrille appeared in a French ballet in 1745, and since that time the dance has gone by that name. Like many other dances, it came from Paris to Almack's in 1815, and in its modern form was danced in England for the first time by Lady Jersey, Lady Harriet Butler, Lady Susan Ryder, and Miss Montgomery, with Count Aldegarde, Mr Montgomery, Mr Harley, and Mr Montague. It immediately became popular. It then consisted of very elaborate steps, which in England have been simplified until the degenerate practice has become common of walking through the dance. It can hardly be said to be popular in England to-day. This is a pity, for the Quadrille, properly danced, has many of the graces of the Minuet. It is often stated that the *Contredanse*, or square dance, is of modern French origin. This is incorrect, and probably arises from a mistaken identification of the terms Quadrille and square dance. "Dull Sir John" and "Faine I would" were square dances popular in England three hundred years ago. "Country dance" is a corrupt Anglicization of *contredanse*, and not, as is so often asserted, the true original name of the dance.

The LANCERS were invented by Laborde in Paris in 1836. They were brought over to England in 1850, and were made fashionable by Madame Sacré at her classes in Hanover Square Rooms. The first four ladies to dance the Lancers in England were Lady Georgina Lygon, Lady Jane Fielding, Mdlle Olga de Lechner, and Miss Berkeley.

The POLKA, the chief of the Bohemian national dances, was adopted by Society in 1835 at Prague. Josef Neruda had seen a peasant girl dancing and singing the Polka, and had noted down the tune and the steps. From Prague it rapidly spread to Vienna, and was introduced to Paris by Cellarius, a dancing-master, who gave it at the Odéon in 1840. It took the public by storm, and spread like an infection through England and America. Everything was named after the Polka, from public-houses to articles of dress. Mr Punch exerted his wit on the subject weekly, and even *The Times* complained that its French correspondence was interrupted, since the Polka had taken the place of politics in Paris. The true Polka has three slightly jumping steps, danced on the first three beats of a four-quaver bar, the last beat of which is employed as a rest while the toe of the unemployed foot is drawn up against the heel of the other. The Polka has recently fallen into disuse in England because of the craze for waltzing to every possible and impossible measure.

The GALOP is strictly speaking a Hungarian dance, which became popular in Paris in 1830. But some kind of a dance corresponding to the Galop was always indulged in after *Voltes* and *Contredanses*, as a relief from their grave and constrained measures.

The WASHINGTON POST, PAS DE QUATRE, and several varieties of BARN DANCE are of American origin, and have recently become fashionable. The general tendency of American dances is to be of a lively and romping measure, in which kicking and hopping and waving of the arms take the place of symmetrical figures and rhythmically designed steps.

The POLKA-MAZURKA is extremely popular in Vienna and Buda-Pest, and is a favourite theme with Hungarian composers. The six movements of this dance occupy two bars of 3–4 time, and consists of a mazurka step joined to the polka. It is of Polish origin.

The POLONAISE and MAZURKA are both Polish dances, and are still fashionable in Russia and Poland. Every State ball in Russia is opened with the ceremonious Polonaise.

The SCHOTTISCHE, a kind of modified Polka, was "created" by Markowski, who was the proprietor of a famous dancing academy in 1850. The HIGHLAND SCHOTTISCHE is a fling. The Fling and Reel are Celtic dances, and form the national dances of Scotland and Denmark. They are complicated measures of a studied and classical order in which free use is made of the arms and of cries and stampings. The STRATHSPEY is a slow and grandiose modification of the Reel.

SIR ROGER DE COVERLEY is the only one of the old English social dances which has survived to the present day, and it is frequently danced at the conclusion of the less formal sort of balls. It is a merry and lively game in which all the company take part, men and women facing each other in two long rows. The dancers are constantly changing places in such a way that if the dance is carried to its conclusion everyone will have danced with everyone else. The music was first printed in 1685, and is sometimes written in 2–4 time, sometimes in 6–8 time, and sometimes in 3–9 time.

The COTILLON is a modern development of the French dance of the same name referred to above. It is an extremely elaborate dance, in which a great many toys and accessories are employed; hundreds of figures may be contrived for it, of which the chief are *La Conversation*, *Le Mouchoir*, *La Trompeuse*, *Les Dames Cachées*, *Le Huit entre deux chaises*, *Les Quatre Coins*, *Le Fandango*, *L'Artichaut*, *La Finale*. There are also several figures in which presents, toys, lighted tapers, biscuits, air-balloons, and hurdles are used. Some of these are *Pile ou Face*, *La Parapluie*, *La Pêche à la Ligne*, *La Loterie*, *Le Chevalier de la Triste Figure*, *Les Ballons*, *Steeplechase*, *Le Chasse à Courre*, and *Le Postillon*.

The BALLET is a performance in which dancing, music, and pantomime play equally important parts. The origin of the modern ballet is identical with the revival of dancing, the earliest on record being that given by Bergonzio di Botta at Tortona to celebrate the marriage of the Duke of Milan in 1489. The ballet, like other forms of dancing, was developed and perfected in France; it is closely associated with the history of the opera; but in England it came much later than the opera, for it was not introduced until the 18th century, and in the first Italian operas given in London there was no ballet. During the regency of Lord Middlesex a ballet-master was appointed and a *corps* of dancers formed. The ballet has had three distinct stages in its development. For a long time it was to be found only at the court, when princely entertainments were given to celebrate great occasions. At that time ladies of the highest rank performed in the ballet, and spent much time in practising and perfecting themselves for it. Catherine de' Medici introduced these entertainments into France, and spent large sums of money on devising performances to distract her son's attention from the affairs of the State. Baltasarini, otherwise known as Beaujoyeulx, was the composer of a famous entertainment given by Catherine in 1551 called the "Ballet Comique de la Reyne." This marks an era in the history of the opera and ballet, for we find here for the first time dance and music arranged for the display of coherent dramatic ideas. Henry IV., Louis XIII. and XIV., were all lovers of the ballet and performed various characters in them, and Richelieu used the ballet as an instrument for the expression of political purposes. Lully was the first to make an art of the composition of ballet music, and he was the first to insist on the admission of women as ballet dancers, feminine characters having hitherto been assumed by men dressed as women. When Louis XIV. became too fat to dance, the ballet at court became unpopular, and thus was ended the first stage of its development. It then was adopted in the colleges at prize distributions and other occasions, when the ballets of Lully and Quinault were commonly performed. The third period in the history of the ballet was marked by its appearance on the stage, where it has remained ever since. It should be added that up till the third period dramatic poems had accompanied the ballet, and the dramatic meaning was helped out with speech and song; but with the advent of the third period speech disappeared, and the purely pantomime performance, or *Ballet d'Action*, was instituted. The father of ballet dancing as we know it at the present day was Jean George Noverre, who appeared in 1749. He has left voluminous writings; they are remarkable for a refined literary style, and in them he sets forth at length his theories and practices as an artist of dancing. The *Ballet d'Action* was really invented by him; in fact, the ballet has never advanced beyond the stage to which he brought it; it has rather gone back. Noverre held the opinion that words only served to weaken the action and partly destroy its effects. He held that a pantomime which, in order to be understood, had to borrow the help of a verbal explanation, was imperfect. "When dancers shall feel, and, Proteus-like, transform themselves into various shapes," he says, "to express to the life the

conflict of passions; when their features, their very looks, shall speak their inward feelings; when, extending their arms beyond the narrow circle prescribed by the rigid rules of pedantry, and with equal grace and judgment giving them a fuller scope, they shall by proper situations describe the gradual and successive progress of the passions; when, in fine, they call good sense and genius to the assistance of their art; then they may expect to distinguish themselves: explanatory speeches will become useless; a mute but powerful eloquence will be substituted to much better effect; each motion will be a sentence; every attitude will portray a situation; each gesture convey a thought, and each glance a new sentiment: every part will please, because the whole will be a true and faithful imitation of nature." The essence of Noverre's theory was that mere display was not enough to ensure interest and life for the ballet; and the late Sir Augustus Harris expressed a similar opinion when he was asked wherein lay the reason of the decadence of the modern ballet. Noverre brought to a high degree of perfection the art of presenting a story by means of pantomime, and he never allowed dancing which was not the direct expression of a particular attitude of mind. Since Noverre's time the greatest ballet-master was undoubtedly the famous Gaetano Apolline Baltasare Vestris, who modestly called himself "le dieu de la danse," and was accustomed to say that his century had produced only three great men—himself, Frederic II., and Voltaire. He was, indeed, the finest male dancer that Europe ever produced, and was a great man in his time. Gluck composed *Iphigenia in Aulis* in conjunction with Vestris. In 1750 the two greatest dancers of the day performed together in Paris in a ballet-opera called *Léandre et Héro*; the dancers were Vestris and Madame Camargo, who introduced short skirts on the stage. The word "balette" was first used in the English language by Dryden in 1667, and the first descriptive ballet seen in London was *The Tavern Bilkers*, which was played at Drury Lane in 1702. Since then the ballet in England has been purely exotic and has merely followed on the lines of French developments. The palmy days of the ballet in England are said to have been in the first half of the 19th century, when there was a royal revenue spent on the maintenance of this fashionable attraction. Some famous dancers of this period were Carlotta Grisi, Mdlle Taglioni (who is said to have turned the heads of an entire generation), Fanny Elssler, Mdlle Cerito, Miss P. Horton, Miss Lucile Grahn, and Mdlle Carolina Rosati. Miss Kate Vaughan is probably the greatest dancer whom England has produced, and, in Sir Augustus Harris's opinion, she did much to elevate the modern art. She was the first to make skirt-dancing popular, although that achievement will not be regarded as an unmixed benefit by every student of the art. Skirt-dancing, in itself a beautiful exhibition, is a departure from true dancing in the sense that the steps are of little importance in it; and in the present day we have seen its development extend to a mere exhibition of whirling draperies under many coloured lime-lights. The best known of Miss Vaughan's disciples and imitators (each of whom has contributed something to the art on her own account) have been Miss Sylvia Grey, Miss Letty Lind, Miss St Cyr, Miss Mabel Love, and Miss Topsy Sinden. But ballet-dancing, affected by a tendency in modern entertainment to make less and less demands on the intelligence and intellectual appreciation of the public, and more and more demands on the eye,—the sense most easily affected,—has gradually developed into a spectacle, the chief interest of which is quite independent of dancing. Thousands of pounds are spent on dressing a small army of women who do little but march about the stage and group themselves in accordance with some design of colour and mass; and no more is asked of the intelligence than to believe that a ballet dressed, for example, in military uniform is a compliment to or glorification of the army. Only a few out of hundreds of members of the *corps de ballet* are really dancers, and they perform against a background of colour afforded by the majority. It seems unlikely that we shall see any revival of the best period and styles of dancing until a higher standard of grace and manners becomes fashionable in Society. With the constantly increasing abolition of ceremony, courtliness of manner is bound to diminish; and only in an atmosphere of ceremony, courtesy, and chivalry can the dance maintain itself in perfection.

(A. B. F. Y.)

**Danube.**—The river Danube and its tributaries have been described at length in the ninth edition of the *Encyclopædia Britannica*. It is proposed in this article to describe briefly the recent engineering works for the improvement of its navigation, more especially those that have been carried out under international agreement as decided on under the Treaties of Paris, Berlin, and London.

***European Commission.***

The European Commission in 1866 had its powers prolonged for five years, and by the Treaty of London of 1871 it was granted another twelve years' lease of life. At the Congress of Berlin in 1878 its jurisdiction was extended from Isakcha upwards to Galatz, a distance of 25 nautical miles, and it was decided that Rumania should henceforward be represented by a delegate. By the Treaty of London of 1883 the jurisdiction of the Commission was extended from Galatz to Braila—10 miles farther up the river; and its powers were prolonged for twenty-one years (*i.e.* till the 24th of April 1904), at the expiration of which period its existence is to continue by tacit prolongation for successive terms of three years, unless one of the High Contracting Powers should propose any modification in its constitution or attributes. It was also decided to withdraw the Kilia or Northern branch of the mouths of the Danube from the immediate jurisdiction of the European Commission, but Russia and Rumania were to superintend the application of the regulations in force in the Sulina branch in that part of the Kilia branch lying between those countries. Russia was given complete control over that portion of the river which flows exclusively through her own territory, and was authorized to levy tolls intended to cover the expenses of any works of improvement that might be undertaken by her. Article VII. of the same Treaty declared that the regulations for navigation, river police, and superintendence drawn up on the 2nd of June 1882 by the European Commission, assisted by the delegates of Servia and Bulgaria, should be made applicable to that part of the Danube situated between the Iron Gates and Braila. In consequence of Rumania's opposition, the Commission Mixte was never formed, and these regulations have never been put in force. As regards the extension of the Powers of the European Commission to Braila, 10 miles above Galatz, and at the head of the Maritime Navigation, a tacit understanding has been arrived at, under which questions concerning navigation proper come under the jurisdiction of the Commission, while the police of the ports remains in the hands of the Rumanian authorities.

The British delegates on the Commission have been successively:—Sir John Stokes, R.E., K.C.B., whose invaluable services extended over a period of fifteen years, from 1856 to 1871; General C. G. Gordon, R.E. (of Khartum), from 1871 to 1873; Major-General H. T. Siborne, R.E., from 1873 to 1881; Sir Percy Sanderson, K.C.M.G., 1882 to 1894; and Lieutenant-Colonel Henry Trotter, R.E., C.B., since October 1894.

In the ninth edition of the *Encyclopædia Britannica* it was stated, as regards the work effected by the European Commission of the Danube, that between 1858 and 1871 the depth of water at the entrance of the Sulina Port had been increased from 9 to 19 feet. In 1876 the south jetty was prolonged, so as to bring its end exactly opposite the lighthouse on the north pier. This resulted in an increase of the depth to 20½ feet, and for fifteen years, from 1879 to 1895, this depth remained constant without the aid of dredging. In 1894, owing to the constantly increasing size of vessels frequenting the Danube, it was found necessary to deepen the entrance still farther, and to construct two parallel piers between the main jetties, reducing the breadth of the river to 500 feet, and thereby increasing the scour. There is now a continuous channel 5200 feet in length and 24 feet in depth, 300 feet in width between the piers and 600 feet in width outside the extremities of the piers, until deep water is reached in the open sea.

***Improvements.***

In addition to the successful treatment of the main Danube 11 miles below Isakcha, the engineers of the Commission have been equally successful in dealing with the Sulina branch of the river. Its original length of 45 miles from St George's Chatal to the sea was impeded at the commencement of the improvement works by eleven bends, each with a radius of less than 1000 feet, besides numerous others of somewhat larger radius, and its bed was encumbered by ten shifting shoals, varying from 8 to 13 feet in depth at low water. By means of a series of training walls, by groynes thrown out from the banks, by revetments of the banks, and by dredging, all done with the view of narrowing and limiting the breadth of the river, a minimum depth of 11 feet was attained in 1865, and 13 feet in 1871. In 1880 the needs of commerce and the increased size of steamers frequenting the river necessitated the construction of a new entrance from the St George's branch. This work, designed in 1857, but unexecuted during a quarter of a century, owing to insufficiency of funds, was completed in 1882; and in 1886, after other comparatively short cuttings had been made to get rid of difficult bends and further to deepen the channel without having to resort to dredgers, the desired minimum depth of 15 feet was attained. Since that date a series of new cuttings have been made, the last commenced in 1898, and estimated to be completed in 1902. These new cuttings, when the last is completed, will have shortened the length of the Sulina canal by 11 nautical miles, eliminated all the difficult bends and shoals, and provided an almost straight waterway 34 miles in length from Sulina to the St George's Chatal, with a minimum depth of 18 feet when the river is at its lowest.

Two names are indissolubly connected with the eminently satisfactory results obtained both in the river and at its mouth. The English engineer Sir Charles Hartley designed all the works and improvements referred to, and personally superintended their execution from 1856 until 1872, after which time he occupied the post of consulting engineer, while the execution of the works after 1872 devolved on the Danish engineer, Mr Charles Kuhl.

***Finance.***

The Commission has an average annual income of about £80,000, derived from taxes paid by ships when *leaving* the river. The normal annual expenditure amounts to about £56,000, while £24,000 is generally allotted to extraordinary works, such as new cuttings, &c. This large expenditure has, however, been attended with a more than corresponding benefit to commerce. The depth of water over the bar of the Sulina mouth has been increased from 9 feet (in 1856) to the minimum of 24 feet (in 1900). The minimum depth of water in the Sulina branch with the river at its lowest has been increased during the same period from 8 feet to 17 feet. Freights from Galatz and Braila to North Sea ports have fallen from 50s. to about 12s. 6d. per ton. Sailing ships of a maximum of 200 tons register have given way to steamers up to 2600 tons register carrying a dead weight of 5500 tons; and last, but not least, good order has succeeded chaos.

As illustrating the great value, especially to British maritime trade, of the improvements that have been effected by the Danube Commission in the navigable channel of the river from Braila to the sea, it may be mentioned that whilst from 1857 to 1867 the average annual registered tonnage entered was but 450,000 tons, of which only one-third was British, the total tonnage in 1896 had increased to 1,800,000, of which three-fifths was British. Thus in thirty years the whole annual Danubian trade of all European nations increased fourfold, while the tonnage of British ships increased eightfold.

In 1861 the average size of the 3084 vessels visiting the river was 146 tons register only, whereas in 1899–1900 the average size exceeded one thousand tons register.

***Iron Gates.***

Many of the treaties previously alluded to also dealt with the question of the regularization of that part of the Danube lying between Old Moldowa (in Hungary) and Turn-Severin (Rumania). Article VI. of the Treaty of London (1871) authorizes the Powers which possess the shores of that part of the Danube where the cataracts and the Iron Gates offer impediments to navigation, to come to an understanding with the view of removing these impediments, and to have the right of levying a provisional tax on vessels of every flag which may henceforth benefit thereby until the extinction of the debt contracted for the execution of the works. As the riverain Powers could not come to an agreement on the subject, the Great Powers at the Congress of Berlin (1878) intrusted to Austria-Hungary the execution of the works in question. Austria-Hungary subsequently conferred its rights on Hungary, by whom the works were carried out at the cost of about 1½ millions sterling.

For the construction of the works and the formation of a sinking fund by which the capital expenditure will be repaid in ninety-nine years, the Hungarian Government raised a loan of 22½ millions of florins, the interest on this sum, together with the annual expenditure in repairs, maintenance, pilotage, &c., is estimated to amount to 900,000 florins, and the Hungarians claim that the difference between this sum and the estimated revenue, *i.e.*, 500,000 florins, is a generous contribution paid by Hungary for the benefit of navigation in general. The engineering works in the neighbourhood of the Iron Gates are of great interest. The principal obstructions between Old Moldova and Turn-Severin are the Stenka Rapids, the Kozla Dojke Rapids, the Greben section, and the Iron Gates. At the first named there was a bank of rocks, some of them dry at low water, extending almost across the river (985 yards wide). The fall of the river-bed is small, but the length of the rapid 1100 yards. The Kozla Dojke, 9 miles below the Stenka Rapids, extend also for 1100 yards, with a fall 1 in 1000, and are caused by the two banks of rocks which cause a sudden alteration in the direction of the current. The river is here only 170 to 330 yards in width; 6 miles below them is the Greben section, the most difficult part of the works of improvement. A spur of the Greben mountains runs out below two shoals into the river, which suddenly narrows to about 300 yards at low water, although it shortly widens to 1½ miles. Seven miles lower down are the Juez Rapids, where the river-bed has a fall of 1 in 433. At the so-called Iron Gates, between Orsova and Turn-Severin, and 34 miles below the Greben, the Prigrada rocky bank nearly blocked the river at the point where it widens out after leaving the stupendous Kazan defile.

During the 19th century many schemes were worked out for the improvement of this portion of the river, but it was not till 1883 that a practical start was made, and the Hungarian engineers, Messrs Vásárhalyi and Wallandt, prepared the designs which have since been executed. The general object of these works was to give a navigable depth of water at all seasons of 2 metres (6½ feet) on that portion of the river above Orsova, and a depth of 3 metres below that town. To effect this at Stenka, Kozla Dokje, Izlas, and Gachtalia, channels 66 yards wide had to be cut in the solid rock to a depth of 6 feet 6 inches below low water. The point of the Greben spur had to be entirely removed for a distance of 167 yards back from its original face (in the execution of which work in 1894 no less than 2,100,000 cubic feet of rock were thrown down by a single charge of 12 tons of dynamite). Below the Greben point a training wall 7 to 9 feet high, 10 feet at top, and nearly 4 miles in length, has been built along the Servian shore in order to confine the river in a narrow channel. At Juez another similar channel had to be cut and a training wall built. At the Iron Gates a channel 80 yards wide and nearly 2000 yards in length (1720 metres) had to be cut on the Servian side of the river, traversing the Prigrada Bank to a depth of 9 feet 9 inches below high-water level. Training walls have been built on either side of the channel to confine the water so as to raise its level; that on the right bank having a width of 19 feet 6 inches at top, and serving as a tow-path; that on the left being 13 feet in width. These training walls are built of stone with flat revetments to protect them against ice.

***General results.***

These formidable and expensive works have not altogether realized the expectations that had been formed of them. One most important result, however, has been attained, *i.e.*, vessels can now navigate the Iron Gates at all seasons of the year when the river is not closed by ice, whereas formerly at extreme low water, lasting generally for about three months in the late summer and autumn, through navigation was always at a standstill, and goods had to be landed and transported considerable distances by land. The canal was opened for traffic on the 1st October 1898, and during the last three months of that year 180,000 tons of merchandise was carried through the canal out of a total traffic during the year of 500,000 tons. On the other hand, the canal was designed of sufficient width, as was supposed, for the simultaneous passage of boats in opposite directions; but on account of the great velocity of the current, this has been found to be dangerous and impracticable. The slope of the stream at the upper entrance of the canal is from 1 in 200 to 1 in 300, according to the height of the water, producing a velocity varying from 16 to 19½ feet per second, and so lowering the surface of the water that when the river is at its lowest the depth of water in the canal

varies from $7\frac{1}{2}$ to 8 feet only. Similar and other causes, such as the discovery of fresh banks at the island of Ada Kaleh, have produced similar effects higher up the river. Between the Iron Gates and Orsova, at extreme low water, *i.e.*, when the gauge at Orsova reads zero, there is only 3 feet 6 inches of available depth, *i.e.*, at certain seasons 9 inches less than before the works of improvement were commenced. Again, between Orsova and Old Moldova, at extreme low water there is a navigable depth of only 3 feet instead of the anticipated 6 feet 6 inches. It was calculated, however, that with three more years' work and a further expenditure of £240,000, the wished-for depth of 6 feet 6 inches would be obtained throughout the whole distance from Old Moldova to the Iron Gates.

In addition to the works already described, executed under international arrangements, the riverain Powers—Bavaria, Austria, and Hungary—have spent large sums of money in improving the navigation of the Upper Danube. At Vienna the principal channel of the Danube was brought $1\frac{1}{2}$ miles nearer the town by the construction of a new channel 10 miles in length and 330 yards in breadth, with a depth at low water of from 10 to 11 feet. This work, projected in 1866, involved the removal of 12 million cubic metres of sand and gravel, and with its subsidiary works, bridges, quays, &c., cost about $3\frac{1}{4}$ millions of pounds sterling. It has proved an immense success, not only protecting Vienna from disastrous inundations, the principal object in view, but also in improving the railway communication and the navigability of the river.

Very extensive engineering operations have also been carried out at Buda-Pest, where the Soroksar branch of the Danube, which in time of flood carried away one-third of its entire volume of water, has been completely closed, the water passing into the main Promontor channel.

The result of all the combined works for the rectification of the Danube is that from Sulina up to Braila the river is navigable for seagoing vessels of 2500 tons register. From Braila to Turn-Severin it is open for seagoing vessels up to 600 tons, and for flat barges of from 1500 to 2000 tons capacity. From Turn-Severin to Orsova navigation is confined to river steamers, tugs, and barges drawing 6 feet of water. Thence to Vienna the draught is limited to 5 feet, and from there to Ratisbon to a somewhat lower figure. Barges of 600 tons register can be towed from the Lower Danube to Ratisbon, at which place petroleum tanks have been constructed for the storage of Rumanian petroleum, the first consignment of which in 1898, conveyed in tank boats, took six weeks on the voyage up from Giurgevo. The principal navigation company on the Upper Danube is the Société Impériale et Royale Autrichienne of Vienna, which started operations in 1830 with three small steamers, but now possesses a fleet of 151 paddle steamers, 23 screw steamers, 5 powerful tugs, and 850 large barges, besides grain elevators, dredgers, steam launches, &c. &c. In 1896 they carried 579,000 passengers for long distances, 2,220,000 for short distances, 1,113,871 tons of miscellaneous cargo, 978,000 tons of cereals, and 148,609 tons of coal. Their gross receipts during the same year were $14\frac{3}{4}$ million florins. The company transports goods and passengers between Galatz and Ratisbon.

A less important society is the Rumanian State Navigation Company, possessing a large flotilla of tugs and barges, which run to Buda-Pest, where they have established a combined service with the South Danube German Company for the transport of goods from Pesth to Ratisbon. A Hungarian Navigation Company, subsidized by the State, has recently been formed, and the Hungarian railways, the Servian Government, and private owners own between them about 70 tugs and 420 barges of about 380,000 tons burden.

The merchandise carried in 1896 between Sulina and the Iron Gates and intermediate ports amounted to 3,529,575 tons, of which 2,700,000 tons was composed of cereals and the remainder miscellaneous merchandise. Three-fourths of this amount were carried down stream, and one-fourth up.

The following tables show the total amount of tonnage (registered) of ships leaving the Danube and clearing for foreign ports at quinquennial intervals from 1871 to 1896, and for each year from 1889 to 1900 :—

*Quinquennial Returns.*

| Year. | Total Tonnage. | British Tonnage. | Proportion of British to whole. |
|---|---|---|---|
| | | | Per cent. |
| 1871 . . . | 549,720 | 178,858 | 32·54 |
| 1876 . . . | 748,363 | 452,414 | 60·45 |
| 1881 . . . | 793,454 | 498,994 | 62·88 |
| 1886 . . . | 950,567 | 623,479 | 65·59 |
| 1891 . . . | 1,512,030 | 990,935 | 65·53 |
| 1896 . . . | 1,794,934 | 1,097,689 | 62·00 |

*Annual Returns.*

| Year. | Total Number of Vessels. | Total Tonnage. | Number of British Vessels. | Tonnage. | Per cent. |
|---|---|---|---|---|---|
| 1889 | 1870 | 1,473,345 | 842 | 1,000,773 | 67·93 |
| 1890 | 1828 | 1,539,445 | 778 | 983,862 | 63·91 |
| 1891 | 1723 | 1,512,030 | 773 | 990,935 | 65·53 |
| 1892 | 1532 | 1,427,087 | 638 | 866,758 | 60·73 |
| 1893 | 1801 | 1,893,506 | 905 | 1,287,762 | 68·00 |
| 1894 | 1716 | 1,619,703 | 733 | 1,034,097 | 63·84 |
| 1895 | 1619 | 1,554,698 | 604 | 906,043 | 58·27 |
| 1896 | 1713 | 1,794,934 | 699 | 1,097,737 | 61·15 |
| 1897 | 1324 | 1,397,917 | 540 | 855,477 | 61·19 |
| 1898 | 1419 | 1,476,119 | 446 | 694,773 | 47·06 |
| 1899 | 1056 | *1,070,367 | 277 | 446,170 | 41·68 |
| 1900 | 1101 | 1,252,509 | 260 | 458,921 | 36·64 |

* This diminution was due to failure of the harvest in Rumania and Bulgaria.

(H. TR)

**Danvers,** a town of Essex county, Massachusetts, U.S.A. It includes an area of 14 square miles of level country diversified by glacial hills, with a village bearing the same name, and a large rural population. It is traversed by a branch of the Boston and Maine Railway. The village is irregular in plan, contains a State Insane Asylum and a public library, and has manufactures of boots and shoes, leather, &c. Population (1880), 6598; (1890), 7454; (1900), 8542.

**Danville,** capital of Vermilion county, Illinois, U.S.A., on the Vermilion river, at an altitude of 598 feet. Its site is a level prairie, and its street plan is regular. It is entered by three railways, the Chicago, and Eastern Illinois, the Cleveland, Cincinnati, Chicago and St Louis, and the Wabash. Situated in a coal-mining region, it handles and ships large quantities of that commodity. It contains also car shops and ironworks. Population (1880), 7733; (1890), 11,491; (1900), 16,354.

**Danville,** capital of Boyle county, Kentucky, U.S.A., on the Queen and Crescent Railway, at an altitude of 955 feet. It is the seat of Centre College, opened in 1821, and of Caldwell College for women, both Presbyterian institutions, and of the State Deaf and Dumb Institute. Population (1880), 3074; (1890), 3766; (1900), 4285.

**Danville,** capital of Montour county, Pennsylvania, U.S.A., in 40° 58′ N. lat. and 76° 37′ W. long., on the north branch of the Susquehanna, at an altitude of 471 feet. The borough is irregular in plan, though situated on a level plain. It is on the Delaware, Lackawanna, and Western, and the Philadelphia and Reading Railways. It is of importance because of its iron manufactures. Population (1880), 8346; (1890), 7998; (1900), 8042.

**Danville,** a city of Virginia, U.S.A. Though within the limits of Pittsylvania county, it is not subject to county organization. It is on the Danville river, at the falls, near the southern boundary of the state, at an altitude of 413 feet, and is traversed by the Southern and the Danville and Western Railways. It is the seat of Roanoke Female College. The city has long been prominent in the tobacco trade, and in the manufacture of smoking and chewing tobacco. It is also becoming important in the manufacture of cotton. Population, including the annexed town of North Danville (1880), 8726; (1890), 14,104; (1900), 16,520.

**Danzig,** a strong maritime fortress and seaport town of Prussia, capital of the province of West Prussia, headquarters of the 17th German Army Corps, standing on the Vistula, 3 miles south of its entrance into the Baltic. The

old fortifications, which, with their twenty-two bastions, surrounded the inner town, were taken down on the west and north sides in 1895–96. The trenches have been filled in, and the area thus freed has been laid out on a spacious plan. One portion, acquired by the corporation, has been turned into promenades and gardens, the New Steffens Park, 50 acres in extent, outside the Olivner Thor, occupying the north-western corner. The remainder of the area remains in the hands of the military authorities. A cordon of detached forts has lately been built for the defence of the harbour, which is now strongly protected against attack from the sea. The natural history and archæological collections of the West Prussian Museum are preserved in the Green Gate; the provincial industrial museum and the municipal picture gallery in a former Franciscan monastery. The most recent public buildings are the extensive slaughter-houses, the market-hall, the imperial post office, a new railway station, and a new Evangelical church. The educational and similar institutions embrace a military school, an art and a technical school, a school of navigation, a commercial academy, and a couple of observatories; whilst a technical high school was built in 1900–01. Danzig owed its commercial importance to the fact that it was the shipping port for the corn grown in Poland, and the adjacent regions of Russia and Prussia; but for some few years past this trade has been slipping away from her. On the other hand, her trade in timber and sugar has grown proportionally. Nevertheless energetic efforts are being made to check any loss of importance—first, in 1898, by a determined attempt to make Danzig an industrial centre, manufacturing on a large scale; and secondly, by the construction, and opening in 1899, of a free harbour at the mouth of the Vistula. The industries which it has been principally aimed to establish are shipbuilding (naval and marine), steel foundries and rolling mills, sugar refineries, flour and oil mills, and distilleries. The free port at Neufahrwasser, at the mouth of the Vistula, has a total area of 39½ acres. Vessels drawing 16½ feet can, however, get up to the wharves of Danzig itself, the approach being kept open in winter by ice-breakers. The port is cleared by an average of 1433 vessels of 481,000 tons annually (1712 vessels of 651,821 tons in 1899), a decrease as compared with 1805 vessels of 796,065 tons cleared in 1884. The exports reach an average of £4,972,150 annually (£3,230,000 in 1884); whilst the imports, chiefly coal, average £4,219,700 annually (£2,960,000 in 1884). The mercantile fleet of Danzig numbered, in 1900, 49 seagoing vessels of some 26,956 tons. Population (1885), 114,805; (1895), 125,605; (1900), 140,539.

**Darbhanga,** a town and district of British India, in the Patna division of Bengal. The town is on the left bank of the Little Baghmati river, and has a railway station. The population in 1881 was 65,955; in 1891 it was 73,561; and in 1901 it was 65,990. The town is really a collection of villages that have grown up round the residence of the Raja, who ranks as the first nobleman of Behar. This is now a magnificent palace, with gardens, a menagerie, and a good library. There are a first-class hospital, with a Lady Dufferin hospital attached; a handsome market-place; an Anglo-vernacular school; and four printing-presses.

The DISTRICT OF DARBHANGA lies in North Behar, extending from the Nepal frontier to the Ganges. It was constituted in 1875 out of the unwieldy district of Tirhut. Its area is 3335 square miles. The population in 1881 was 2,630,496; in 1891 it was 2,801,955, giving an average density of 840 persons per square mile. Classified according to religion, Hindus numbered 2,462,308; Mahomedans, 338,667; Christians, 380, of whom 200 were Europeans; "others," 600. In 1901 the population was 2,914,577, showing an increase of 4 per cent. The land revenue and rates were Rs.10,51,273; the number of police was 471; the number of boys at school in 1896–97 was 31,410, being 15·2 per cent. of the male population of school-going age; the registered death-rate in 1897 was 27·36 per thousand. There are 30 indigo factories, with a capital of Rs.61,36,000, employing 26,000 hands, and producing an out-turn valued at Rs.15,00,000; 54 saltpetre refineries; and a tobacco factory, producing cigars valued at Rs.37,000. The district is traversed by the main line and branches of the Tirhut State Railway, originally begun as a famine relief work in 1874.

**Dardanelles** (Town) [*Sultanieh Kalehsi*, or *Chanak Kalehsi*, of the Turks], the chief town and seat of government of the lesser Turkish province of Bigha, Asia Minor. It is situated at the mouth of the Rhodius, and at the narrowest part of the Strait of the Dardanelles, where its span is but a mile across between the continents of Europe and Asia. Its recent growth has been rapid, and it possesses a lyceum, a military hospital, a public garden, a theatre, quays, and water-works, besides many private houses and a suburb. Exclusive of the garrison, the population is estimated at 13,000, of whom one-half are Turkish, and the remainder Greek, Jewish, Armenian, and European. The town contains many mosques; Greek, Armenian, and Catholic churches; and a synagogue. There is a resident Greek bishop. Strategically the Dardanelles is a point of great importance, since it commands the approach to Constantinople from the Mediterranean. The civil governor, and the military commandants of the numerous fortresses on each side of the Strait, are stationed here. Many important works have been added to the defences. Armed with modern artillery and protected by torpedoes, the forcing of the passage would be a difficult operation. The Ottoman Fleet is stationed not far from the town, at Abydos, now called Nagara. The average annual number of merchant vessels passing the Strait is 12,000, and the regular commercial vessels calling at the port of Dardanelles are represented by numerous foreign agencies. Besides the Turkish telegraph service, the Eastern Telegraph Company has a station at Dardanelles, and there are Turkish, Austrian, French, and Russian post offices. The import trade consists of manufactures, sugar, flour, coffee, rice, leather, and iron. The export trade consists of valonia (largely produced in the province), wheat, barley, beans, chick-peas, canary seed, liquorice root, pine and oak timber, wine, and pottery. Excepting in the items of wine and pottery, the export trade shows steady increase. Immigration brings a larger area of land under cultivation year by year, and every year adds to the number of mature (*i.e.*, fruit-bearing) valonia trees. Vine-growers are discouraged by heavy fiscal charges, and by the low price of wine. Many are uprooting their vineyards. The pottery trade is affected by change of fashion, and the old potteries of *Chanak* Kalehsi are losing their importance. The lower quarters of the town were heavily damaged in the winter of 1900–1 by repeated inundations caused by the overflow of the Rhodius. (E. W*.)

**Dar el Baida** (in English, *White House;* in Spanish, *Casa Blanca*), a growing grain port of Central Morocco, with numerous foreign merchants, Franciscan and Protestant missions, and a consular corps. Exports: 1896, £197,131; 1897, £212,824; 1898, £281,247. Imports: 1896, £175,788; 1897, £176,713; 1898, £211,461. Shipping: 1897, 155,315 tons; 1898, 150,048 tons. Population, probably about 20,000.

**Darial,** a widely renowned gorge in the Caucasus, through which the Terek pierces, for a distance of 8 miles, between vertical walls, the Side Range of the Caucasus. It is fortified at its northern entrance. It was known to Pliny and to Procopius, and mentioned in the Georgian annals under the names of Ral-ani, Dargani, Darialani, &c., of which the root is the Persian *dar* or *der*, meaning "door." The Persians and the Arabs knew it as the Gate of the Alans. Being the only available passage across the Caucasus, it was fortified since a remote antiquity, at least in 150 B.C. In Russian poetry it has been immortalized by Lermontoff. The present Russian fort, Darial, is at the northern issue of the gorge, at an altitude of 4122 ft.

**Darjiling,** a hill station and district of British India, in the Rajshahi division of Bengal. The sanitary station is situated 367 miles by rail north of Calcutta. In 1881 it had a population of 7018, and in 1891 of 14,145. It is now the summer quarters of the Bengal Government. There are several schools of considerable size for European boys and girls, and the Government boarding-school at Kurseong can accommodate 200 boys. Three breweries have an out-turn of 80,000 gallons. The buildings and the roads suffered severely from the earthquake of June 12, 1897. But a more terrible disaster occurred in October 1899, when a series of landslips carried away houses and broke up the hill railway. The total value of the property destroyed was returned at Rs.25,00,000.

The DISTRICT comprises an area of 1164 square miles. The population in 1881 was 155,645, and in 1891 was 223,314, giving an average density of 192 persons per square mile. Classified according to religion, Hindus numbered 171,171; Mahommedans, 10,011; Buddhists, 40,600; Christians, 1502, of whom 1049 were Europeans; "others," 30. In 1901 the population was 249,232, showing an increase of 12 per cent., compared with an increase of 43 per cent. in the previous decade. The land revenue and rates were Rs.1,65,806; the number of police was 395; the number of boys at school in 1896–97 was 2938, being 15·9 per cent. of the male population of school-going age; the registered death-rate in 1897 was 42·16 per thousand. The cultivation of tea was introduced in 1856. In 1897 there were 186 gardens, with 55,822 acres under tea, employing 32,897 persons permanently and 14,108 persons temporarily, and producing nearly 12 million ℔. Cinchona cultivation was introduced by the Government in 1862, and has since been taken up by private enterprise. In 1896–97 the number of plants in the Government plantations was nearly 2½ millions; and the amount of dry bark produced was 318,715 ℔. Including bark bought from private plantations, the out-turn of the Government factory was 10,149 ℔ of sulphate of quinine, and 4075 ℔ of cinchona febrifuge; the gross receipts were Rs.1,76,798, and the net profits Rs.9767. The three forest divisions of Darjiling yielded in that year a gross revenue of Rs.1,36,058. There is a coal-mine at Daling, employing 260 persons, with an output of 2000 tons. The Darjiling Himalayan Railway of 2 feet gauge, opened in 1880, runs for 50 miles from Siliguri in the plains on the Eastern Bengal line.

See G. S. BOMWETSCH. *A Handbook to Darjiling and its Railway.* Calcutta, 1899.

**Darlington,** a municipal and parliamentary borough (one member) and market-town of Durham, England, on the Skerne, 1 mile from its confluence with the Tees, 18 miles south of Durham city by rail. There are now, in all, seven Established churches, two Roman Catholic churches and a school chapel, and twelve Nonconformist churches or chapels. The training-school for schoolmistresses has been enlarged and a school for children added. Recent erections are a cattle market, a corn exchange, hospital, library, and new theatre. A technical school has been formed, the public park enlarged to an area of 44 acres, and the baths twice extended. The worsted spinning mills of Pease & Company have upwards of 18,000 spindles, and employ between 500 and 600 hands. The Pease Partners Company (Limited) employ at their collieries, ironstone mines, quarries, brickworks, &c., over 6000 workmen, and raise about 3,000,000 tons of minerals per annum. Darlington possesses important works for the manufacture of iron and steel bars, and the specialties required for engineering, bridge-building, ship-building, locomotive engine-work, railway waggon building, collieries, &c. At the Rise Carr Rolling Mills (belonging to Sir Theodore Fry & Company, Limited) about 700 men are employed, and in 1899 the output of finished iron and steel work amounted to 25,840 tons. The Darlington Forge Company (Limited), with premises of 100 acres in area, of which about 40 acres were in 1901 occupied by their rapidly extending works, employ from 1000 to 1200 men, and, besides turning out steel castings and steel and iron forgings for engineering purposes, manufacture gun work, shells, &c., for British and foreign shipyards and arsenals; the annual output, of all descriptions, being from 10,000 to 12,000 tons, representing a value of about £250,000.

Extended municipal area, 3945 acres. Population on this in 1881, 35,104; in 1891, 38,060; in 1901, 44,496. Parliamentary area since 1885, 3602 acres. Population on this in 1881, 34,831; in 1891, 38,033; in 1901, 44,496. Rateable value of municipal borough in 1900, £183,725.

**Darmesteter, James** (1849–1894), author and antiquarian, was born of Jewish parents on 28th March 1849. He was educated at Paris, where, under the guidance of M. Michel Bréal, he imbibed a love for Oriental studies, to which for a time he entirely devoted himself. In 1875 he published a thesis on the mythology of the Zendavesta, and in 1877 became university professor of Zend. He followed up his researches with his *Études Iraniennes* (1883), and ten years later published a complete translation of the Avesta, with commentary, in the *Musée Guimet*. An interesting episode in his life was his journey to India in 1886, undertaken for the purpose of collecting the popular songs of the Afghans, a translation of which, with a valuable essay on the Afghan language and literature, he published on his return. His impressions of English dominion in India were conveyed in *Lettres sur l'Inde* (1888). England interested him deeply; his attachment for a gifted English poetess, whom he eventually married, led him to translate the poems of Mary Robinson; and two years after his death a collection of excellent essays on English subjects was published in English. He also wrote *Le Mahdi*, *Origine de la Poësie Persane*, *Prophètes d'Israel*, and other books on topics connected with the East, and from 1883 onwards drew up the annual reports of the Société Asiatique. He had just become connected with the *Revue de Paris*, a new undertaking of great importance, when his delicate constitution succumbed to a slight attack of illness on 19th October 1894. (R. G.)

**Darmstadt,** a town of Germany, capital of grand-duchy of Hesse-Darmstadt, 21 miles by rail south-east from Mainz and 17 miles south from Frankfort-on-Main. Here are a technical high school, possessing (since 1900) power to confer the degrees of doctor of engineering (doctor of the technical sciences in Prussia), a school of agriculture, an artisans' school, and a botanical garden. The chemist von Liebig was born in Darmstadt in 1803. Principal industries: the production of machinery, carpets, playing

cards, chemicals, tobacco, hats, wine, and beer. In 1888 Bessungen was incorporated with Darmstadt. Population (1885), 50,609; (1895), 63,745; (1900), 72,019 (provisional census results).

**Darrang,** a district of British India, in the Brahmaputra Valley division of Assam. It lies between the Bhutan and Dafla Hills and the Brahmaputra, including many islands in the river. The administrative headquarters are at Tezpur. Its area is 3418 square miles. The population in 1881 was 273,333; in 1891 it was 307,761, giving an average density of 90 persons per square mile. Classified according to religion, Hindus numbered 196,037; Mahommedans, 18,454; hill tribes, 91,870; Christians, 849, of whom 183 were Europeans; "others," 551. In 1901 the population was 337,724, showing an increase of 10 per cent. The land revenue was Rs.7,15,656, the incidence of assessment being Rs.2–10–2 per acre; the number of police was 195; the number of boys at school in 1896–97 was 4114, being 17 per cent. of the male population of school-going age; the registered death-rate in 1897 was 45·68 per thousand. In 1897 the number of tea gardens was 89, with 33,984 acres under tea, employing 71,535 persons, of whom 23,424 were children, and producing an out-turn of over 11 million ℔, or at the rate of 407 ℔ per acre. There is a timber mill, producing 25,000 tea-chests, valued at Rs.20,000. Almost the only means of communication is by river. A steam tramway of 2½ feet gauge has been opened from Tezpur to Balipara, a distance of 20 miles. A similar tramway is proposed at Mangaldai, with a length of 35 miles.

**Dartford,** a market-town in the Dartford parliamentary division of Kent, England, on the Darenth, 16 miles east-south-east of London by rail. Recent erections are a Martyrs' Memorial Hall and a cottage hospital. On Dartford Heath is the lunatic asylum of the London County Council, and, at Long Reach, the infectious diseases hospital of the Metropolitan Asylums Board. Iron, chemical, and cement works have been introduced. Area of parish (an urban district), 4251 acres. Population (1881), 10,163; (1891), 11,962; (1901), 18,615; of parliamentary division (1891), 79,853.

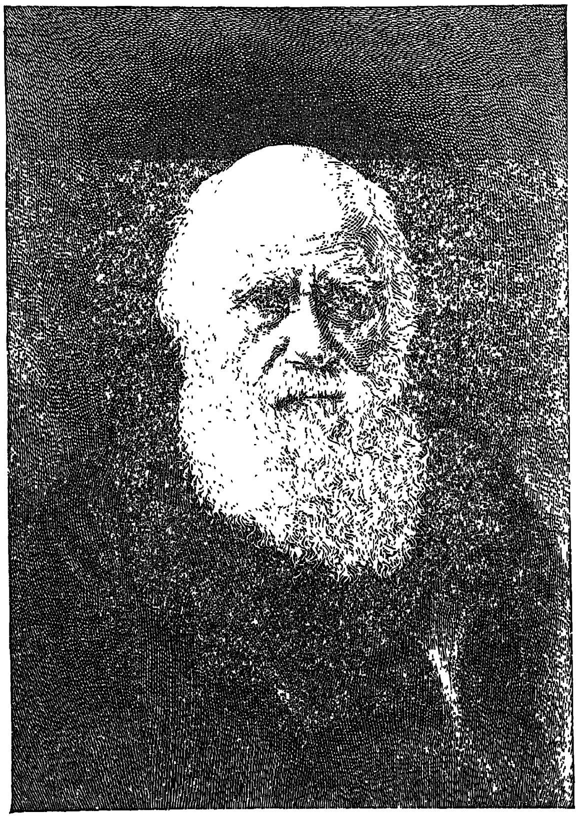
**Dartmouth,** a municipal borough, seaport, and market-town in the Torquay parliamentary division of Devonshire, England, on the west side of the estuary of the Dart, 28 miles east of Plymouth. The town is connected with the Great Western Railway by a steam ferry to Kingswear on the opposite side of the Dart. There is an embankment 600 yards long, constructed by the Dartmouth Harbour Commissioners. A cottage hospital has been erected. Yacht and boat building are carried on; there is a large paint factory. The port is used as a coaling station for yachts and ocean steamers. Area, 1924 acres. Population (1881), 5725; (1901), 6037.

**Dartmouth,** a town in Halifax County, Nova Scotia, on the eastern side of Halifax harbour, connected with Halifax by a steam ferry. It contains four churches, large sugar refinery, foundries, machine shops, three saw mills, several factories, and a bank. Population, about 6500.

**Darwen,** a municipal borough in the Darwen parliamentary division of Lancashire, England, 4 miles south of Blackburn by rail. It is a centre of the cotton trade, and has also blast furnaces, and paper-making, paper-staining, and fire-clay works. New sewerage filtration works have been completed at a cost of £30,000. Recent erections are new buildings for the free library and a technical school. Area, 5952 acres. Population (1881), 29,744; (1891), 34,192; (1901), 38,311; of parliamentary division (1881), 61,092; (1891), 70,475; (1901), 78,793. The parish of Over-Darwen, which, together with various hamlets, and portions of Eccleshill and Lower Darwen, makes up the municipal borough, has an area of 5134 acres. Population (1881), 27,626; (1891), 31,680.

**Darwin, Charles Robert** (1809–1882), the famous English naturalist, author of the *Origin of Species*, was born at Shrewsbury on 12th February 1809. He was the younger of the two sons and the fourth child of Dr Robert Waring Darwin (1766–1848), a successful medical practitioner at Shrewsbury. His mother, a daughter of Josiah Wedgwood, died when Charles Darwin was eight years old. His grandfather was the great genius Dr Erasmus Darwin (1731–1802), who made suggestions upon the origin of species in many respects similar to those which were later more completely elaborated by Lamarck. Charles Darwin's elder brother, Erasmus Alvey (1804–1881), was interested in literature and art rather than science: on the subject of the wide difference between the brothers Charles wrote that he was "inclined to agree with Francis Galton in believing that education and environment produce only a small effect on the mind of anyone, and that most of our qualities are innate" (*Life and Letters*, London, 1887, p. 22). Darwin considered that his own success was chiefly due to "the love of science, unbounded patience in long reflecting over any subject, industry in observing and collecting facts, and a fair share of invention as well as of common sense" (*l.c.*, p. 107). He also says: "I have steadily endeavoured to keep my mind free so as to give up any hypothesis, however much beloved (and I cannot resist forming one on every subject), as soon as facts are shown to be opposed to it" (*l.c.*, p. 103). The essential causes of his success are to be found in this latter sentence, the creative genius ever inspired by existing knowledge to build hypotheses by whose aid further knowledge could be won, the calm unbiassed mind, the transparent honesty and love of truth which enabled him to abandon or to modify his own creations when they ceased to be supported by observation. The even balance between these powers was as important as their remarkable development. The great naturalist appeared in the ripeness of time, when the world was ready for his splendid generalizations. Indeed naturalists were already everywhere considering and discussing the problem of evolution, although Alfred Russel Wallace was the only one who, independently of Darwin, saw his way clearly to the solution. It is true that hypotheses essentially the same as natural selection were suggested much earlier by W. C. Wells (*Phil. Trans.*, 1813) and Patrick Matthew (*Naval Timber and Arboriculture*, 1831), but their views were lost sight of and produced no effect upon the great body of naturalists. In the preparation for Darwin Sir Charles Lyell's *Principles of Geology* played an important part, accustoming men's minds to the vast changes brought about by natural processes, and leading them, by its lucid and temperate discussion of Lamarck's and other views, to reflect upon evolution. Darwin's early education was conducted at Shrewsbury, first for a year at a day-school, then for seven years at Dr Butler's. He gained but little from the narrow system which was then universal. In 1825 he went to Edinburgh to prepare for the medical profession, for which he was unfitted by nature. After two sessions his father realized this, and in 1828 sent him to Cambridge with the idea that he should become a clergyman. He matriculated at Christ's College, and took his degree in 1831, tenth in the list of those who do not seek honours. Up to this time he had been keenly interested in sport, and in entomology, especially the collecting of beetles. Both at Edinburgh, where in 1826

he read his first scientific paper, and at Cambridge he gained the friendship of much older scientific men—Grant and Macgillivray at the former, Henslow and Sedgwick at the latter. He had two terms' residence to keep after passing his last examination, and studied geology with Sedgwick. Returning from their geological excursion together in North Wales (August 1831), he found a letter from Henslow urging him to apply for the position of naturalist on the *Beagle*, about to start on a surveying expedition. His father at first disliked the idea, but his uncle, Josiah Wedgwood, pleaded with success, and Darwin started on December 27, 1831, the voyage lasting until October 2, 1836. It is practically certain that he never left Great Britain after this latter date. After visiting the Cape de Verde and other Atlantic Oceanic islands, they surveyed on the South American coasts and adjacent islands (including the Galapagos), afterwards visiting Tahiti, New Zealand, Australia, Tasmania, Keeling Island, Maldives, Mauritius, St Helena, Ascension; and Brazil, de Verdes, and Azores on the way home. His work on the geology of the countries visited, and that on coral islands, became the subject of volumes which he published after his return, as well as his *Journal of a Naturalist*, and his other contributions to the official narrative. The voyage must be regarded as the real preparation for his life-work. His observations on the relation between animals in islands and those of the nearest continental areas, near akin and yet not the same, and between living animals and those most recently extinct and found fossil in the same country, here again related but not the same, led him even then to reflect deeply upon the modification of species. He had also been much impressed by "the manner in which closely allied animals replace one another in proceeding southwards" in South America. On his return home Darwin worked at his collections, first at Cambridge for three months and then in London. His pocket-book for 1837 contains the words: "In July opened first notebook on Transmutation of Species. Had been greatly struck from about the month of previous March [while still on the voyage and just over twenty-eight years old] on character of South American fossils, and species on Galapagos Archipelago. These facts (especially latter) origin of all my views." From 1838 to 1841 he was secretary of the Geological Society, and saw a great deal of Sir Charles Lyell, to whom he dedicated the second edition of his *Journal*. On January 29, 1839, he married his cousin, Emma Wedgwood, the daughter of Josiah Wedgwood of Maer. They lived in London until September 1842, when they moved to Down, which was Darwin's home for the rest of his life. His health broke down many times in London, and remained precarious during the whole of his life. The immense amount of work which he got through was only made possible by the loving care of his wife. For eight years (1846 to 1854) he was chiefly engaged upon four monographs on the recent and fossil Cirripede Crustacea (*Ray Soc.*, 1851 and 1854; *Palæontograph. Soc.*, 1851 and 1854). Towards the close of this work Darwin became very wearied of it, especially of the synonymy. For a time he hoped to start a movement which should discourage the habit of appending the name of the describer to the name of the species, a custom which he thought led to bad and superficial work. From this time he was engaged upon the numerous lines of inquiry which led to the great work of his life, the *Origin of Species*, published in November 1859.



CHARLES ROBERT DARWIN.
*(From a photograph by Elliott & Fry, London.)*

Soon after opening his note-book in July 1837, he began to collect facts bearing upon the formation of the breeds of domestic animals and plants, and quickly saw "that selection was the keystone of man's success. But how selection could be applied to organisms living in a state of nature remained for some time a mystery to me." Various ideas as to the causes of evolution occurred to him, only to be successively abandoned. He had the idea of "laws of change" which affected species and finally led to their extinction, to some extent analogous to the causes which bring about the development, maturity, and finally death of an individual. He also had the conception that species must give rise to other species or else die out, just as an individual dies unrepresented if it bears no offspring. These and other ideas, of which traces exist in his Diary, arose in his mind, together with perhaps some general conception of natural selection, during the fifteen months after the opening of his notebook. In October 1838 he read *Malthus on Population*, and his observations having long since convinced him of the struggle for existence, it at once struck him "that under these circumstances favourable variations would tend to be preserved, and unfavourable ones to be destroyed. The result of this would be the formation of new species. Here, then, I had a theory by which to work." In June 1842 he wrote out a sketch, which two years later he expanded to an essay occupying 231 pages folio. The idea of progressive divergence as an advantage in itself, because the competition is most severe between organisms most closely related, did not occur to him until long after he had come to Down. During the growth of the *Origin* Sir Joseph Hooker was his most intimate friend, and on January 11, 1844, he wrote: "at last gleams of light have come, and I am almost convinced (quite contrary to the opinion I started with) that species are not (it is like confessing a murder) immutable" (*l.c.*, ii. 23). In 1855 he began a correspondence with the great American botanist Asa Gray, and in 1857 explained his views in a letter which afterwards became classical. In 1856, urged by Lyell, he began the preparation of a third and far more expanded treatise, and had completed

about half of it when, on June 18, 1858, he received a manuscript essay from A. R. Wallace, who was then at Ternate in the Moluccas. Wallace wanted Darwin's opinion on the essay, which he asked should be forwarded to Lyell. Darwin was much startled to find in the essay a complete abstract of his own theory of natural selection. He forwarded it the same day, writing to Lyell, "your words have come true with a vengeance—that I should be forestalled." He placed himself in the hands of Lyell and Hooker, who decided to send Wallace's essay to the Linnean Society, together with an abstract of Darwin's work, which they asked him to prepare, the joint essay being accompanied by a preface in the form of an explanatory letter written by them to the secretary. The title of the joint communication was "On the Tendency of Species to form Varieties; and on the Perpetuation of Varieties and Species by Natural Means of Selection." It was read on July 1, 1858, and appears in the *Linn. Soc. Journal* (Zoology) for that year. In this statement of the Theory of Natural Selection, Darwin's part consisted of two sections, the first being extracts from his 1844 essay, including a brief account of sexual selection; the second consisting of an abstract of his letter to Asa Gray dated September 5, 1857. This latter, probably his first attempt to expound natural selection, cannot be surpassed as a clear statement of the theory. Darwin explained at the outset, what he insisted on elsewhere, that the facts of adaptation or contrivance in nature are the real difficulty to be explained by a theory of evolution, the stumbling-block of every previous suggestion. Until he could explain "the mistletoe, with its pollen carried by insects, and seed by birds—the woodpecker, with its feet and tail, beak and tongue, to climb the tree and secure insects"—he was "scientifically orthodox." Nevertheless he was led to believe in evolution, apart from any possible motive-cause, by "general facts in the affinities, embryology, rudimentary organs, geological history, and geographical distribution of organic beings." He then proceeds to describe the manner in which he met the difficulty of adaptation by "his notions on the means by which Nature makes her species." The essentials of the statement are as follows:—I. Man has made his domestic breeds of animals and plants by selection, conscious or unconscious, of very slight or greater variations. II. The material for selection exists in nature, namely, slight variations of all parts of the organism. III. The "unerring power" which sifts these variations is *Natural Selection* . . . which selects exclusively for the good of each organic being." The rate of increase is such that only a few in each generation can live: hence the never sufficiently appreciated struggle for life. "What a trifling difference must often determine which shall survive and which perish!" The remaining heads explain the complex nature of the struggle, the reasons for deficient direct evidence, the advantage of divergence, &c. In the Joint Essay the phrases "Natural Selection" and "Sexual Selection" were first made public by Darwin, the "struggle for existence" by Wallace. Darwin and Wallace had only met once before the departure of the latter for the East. Their rivalry in the discovery of the great principle of Natural Selection was the beginning of a lifelong friendship. Wallace was lying ill with intermittent fever at Ternate in February 1858, when he began to think of Malthus's Essay, read several years before: suddenly the idea of the survival of the fittest flashed upon him. In two hours he had "thought out almost the whole of the theory," and in three evenings had finished his essay. Darwin, also inspired after reading Malthus, in October 1838, did not publish until nearly twenty years had elapsed, and then only when Wallace sent him his essay. Canon Tristram was the first to apply the new theory, explaining by its aid the colours of desert birds, &c. (*Ibis*, October 1859).

Acting under the advice of Lyell and Hooker, Darwin then began to prepare what was to become the great work of his life. It appeared November 24, 1859, with the full title, *On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life*. The whole edition of 1250 copies was exhausted on the day of issue. The first four chapters explain the operation of artificial selection by man and of natural selection in consequence of the struggle for existence. The fifth chapter deals with the laws of variation and causes of modification other than natural selection. The five succeeding chapters consider difficulties in the way of a belief in evolution generally as well as in natural selection. The three remaining chapters (omitting the recapitulation which occupies the last) deal with the evidence for evolution. The theory which suggested a cause of evolution is thus given the foremost place, and the evidence for the existence of evolution considered last of all. This method of presentation was no doubt adopted because it was just the want of a reasonable motive-cause which more than anything else prevented the acceptance of evolution. But the other side of the book must not be eclipsed by the brilliant theory of Darwin and Wallace. The evidence for evolution itself had never before been thought out and marshalled in a manner which bears any comparison with that of Darwin in the *Origin*, and the work would have been in the highest degree epoch-making had it consisted of the later chapters alone. In the fifth chapter Darwin incorporated a certain proportion of the doctrines of Buffon,—modifications due to the direct influence of environment; and of Lamarck,—the hereditary effects of use and disuse. Lyell for a long time hesitated to accept the new teaching, and Darwin carried on a long correspondence with him. His public confession of faith was made at the Anniversary Dinner of the Royal Society in 1864. A storm of controversy arose over the book, reaching its height at the meeting of the British Association at Oxford in 1860, when the celebrated duel between Huxley and the Bishop of Oxford took place. Throughout these struggles Huxley was the foremost champion for evolution and for fair play to natural selection, although he never entirely accepted the latter theory, holding that until man by his selection had made his domestic breed sterile *inter se*, there was no sufficient evidence that selection accounts for natural species which are thus separated by the barrier of sterility. The theory of natural selection was at first greatly misunderstood. Thus some writers thought it implied conscious choice in the animals themselves, others that it was the personification of some active power. By many it was thought to be practically the same idea as Lamarck's. Herbert Spencer's alternative phrase, "the survival of the fittest," probably helped to spread a clear appreciation of Darwin's meaning.

The history of opinion since 1859 may be summed up as follows. Evolution soon gained general acceptance, except among a certain number of those of middle or more advanced age at the time when the *Origin* appeared. Although natural selection had been an essential force in producing this conviction, there gradually grew up a tendency to minimize its importance in relation to the causes originally suggested by Buffon and Lamarck, which were ably presented and further elaborated by Herbert Spencer. In America a school of Neo-Lamarckians appeared, and for a time flourished under the inspiration of the vigorous personality of E. D. Cope. The writings of August Weismann next raised a controversy over the scope of heredity, assailing the very foundation of the hypotheses of Buffon, Lamarck, and Herbert Spencer by demanding

evidence that the "acquired characters" upon which they rest are capable of hereditary transmission. The quantitative determination of heredity has been the subject of much patient investigation under the leadership of Francis Galton. The question of isolation as a factor in species-formation has been greatly discussed, G. J. Romanes proposing, in his hypothesis of "Physiological Selection," that the barrier of sterility may arise spontaneously by variation between two sets of individuals as the beginning instead of the climax of specific distinction. Others have fixed their attention upon the variations, which provided the material for natural selection, and have advocated the view that evolution proceeds by immense strides instead of the minute steps in which Darwin and Wallace believed. Others, again, have found significance in the artificial production of "monstrosities" or huge modifications during individual development. All through the period a varying proportion of naturalists, probably larger now than at any other time, has followed the founders of the theory, and has sought the motive-cause of evolution in "the accumulative power of natural selection," which Darwin, as his first public statement indicates, looked upon "as by far the most important element in the production of new forms." They hold, with Darwin and Wallace, that although variation provides the essential material, natural selection, from its accumulative power, is of such paramount importance that it may be said to create new species as truly as a man may be said to make a building out of the material provided by stones of various shapes, a metaphor suggested and elaborated by Darwin, and forming the concluding sentences of *The Variation of Animals and Plants under Domestication.* This, probably the second in importance of all his works, was published in 1868, and may be looked upon as a complete account of the material of which he had given a very condensed abstract in the first chapter of the *Origin*, together with the conclusions suggested by it. He finally brought together an immense number of apparently disconnected sets of observations under his "provisional hypothesis of pangenesis," which assumes that every cell in the body, at every stage of growth and in maturity, is represented in each germ-cell by a gemmule. The germ-cell is only the meeting-place of gemmules, and the true reproductive power lies in the whole of the body-cells which despatch their representatives, hence "pangenesis." There are reasons for believing that this infinitely complex conception, in which, as his letters show, he had great confidence, was forced upon Darwin in order to explain the hereditary transmission of acquired characters involved in the small proportion of Lamarckian doctrine which he incorporated. If such transmission does not occur, a far simpler hypothesis based on the lines of Weismann's "continuity of the germ-plasm" is sufficient to account for the facts.

The *Descent of Man, and Selection in Relation to Sex*, was published in 1871; as the title implies, it really consists of two distinct works. The first, and by far the shorter, was the full justification of his statement in the *Origin* that "light would be thrown on the origin of man and his history." In the second part he brought together a large mass of evidence in support of his hypothesis of sexual selection which he had briefly described in the 1858 essay. This hypothesis explains the development of colours and structures peculiar to one sex and displayed by it in courtship, by the preferences of the other sex. The majority of naturalists probably agree with Darwin in believing that the explanation is real, but relatively unimportant. It is interesting to note that only in this subject and those treated of in the *Variation under Domestication* had Darwin exhausted the whole of the material which he had collected. The *Expression of the Emotions*, published in 1872, offered a natural explanation of phenomena which appeared to be a difficulty in the way of the acceptance of evolution. In 1876 Darwin brought out his two previously published geological works on *Volcanic Islands* and *South America* as a single volume. The widely read *Formation of Vegetable Mould through the Action of Worms* appeared in 1881. He also published the following volumes on Botanical subjects. The *Fertilization of Orchids* appeared in 1862. The subject of cross-fertilization of flowers was in Darwin's mind, as shown by his notebook in 1837. In 1841 Robert Brown directed his attention to Sprengel's work (Berlin, 1793), which confirmed his determination to pursue this line of research. *The Effects of Cross- and Self-Fertilization in the Vegetable Kingdom* (1876) contained the direct evidence that the offspring of cross-fertilized individuals are more vigorous, as well as more numerous, than those produced by a self-fertilized parent. *Different Forms of Flowers on Plants of the Same Species* appeared in 1877. It is here shown that the different forms, although each possesses both kinds of sexual organs, is specially adapted to be fertilized by the pollen of another form, and that when artificially fertilized by its own pollen less vigorous offspring, bearing some resemblance to hybrids, are produced. He says, "no little discovery of mine ever gave me so much pleasure as the making out the meaning of heterostyled flowers" (*Autobiography*). *Climbing Plants* was published in 1875, although it had, in large part, been communicated to the Linnean Society, in whose publications much of the material of several of his other works appeared. This inquiry into the nature of the movements of twining plants was suggested to him in a paper by Asa Gray. *The Power of Movement in Plants* (1880) was produced by him in conjunction with his son Francis. It was an inquiry into the minute power of movement possessed, he believed, by plants generally, out of which the larger movements of climbing plants of many different groups had been evolved. The work included an investigation of other kinds of plant movement due to light, gravity, &c., all of which he regarded as modifications of the one fundamental movement (circumnutation), which exists in a highly specialized form in climbing plants. *Insectivorous Plants* (1875) is principally concerned with the description of experiments on the Sun-dew (*Drosera*), although other insect-catching plants, such as *Dionæa*, are also investigated.

Charles Darwin's long life of patient, continuous work, the most fruitful, the most inspiring, in the annals of modern science, came to an end on April 19, 1882. He was buried in Westminster Abbey on April 26. It is of much interest to attempt to set forth some of the main characteristics of the man who did so much for modern science, and in so large a measure moulded the form of modern thought. Although his ill-health prevented Darwin, except on rare occasions, from attending scientific and social meetings, and thus from meeting and knowing the great body of scientific and intellectual workers of his time, probably no man has ever inspired a wider and deeper personal interest and affection. This was in part due to the intimate personal friends who represented him in the circles he was unable frequently to enter, but chiefly to the kindly, generous, and courteous nature which was revealed in his large correspondence and published writings, and especially in his treatment of opponents.

In a deeply interesting chapter of the *Life and Letters* Francis Darwin has given us his reminiscences of his father's everyday life. Rising early, he took a short walk before breakfasting alone at 7.45, and then at once set to work, "considering the 1½ hours between 8.0 and 9.30 one of his best working times." He then read his letters and listened to reading aloud, returning to work at about

10.30. At 12 or 12.15 "he considered his day's work over," and went for a walk, whether wet or fine. For a time he rode, but after accidents had occurred twice, was advised to give it up. After lunch he read the newspaper and wrote his letters or the MS. of his books. At about 3.0 he rested and smoked for an hour while being read to, often going to sleep. He then went for a short walk, and returning about 4.30, worked for an hour. After this he rested and smoked, and listened to reading until tea at 7.30, a meal which he came to prefer to late dinner. He then played two games of backgammon, read to himself, and listened to music and to reading aloud. He went to bed, generally very much tired, at 10.30, and was often much troubled by wakefulness and the activity of his thoughts.

It is thus apparent that the number of hours devoted to work in each day was comparatively few. The immense amount he achieved was due to concentration during these hours, also to the unfailing and, because of his health, the necessary regularity of his life.

The appearance of Charles Darwin has been made well known in numerous portraits and statues. He was tall and thin, being about 6 feet high, but looked less because of a stoop, which increased towards the end of his life. As a young man he had been active, with considerable powers of endurance, and possessed in a marked degree those qualities of eye and hand which make the successful sportsman.

Charles Darwin was, as a young man, a believer in Christianity, and was sent to Cambridge with the idea that he would take Holy Orders. It is probable, however, that he had merely yielded to the influences of his home, without thinking much on the subject of religion. He first began to reflect deeply on the subject during the two years and a quarter which intervened between his return from the *Beagle* (October 2, 1836) and his marriage (January 29, 1839). His own words are, "disbelief crept over me at a very slow rate, but was at last complete. The rate was so slow that I felt no distress."

His attitude was that of the tolerant unaggressive agnostic, sympathizing with and helping in the social and charitable influences of the English Church in his parish. He was evidently most unwilling that his opinions on religious matters should influence others, holding, as his son, Francis Darwin, says, "that a man ought not to publish on a subject to which he has not given special and continuous thought" (*l.c.*, i. p. 305).

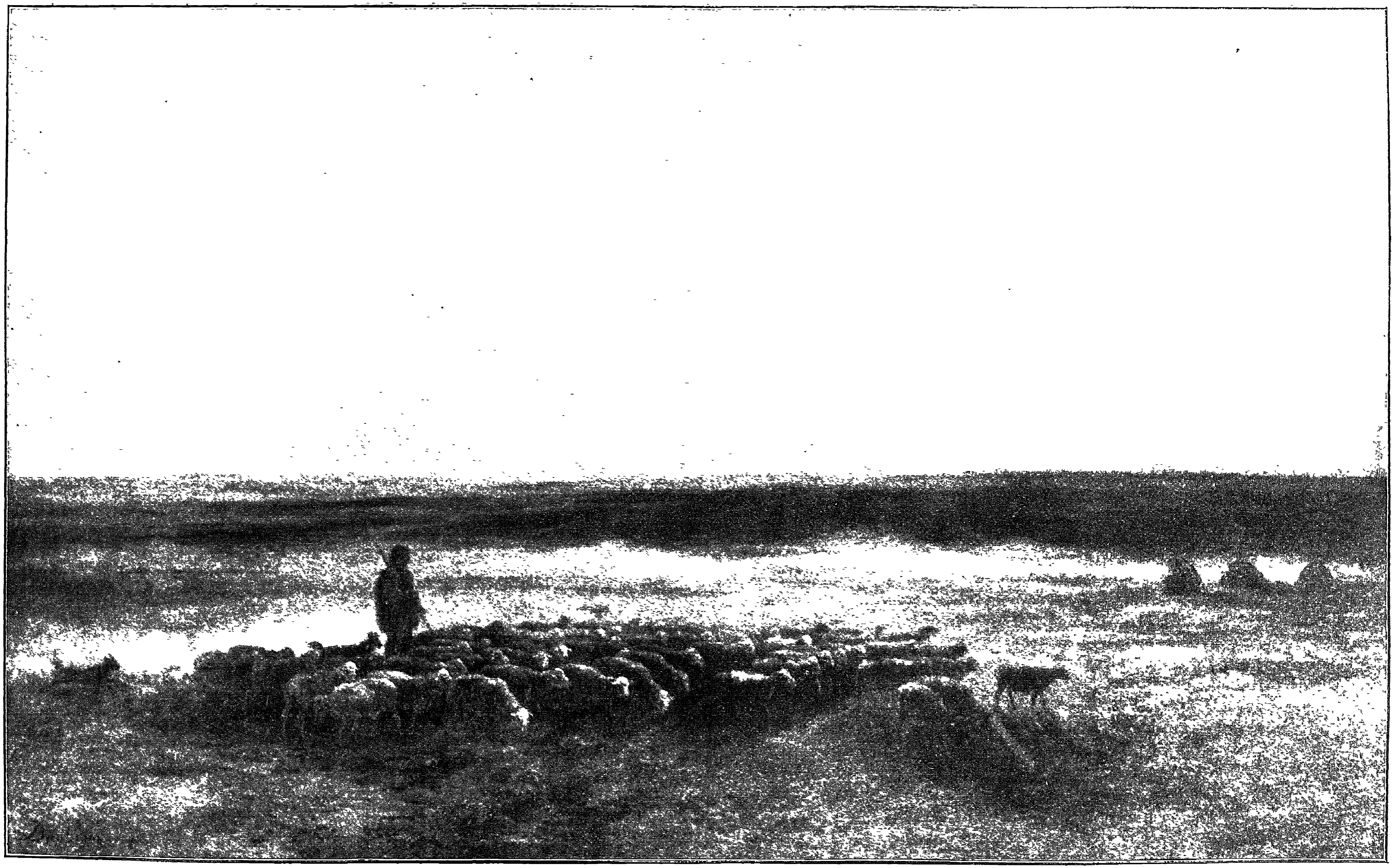
In addition to the personal qualities and powers of Charles Darwin, there were other contributing causes without which the world could never have reaped the benefit of his genius. It is evident that Darwin's health could barely have endured the strain of working for a living, and that nothing would have been left over for his researches. A deep debt of gratitude is owing to his father, Dr Darwin, who placed him in a position in which all his energy could be devoted to scientific work and thought. But his ill-health was such that this important and essential condition would have been insufficient without another even more essential. Francis Darwin, in the *Life and Letters* (i. pp. 159–160), writes these eloquent and pathetic words:—"No one indeed, except my mother, knows the full amount of suffering he endured, or the full amount of his wonderful patience. For all the latter years of his life she never left him for a night; and her days were so planned that all his resting hours might be shared with her. She shielded him from every avoidable annoyance, and omitted nothing that might save him trouble, or prevent him becoming over-tired, or that might alleviate the many discomforts of his ill-health. I hesitate to speak thus freely of a thing so sacred as the lifelong devotion which prompted all this constant and tender care. But it is, I repeat, a principal feature of his life, that for nearly forty years he never knew one day of the health of ordinary men, and that thus his life was one long struggle against the weariness and the strain of sickness. And this cannot be told without speaking of the one condition which enabled him to bear the strain and fight out the struggle to the end."

Charles Darwin was honoured by the chief societies of the civilized world. He was made a Knight of the Prussian Order, "Pour le Mérite" in 1867, a Corresponding Member of the Berlin Academy of Sciences in 1863, a Fellow in 1878, and later in the same year a Corresponding Member of the French Institute in the Botanical Section. He received the Bressa Prize of the Royal Academy of Turin, and the Baly Medal of the Royal College of Physicians in 1879, the Wollaston Medal of the Geological Society in 1859, a Royal Medal of the Royal Society in 1853, and the Copley Medal in 1864. His health prevented him from accepting the Honorary Degree which Oxford University wished to confer on him, but his own University had stronger claims, and he became an Honorary LL.D. Cantab. in 1877.

*The Life and Letters of Charles Darwin, including an autobiographical chapter.* Edited by his son FRANCIS DARWIN. 3 vols. London, 1887.—*Charles Darwin: his life told in an autobiographical chapter, and in a selected series of his published letters.* Edited by his son FRANCIS DARWIN. London, 1892.—*Charles Darwin and the Theory of Natural Selection.* By E. B. POULTON. London, 1896. —*Life and Letters of Thomas Henry Huxley.* By his son LEONARD HUXLEY. 2 vols. London, 1900. (E. B. P.)

**Datia,** a native state of India, in the Bundelkhand agency. It lies in the extreme north-west of Bundelkhand, near Gwalior. Area, 837 square miles. Population, (1881), 182,598; (1891), 186,440, showing an increase of 2 per cent.; average density, 223 persons per square mile. Estimated gross revenue, Rs.10,00,000; tribute to Sindhia paid through the British Government, Rs.15,000. The chief, whose title is Maharaja, is a Rajput of the Bundela clan, being descended from a younger son of a former chief of Orchha. The present Maharaja was appointed K.C.S.I. in 1898. The state suffered from famine in 1896–97, and again to a less extent in 1899–1900. It is traversed by the branch of the Indian Midland Railway from Jhansi to Gwalior. The TOWN of DATIA is situated in 25° 40′ N. lat. and 78° 30′ E. long.; railway station, 16 miles from Jhansi. Population (1881), 28,346; (1891), 27,566. It is surrounded by a stone wall, enclosing handsome palaces, with gardens.

**Daubigny, Charles-François** (1817–1878), French landscape painter, allied in several ways with the Barbizon School. He was born in Paris, 15th February 1817, but spent much time as a child at Valmondois, a village on the Oise to the north-west of Paris. Daubigny was the son of an artist, and most of his family were painters. He began to paint very early in life, and at the age of seventeen he took a studio of his own. Within twelve months he had saved enough to go to Italy, where he studied and painted for nearly two years; he then returned to Paris, not to leave it again until, in 1860, he took a house at Auvers on the Oise. By 1837 Daubigny had become famous as a river and landscape painter, although he had been devoting himself as well to drawing in black-and-white, to etching, wood engraving, and lithography. In 1855 his picture, "Lock at Optevoz," now in the Louvre, was purchased by the State; four years later Daubigny was created Knight of the Legion of Honour, and in 1874 he was promoted to be an Officer. In 1866, at the invitation of Lord, then Mr, Leighton and others, he visited London, where, however, he was hurt by



"MOONLIGHT." BY C. F. DAUBIGNY.

*(From the Picture in the possession of the Hon. George A. Drummond, Montreal, Canada.)*

his now famous "Moonlight" being badly hung in the Old Royal Academy. But the personal encouragement of his admirers in England made up for the disappointment, and the sale of his picture to a Royal Academician greatly pleased him. In 1870–71 he again visited London, and subsequently Holland, where he painted a number of river scenes with windmills. In 1874, having returned to Paris, he fell ill, and from that time until he died (on 19th February 1878) his work won less distinction than before. Daubigny's finest pictures were painted between 1864 and 1874, and these for the most part consist of carefully completed landscapes with trees, river, and a few ducks. It has curiously been said, yet with some appearance of truth, that when Daubigny liked his pictures himself he added another duck or two, so that the number of ducks often indicates greater or less artistic quality in his pictures. One of his sayings was, "The best pictures do not sell," as he frequently found his finest achievements little understood. Yet although during the latter part of his life he was considered a highly successful painter, the money value of his pictures since his death has increased nearly tenfold. Daubigny is chiefly preferred in his riverside pictures, of which he painted a great number, but although there are two large landscapes by Daubigny in the Louvre, neither is a river view. They are for that reason not so typical as many of his smaller Oise and Seine pictures. None of his paintings can be seen in public galleries in Great Britain, although they frequently appear in loan exhibitions both in London and in Scotland.

The works of Daubigny are, like Corot's, to be found in many modern collections. His most ambitious canvases are: "Spring-time" (1857), in the Louvre; "Borde de la Cure, Morvan" (1864); "Villerville sur Mer" (1864); "Moonlight" (1865); "Andrésy sur Oise" (1868); and "Return of the Flock—Moonlight" (1878).

His followers and pupils were his son Karl (who sometimes painted so well that his works are occasionally mistaken for those of his father, though in few cases do they equal his father's mastery), Oudinot, Delpy, and Damoye.

FRED HENRIET. *C. Daubigny et son Œuvre.* Paris, 1878.—D. CROAL THOMSON. *The Barbizon School of Painters.* London, 1890.—J. W. MOLLETT. *Daubigny.* London, 1890.—J. CLARETIE. *Peintres and Sculpteurs Contemporains: Daubigny.* Paris, 1882.—ALBERT WOLFF. *La Capitale de l'Art: Ch. François Daubigny.* Paris, 1881. (D. C. T.)

**Daudet, Alphonse** (1840–1897), French novelist, was born at Nîmes on the 13th May 1840. His family, on both sides, belonged to the *bourgeoisie*. The father, Vincent Daudet, was a silk manufacturer—a man dogged through life by misfortune and failure. The lad, amid much truancy, had but a depressing boyhood. In 1856 he left Lyons, where his schooldays had been mainly spent, and began life as an usher at Alais, in the south. The position proved to be intolerable. As Dickens declared that all through his prosperous career he was haunted in dreams by the miseries of his apprenticeship to the blacking business, so Daudet says that for months after leaving Alais he would wake with horror thinking he was still among his unruly pupils. On the 1st November 1857 he abandoned teaching, and took refuge with his brother Ernest, only some three years his senior, who was trying, "and thereto soberly," to make a living as a journalist in Paris. Alphonse betook himself to his pen likewise,—wrote poems, shortly collected into a small volume *Les Amoureuses* (1858), which met with a fair reception,—obtained employment on the *Figaro*, then under Villemessent's energetic editorship, wrote two or three plays, and began to be recognized, among those interested in literature, as possessing individuality and promise. Morny, the emperor's all-powerful minister, appointed him to be one of his secretaries,—a post which he held till Morny's death in 1865,—and showed him no small kindness. He had put his foot on the road to fortune. The first of his longer books, *Le Petit Chose* (1868), did not, however, produce any very popular sensation. It is, in its main feature, the story of his own earlier years told with much grace and pathos. But the next book, *Froment jeune et Risler aîné* (1874), at once took the world by storm. It struck a note, not new certainly in English literature, but comparatively new in French. Here was a writer who possessed the gift of laughter and tears, a writer not only sensible to pathos and sorrow, but also to moral beauty. He could create too. His characters were real and also typical; the *ratés*, the men who in life's battle had flashed in the pan, were touched with a master hand. The book was alive. It gave the illusion of a real world. *Jack*, the story of an illegitimate child, a martyr to his mother's selfishness, which followed in 1876, served only to deepen the same impression. Henceforward his career was that of a very successful man of letters,—publishing novel on novel, *Le Nabab* (1877), *Les Rois en Exil* (1879), *Numa Roumestan* (1880), *Sapho*, *L'Immortel*,—and writing for the stage at frequent intervals,—giving to the world his reminiscences in *Trente ans de Paris* and *Souvenirs d'un homme de lettres*. These, with the three *Tartarins*,—Tartarin the mighty hunter, Tartarin the mountaineer, Tartarin the colonist,—and the admirable short stories, written for the most part before he had acquired fame and fortune, constitute his life work. Though Daudet defended himself from the charge of imitating Dickens, it is difficult altogether to believe that so many similarities of spirit and manner were quite unsought. What, however, was purely his own was his style. It is a style that may rightly be called "*impressionist*," full of light and colour, not descriptive after the old fashion, but by a masterly juxtaposition of words that are like pigments flashing its intended effect. Nor does it convey, like the style of the Goncourts, for example, a constant feeling of effort. It is full of felicity and charm,—*un charmeur* M. Zola has called him. An intimate friend of Edmond de Goncourt (who died in his house), of Flaubert, of M. Zola, Daudet belonged essentially to the naturalist school of fiction. His own experiences, his surroundings, the men with whom he had been brought into contact, various persons who had played a part, more or less public, in Paris life—all passed into his art. But he vivified the material supplied by his memory. His world has the great gift of life. *L'Immortel* is a bitter attack on the French Academy, to which august body Daudet never belonged. His married life—he married in 1867—seems to have been singularly happy. There was perfect intellectual harmony, and Madame Daudet possesses much of his literary gift. In his later years came insomnia, failure of health, and chloral. He died in Paris on the 17th December 1897. The story of Daudet's earlier years is told in his brother Ernest Daudet's *Mon frère et moi*. There is a good deal of autobiographical detail in Daudet's *Trente ans de Paris* and *Souvenirs d'un homme de lettres*, and also scattered in his other books. The references to him in the *Journal des Goncourts* are numerous. (F. T. M.)

**Dauphiné**, one of the old provinces (the name is still in current use in the country) of pre-Revolutionary France, in the south-east portion of France, between Provence and Savoy. After the death of the last king of Burgundy, Rudolf III., in 1032, Dauphiné (as part of his realm) reverted to the far-distant emperor. Much confusion fol-

lowed, out of which the counts of Albon (between Valence and Vienne) gradually came to the front. The first dynasty ended in 1162 with Guigue V., whose daughter and heiress, Beatrice, carried the possessions of her house to her husband, Hugh III., duke of Burgundy. Their son, André, continued the race, this second dynasty making many territorial acquisitions, among them (by marriage) the Embrunais and the Gapençais in 1232. In 1282 the second dynasty ended in another heiress, Anna, who carried all to her husband, Humbert, lord of La Tour du Pin (between Lyons and Grenoble). The title of the chief of the house was Count (later Dauphin) of the Viennois, *not* of Dauphiné.

The origin of the title "Dauphin" (borne also by the allied house of Auvergne) is very obscure. Guigue IV. (1132–1142) seems to have adopted the rare name "Delphinus" as a second Christian name, and so did his son, Guigue V. (1142–1162). The latter's daughter, Beatrice, the heiress, gave it to her son André, to recall his descent from the ancient house of the counts of Albon. Two princes of the second dynasty, namely, Guigue VI. and John I., use the form "Dalphini" (genitive case) as a sort of patronymic. But even under Guigue VI. (1237–1270) the term "Delphinus" is used (especially by foreigners) as a title of dignity, and is so borne regularly by the third dynasty. The "canting arms" of a dolphin were borrowed from the Counts of Clermont (Dauphins of Auvergne), and appear first in 1237 on a seal of Guigue VI., son of André Dauphin (1192–1237). Humbert II. (1333–1349), grandson of the heiress Anna, was the last independent Dauphin, selling his dominions in 1349 to Charles of Valois, and stipulating that every one who inherited this province should bear the name of Dauphin, and quarter the arms of Dauphiné with those of France. As a matter of fact, the title was borne by all succeeding eldest sons of the kings of France. In 1422 the Diois and the Valentinois by the will of the last count passed to the eldest son of Charles VI., and in 1424 were annexed to the Dauphiné. Louis (1440–1461), later Louis XI. of France, was the last Dauphin who occupied a semi-independent position. The suzerainty of the emperor gradually died out. In the 16th century the names of Farel and of the duke of Lesdiguières are prominent in Dauphiné history. The "States" of Dauphiné (dating from about the middle of the 14th century) were suspended by Louis XIII. in 1630. (W. A. B. C.)

**Davenport,** capital of Scott county, Iowa, U.S.A., in 41° 30′ N. lat. and 90° 39′ W. long., on the west bank of the Mississippi, at the foot of Rock Island Rapids, at an altitude on the river bank of 590 feet. It is laid out on a regular plan, is supplied with water from the Mississippi by the Holly pumping system, is well sewered and well paved with brick and macadam, and contains six wards. It is entered by three great railway systems, and enjoys a large trade. In 1890 it contained 475 manufacturing establishments, with a capital of $8,732,122, and employing 5136 hands; the value of the manufactured goods was $10,357,232. The principal articles of manufacture were lumber and flour. The assessed valuation of real and personal property in 1900, on a basis of about one-half of the full value, was $14,396,585, the debt of the municipality was $441,112, and the total rate of taxation was $51·75 per $1000. The death-rate in 1900 was 15·9. Population (1880), 21,831; (1890), 26,872; (1900), 35,254, of whom 8479 were foreign born and 488 negroes.

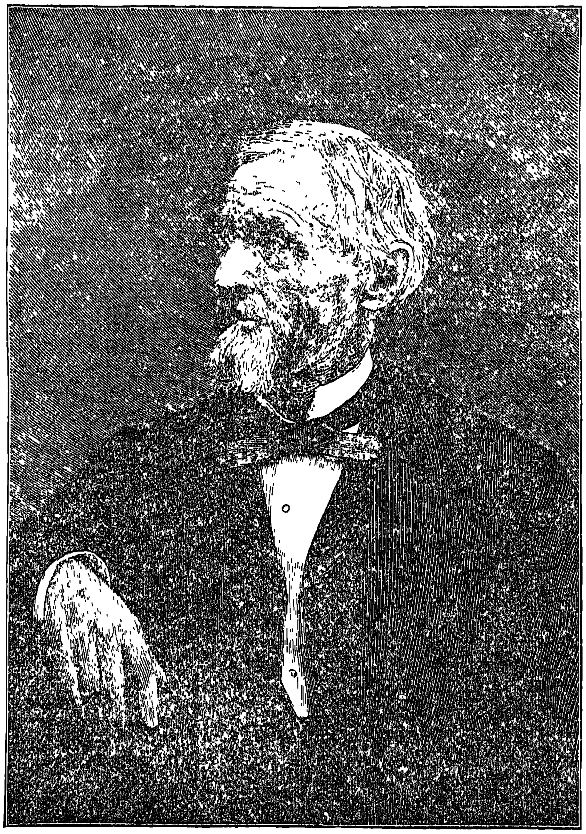
**Daventry,** a municipal borough of Northamptonshire, England, 12 miles west by north of Northampton. There are Established, Roman Catholic, Congregational, and Methodist churches; an endowed grammar school, and a grammar school for girls. A public recreation ground was opened in 1890. The principal industry is the manufacture of boots and shoes. Area, 3427 acres. Population (1881), 3859; (1901), 3780.

**Davey of Fernhurst, Horace Davey,** Baron (1833——), English judge, son of Peter Davey, of Horton, Bucks, was born 30th August 1833, and educated at Rugby and University College, Oxford. He took a double first-class in classics and mathematics, was senior mathematical scholar and Eldon law scholar, and was elected a fellow of his college. In 1861 he was called to the Bar at Lincoln's Inn, and read in the chambers of Mr (afterwards Vice-Chancellor) Wickens. Devoting himself to the Chancery side, he soon acquired a large practice, and in 1875 became a Q.C. In 1880 he was returned to Parliament as a Liberal for Christchurch, Hants, but lost his seat in 1885. On Mr Gladstone's return to power in 1886 he was appointed Solicitor-General and was knighted, but had no seat in the House; from 1888 to 1892 he sat for Stockton-on-Tees. As an equity lawyer Sir Horace Davey ranks among the finest intellects and the most subtle pleaders ever known at the English Bar. He was standing counsel to the University of Oxford, and senior counsel to the Charity Commissioners, and was engaged in all the important Chancery suits of his time. Among the chief leading cases in which he took a prominent part were those of The Mogul Steamship Company, Boswell *v.* Cokes, Erlanger *v.* New Phosphate Co., and the Ooregum Gold Mines Co.; he was counsel for the promoters in the trial of the Bishop of Lincoln, and leading counsel in the Berkeley Peerage case. In 1862 he married Miss Louisa Donkin. In 1893 he was raised to the Bench as a Lord Justice of Appeal, and in the next year was made a Lord of Appeal in Ordinary and a life-peer.

**David, Félicien** (1810–1876), French composer, was born on 13th April 1810 at Cadenet. After having studied for a while at the Paris Conservatoire, he joined the sect of Saint Simonians, and travelled in the East in order to preach the new doctrine. After three years' absence, during which he visited Constantinople, Smyrna, and spent some time in Egypt, he returned to France and published a collection of Oriental melodies. For several years he worked in retirement, and wrote two symphonies, some chamber music, and songs. On the 8th of December 1844 he suddenly leapt into fame through the extraordinary success obtained by his symphonic ode entitled *Le Désert*, produced at the Conservatoire. In this work David had struck out a new line. He had attempted in simple strains to evoke the majestic stillness of the desert. Notwithstanding its title of "symphonic ode," *Le Désert* has little in common with the symphonic style. What distinguishes it is a certain *naïveté* of expression and an effective Oriental colouring. In this last respect David may be looked upon as the precursor of a whole army of composers. His succeeding works, *Moïse au Sinaï* (1846), *Christophe Colomb* (1847), *L'Eden* (1848), scarcely bore out the promise shown in *Le Désert*, although the second of these compositions was successful at the time of its production. David now turned his attention to the theatre, and produced the following operas in succession: *La Perle du Brésil* (1851), *Herculanum* (1859), *Lalla-Roukh* (1862), *Le Saphir* (1865). Of these, *Lalla-Roukh* is the one which has obtained the greatest success. It is still played in France. He died at Saint-Germain-en-Laye on the 29th of August 1876. If David can scarcely be placed in the first rank of French composers, he nevertheless deserves the consideration due to a sincere artist, one who was undoubtedly inspired by lofty ideals. At a time when the works of Berlioz were caviare to the general, David succeeded in making the public take interest in music of a picturesque and descriptive kind. Thus he may be considered as one of the pioneers of modern French musical art. (A. He.)

**Davis, Jefferson** (1808–1889), American soldier and statesman, President of the Confederate States in the American War of Secession, was born on 3rd June 1808 in Christian (now Todd) county, Kentucky. His father, Samuel Davis, was of Welsh, his mother, Jane Cook, of Scotch-Irish, descent. Jefferson Davis was edu-

cated at Transylvania College and West Point Academy. From the latter he graduated in July 1828, with the rank of second lieutenant of infantry. He was assigned for duty to Jefferson Barracks at St Louis, and later to Fort Crawford, now Prairie du Chien, Wisconsin. Here he met Sarah Knox, the daughter of the commanding officer, whom he married two years later. During the Black Hawk war he was under General Winfield Scott at Fort Snelling, and was sent to Dixon, Illinois, to muster into service some volunteers from that State. Their captain was Abraham Lincoln, and Lieutenant Davis is said to have administered to him his first oath of allegiance. After his marriage, he resigned from the army and settled in Mississippi, where Mrs Davis died of fever, and Jefferson Davis afterwards married Miss Varina Howell of Mississippi. In 1843 Mr Davis entered the field of politics as a Democrat, and exhibited great power as a public speaker. In 1844 he was chosen as Presidential Elector, and in 1845 was elected to Congress. From the beginning of his political career he advocated a strict construction of the United States Constitution. He was an ardent admirer of John C. Calhoun and his political opinions. In his speeches in Congress, which were few, he clearly defined his position in regard to State Rights, which he consistently held ever afterwards. During his first session, war with Mexico was declared, and he left his seat to take command of the First Regiment of Mississippi Volunteers. He was greatly distinguished for gallantry and soldierly conduct at Monterey and Buena Vista. In this last battle he was severely wounded early in the engagement, but continued in command until victory crowned the American arms.


JEFFERSON DAVIS.
*(From a photograph by Sarony, New York.)*

Upon his return to his home, he was made a United States Senator. After a service of nearly six years, he resigned his seat to accept the nomination for Governor of his State, but was defeated. In 1853 he accepted the position of Secretary of War in the Cabinet of President Pierce, and for four years performed the duties of the office with great distinction and with lasting benefit to the nation. He organized the engineer companies which explored and reported on the several proposed routes for a railway connecting the Mississippi Valley with the Pacific Ocean. He effected the enlargement of the army, and made material changes in its equipment of arms and ammunition, utilizing the latest improvements. He made his appointments of subordinates on their merits, regardless of party considerations. He revised the system of tactics, perfected the signal corps service, and enlarged the coast and frontier defences of the country. At the end of his service in the Cabinet, he was returned to the Senate, and continued as a member until the secession of his State in 1861. As a senator he stood in the front rank in a body distinguished for its ability; and his purity of character and courteous manner, together with his intellectual gifts, won him the esteem of all parties. While believing in Secession as a last resort, he earnestly sought to avoid the necessity, and when his State passed the ordinance he resigned his seat with the saddest forebodings of the impending conflict. His parting speech was a clear and able statement of the position taken by his State, and a most pathetic expression of his feelings in saying farewell to his associates.

On 25th January 1861 Mr Davis was commissioned Major-General of the forces Mississippi was raising in view of the threatened conflict. On the 9th of February he received the unanimous vote of the Congress of the seceded States as President of the "Confederate States of America." This office he had not sought, preferring service in the field. His brilliant career, both as a civilian and a soldier, drew all eyes to him as best fitted to guide the fortunes of the new Confederacy, and with a deep sense of the responsibility he obeyed the call. He heartily approved of the "Peace Conference," which attempted to draw up a plan of reconciliation between the two sections, but whose failure made war inevitable. The disparity between the hostile sections was very great. In white population the North had four times that of the South, and her manufacturing resources were nearly five hundred times as great; she had uninterrupted commerce with the outside world, and out of her population and the great stream of immigrants she had an unlimited supply of soldiery. She had the army and navy, with the munitions of war belonging to the Federal Government. On the other hand, the South had to create everything needed for war. Never having been a manufacturing people, and having her ports soon blockaded, she was greatly at a disadvantage. It was, indeed, astonishing that she was able to maintain the unequal contest for four years. Montgomery, Alabama, was the first Confederate capital, but after Virginia joined her sister States, the seat of government was removed to Richmond. How Mr Davis—of whom Mr Gladstone, in the early days of English sympathy with the South, said that he had "made a nation"—bore himself in his most responsible position during the gigantic conflict which ensued, cannot here be related in detail. It is sufficient to say that it was with great ability and an unblemished character. In a wonderfully short time he organized and put into the field one of the finest bodies of soldiers of which history has record. Factories sprung up in the South in a few months, supplying the army with arms and munitions of war, and the energy of the President was everywhere apparent. That he committed serious errors, his warmest admirers will hardly deny. Unfortunately his firmness developed into obstinacy, and exhibited itself in continued confidence in officers who had proved to be failures, and in dislike of some of his ablest generals. He committed the great mistake, too,

of directing the movements of distant armies from the seat of government, though those armies were under able generals. This naturally caused great dissatisfaction, and more than once resulted in irreparable disaster.

Only two instances need be cited. In the winter of 1861–62 General Thomas J. ("Stonewall") Jackson was in command of the Valley forces. He planned and executed a brilliant winter attack on Romney in Hampshire county, occupied by the Federals, and during his march destroyed a dam on the Chesapeake and Ohio Canal, an important feeder to Washington. The position gained was very important in the defence of the Valley of Virginia. General Loring, with a part of the command, was left at Romney to hold the advantages gained. But he communicated with the War Department, and requested to be allowed to retire, on the plea that he might be cut off, although Jackson was within supporting distance. Thereupon, the administration, without consultation with General Jackson, ordered Loring's withdrawal, which resulted in a serious disadvantage in the defence of the Valley. General Jackson at once tendered his resignation, and it was with the greatest difficulty that the Governor of Virginia, with something like an apology from the War Department, was able to retain for the Confederacy the services of this great military genius. In 1864 General Joseph E. Johnston, in command of the army of Tennessee, was faced by General Sherman with nearly double his force. Johnston eluded Sherman's efforts to outflank him, and in a series of engagements, inflicting great loss, drew him some hundreds of miles from his base. He then urged Mr Davis to send a strong body of cavalry to the rear of Sherman and destroy his line of supplies. This Mr Davis declined to do, but instead insisted on Johnston's stopping the advance of his opponent. General Sherman commanded the best of the Federal troops, and Johnston, having reached Atlanta and having prepared to defend it on his own chosen ground, declined to say what his future movements might be, as they were dependent on the fortunes of war. Whereupon Mr Davis relieved him and placed in command General J. B. Hood, a greatly inferior soldier, who, in a series of wild assaults on Sherman, soon shattered the magnificent army which Johnston had led with such ability.

The defeats of Hood hastened the fate of the Confederacy. During the winter of 1864–65 the resources of the Government showed such exhaustion that it was apparent that the end would come with the opening of the Spring campaign. This was clearly stated in the reports of the Heads of Departments and of General Lee. President Davis, however, acted as if he was assured of ultimate success. He sent Duncan F. Kenner as special commissioner to the courts of England and France to obtain recognition of the Confederacy on condition of the abolition of slavery. When a conference was held in Hampton Roads on 3rd February 1865 between President Lincoln and Secretary Seward on the one side, and A. H. Stevens, R. M. T. Hunter, and Judge James A. Campbell, representing President Davis, on the other, he instructed his representatives to insist on the recognition of the Confederacy as a condition to any arrangement for the termination of the war. This defeated the object of the conference, and deprived the South of terms which would have been more beneficial than those imposed by the conqueror when the end came a few weeks later. The last days of the Confederate Congress were spent in recriminations between that body and President Davis, and the popularity with which he commenced his administration had almost entirely vanished.

After the surrender of the armies of Lee and Johnston in April 1865, President Davis attempted to make his way through Georgia across the Mississippi, in the vain hope of continuing the war with the forces of Generals Smith and Magruder. He was taken prisoner by Federal troops before he reached the river, and was brought back to Old Point, Virginia, that he might be confined in prison at Fortress Monroe. His prison was a casemate under a damp parapet, in which a light was kept constantly burning, and sentinels paced backwards and forwards continually. He was heavily chained, and his coarse food was served in filthy vessels. He entered the prison a feeble man, and such treatment soon brought him to death's door. Dr Craven, the Federal surgeon who attended him, by earnest pleas had his treatment changed and saved his life. Persistent efforts were made to connect him with the assassination of President Lincoln and with the harsh treatment of prisoners at Andersonville, but without avail. Two indictments were found against him for treason, and for several years he was denied trial or bail. Such cruel treatment aroused the sympathy of the Southern people, who regarded him as a martyr to their cause, and in a great measure restored him to that place in their esteem which by his blunders he had lost. It also aroused a general feeling in the North, and when finally he was admitted to bail, Horace Greely, Cornelius Vanderbilt, Gerrett Smith, and others in that section who had been his political opponents, became his sureties. Charles O'Conor, a leader of the New York Bar, volunteered to act as his counsel. With him was associated Robert Ould of Richmond, a lawyer of great ability. They moved to quash the indictment on which he was brought to trial. Chief Justice Chase and Judge Underwood constituted the court, which was divided, the Chief Justice voting to sustain the motion and Underwood to overrule it. The matter was thereupon certified to the Supreme Court of the United States, and no decision of which there is record was ever announced by that high tribunal. Meanwhile the administration dismissed the prosecution and discharged the accused. The health of Mr Davis was greatly injured by the harsh treatment inflicted on him while at Fortress Monroe, a harrowing account of which is given by the Federal surgeon Dr Craven in his *Prison Life of Jefferson Davis.* It was some years before he was sufficiently recovered to write his *Rise and Fall of the Confederate States of America.* In this volume he attempted to vindicate his administration, and in so doing he attacked the records of those generals he disliked. He died on 6th December 1889 at New Orleans, leaving a widow and two daughters—Margaret, who married J. A. Hayes, and Varina, better known as "Winnie" Davis, the "daughter of the Confederacy," who died unmarried in 1899.

The life of Jefferson Davis has been written several times. The most prominent of these publications are those by J. William Jones, D.D., and by Mrs Varina Davis, his widow. But his life is so prominently identified with the struggle between the States, that every history of that great contest must present him in the foreground. (W. W. H*.)

**Dawlish,** a seaside resort in the Ashburton parliamentary division of Devonshire, England, 11 miles south by east of Exeter by rail. A masonic hall was built in 1890. A dispensary was established in 1885, and an infirmary in 1896. The cottage hospital, founded in 1871, was removed to other premises in 1880. The area of the civil parish is 5370 acres. The population in 1881 was 4595, and in 1891 it was 4925. The area of the urban district is 1500 acres. The population in 1881 was 3977; in 1901, 4003.

**Dawson, Sir John William** (1820–1899), Canadian man of science, was born at Pictou, Nova Scotia, on 30th October 1820. Of Scottish descent, he went to Edinburgh to complete his education, and graduated at

that university in 1842. Returning to Canada he carried out some geological explorations under the direction of Sir Charles Lyell, and was afterwards appointed superintendent of education for Nova Scotia, a position in which he was responsible for important reforms in the educational arrangements of the province. From 1855 to 1893 he was principal of M'Gill University, which prospered under his fostering care and attained a reputation that was a good deal more than local. When the Royal Society of Canada was constituted he was the first to occupy the presidential chair, and he also acted as president of the British Association at its meeting at Birmingham in 1866, and of the American Association for the Advancement of Science. Sir William Dawson's name is especially associated with the *Eozoon Canadense*, which in 1865 he described as an organism existing in a fossil state in the Laurentian rocks, but his views on the subject were far from commanding general assent. Besides many memoirs published in the *Transactions* of various learned societies, he was the author of numerous popular books on geological subjects. In these he maintained a distinctly theological attitude, declining to admit the descent or evolution of man from brute ancestors, and holding that the human species only made its appearance on this earth within quite recent times. He died on 20th November 1899. His son, George Mercer Dawson (1849–1901), was born at Pictou on 1st August 1849, and received his education at M'Gill University and the Royal School of Mines, London, where he had a brilliant career. In 1873 he was appointed geologist and naturalist to the North American Boundary Commission, and two years later he joined the staff of the Geological Survey of Canada, of which he became assistant director in 1883, and director-general in 1895. He was in charge of the Canadian Government's Yukon Expedition in 1887, and as one of H.M. Bering Sea Commissioners spent the summer of 1891 investigating the facts of the seal fisheries on the northern coasts of Asia and America. For his services there, and at the subsequent arbitration in Paris, he was made a C.M.G. He died on 2nd March 1901. He was the author of many scientific papers and reports, especially on the surface geology and glacial phenomena of the northern parts of America, and he was largely responsible for the Canadian articles in this *Supplement*.

**Dax,** chief town of arrondissement, in the department of Landes, France, 35 miles west-south-west of Mont-de-Marsan, with station on railway from Bordeaux to Bayonne. It is an important market for resinous substances, cattle, mules, and horses, and has considerable mercantile interchange with Spain. In the middle of the town there is a hot sulphur spring of a temperature of 140° Fahr.; and the place is consequently frequented by visitors for the sake of the baths. An important new bathing establishment, beautifully situated on the site of the old castle and near the Adour, was opened by the President of the Republic in 1891. In the same year a monument to the engineer Borda (d. 1799) was unveiled. Population (1881), 8359; (1891), 8403; (1896), 8307, (comm.) 9836; (1901), 10,329.

**Dayton,** a city of Campbell county, Kentucky, U.S.A., on the south bank of the Ohio river, opposite Cincinnati, and adjoining Bellevue and Newport, Ky., in the northern part of the state. Population (1890), 4264; (1900), 6104, of whom 655 were foreign-born and 63 negroes.

**Dayton,** capital of Montgomery county, Ohio, U.S.A., in 39° 44′ N. lat. and 84° 08′ W. long., on the Great Miami river, which here is not navigable, at an altitude of 737 feet. The site is level, and the streets broad, with a fairly regular plan, and paved with gravel. It is supplied with water by the Holly pumping system, the works being owned by the city. Dayton is a commercial city of importance, being on the Miami and Erie Canal, and on ten lines of railway, belonging to five railway companies, and radiating in all directions. Its manufactures are large and varied. In 1890 the invested capital was $13,470,000, employing over 12,000 hands. The product was valued at $22,446,572. The more prominent of the products were agricultural implements, flour, and iron and steel goods. The assessed valuation of real and personal property, on a basis of about 55 per cent. of the full value, was, in 1899, $42,565,200, the net debt of the municipality, $3,562,943, and the rate of taxation, $25·60 per $1000. The city had a slow growth between 1870 and 1880, but from then until 1900 it increased rapidly, owing to the development of manufactures and trade. Population (1880), 38,678; (1890), 61,220; (1900), 85,333, of whom 10,053 were foreign-born and 3387 negroes. The death-rate in 1900 was 16·5.

**Deacon.**—The germ of the Christian diaconate may be seen in the choosing of the Seven (Acts vi.), whose primary function was "to serve tables"; but its definite and permanent shape comes from the Greek churches founded by St Paul. The ministers of these formed two distinct classes, "those who rule" and "those who serve," with the designations ἐπίσκοποι and διάκονοι; and St Paul enumerates their qualifications in 1 Tim. iii. 8–13, &c. With the development of the episcopate (in the later sense), the deacons became the immediate ministers of the bishop for disciplinary purposes; and their primary function was extended to include supervising church property, visiting the sick, distributing alms, &c. By degrees these became subsidiary to another function, that of ministering in the church, especially in Baptism and the Eucharist, and later on that of teaching too. And thus the duties of the deacon came to be summed up as follows in the Roman Pontifical: *diaconus oportet ministrare ad altare, baptizare et prædicare.* (In the English Ordinal both functions, ministering in temporal matters and ministering in the congregation, are kept in view.) But the fundamental character of his office remained: on the one hand he was sharply distinguished, as being in "holy orders" like the bishop and presbyter, from the various lower orders in the ancient Church; on the other hand, he "ministered" to those of higher degree. And although in their absence fresh functions devolved upon him (varying with times and regions), he could never perform strictly "sacerdotal" functions, such as consecrating the Eucharist. The office frequently led in ancient days to the higher orders; but it was frequently held for life, and in great cities, where the number of deacons was long restricted to seven, it became one of high honour and emolument. In modern days both tendencies are represented: in the West the office is usually a stepping-stone to the priesthood, whereas in the East it is often held for life, and some high offices are reserved to deacons. The ancient canonical age for the diaconate was twenty-five; it is now twenty-three. In the Lutheran Churches the *Diakonat* is merely a title of certain assistant clergy, not a separate order; in most other non-Episcopal Churches it is practically a lay office.

Thomassinus. *Vetus ac Nova Disciplina*, pars i. lib. i. c. 51 f. and lib. ii. c. 29 f. Lugdunum, 1706.—J. N. Seidl. *Der Diakonat in der katholischen Kirche.* Regensburg, 1884.—R. Sohm. *Kirchenrecht*, i. 121–137. Leipzig, 1892.—Smith and Cheetham. *Dictionary of Christian Antiquities*, art. "Deacon." (W. E. Co.)

**Deaconess.**—The office of deaconess has a special importance at the present day, in view of the movement for its revival. It may now be considered certain that (*a*)

there was a true diaconate of women in the churches founded by St Paul. Bishop Lightfoot held that Phœbe, διάκονος of the church at Cenchreæ (Rom. xvi. 1), "is as much a deacon as Stephen or Philip is a deacon"; and even if the word be used loosely here, it is clear that 1 Tim. iii. 11 means "Women (-deacons) in like manner," &c. (*b*) Nor must they be confused with the "widows" of the ancient Church, to whom certain functions were sometimes intrusted; they were ordained (excepting apparently for a time in Egypt) and had a definite position "about the altar," *i.e.*, in the ranks of the clergy. Their work was to visit and instruct the women, to have charge of them during service, and to anoint women and children for baptism; sometimes also to cleanse the sanctuary and even administer the chalice to women. At first they ranked with, but below, the men-deacons; in course of time, however, the former rose in the scale and the latter fell, ranking below the sub-deacons; and indeed the author of the TESTAMENTUM DOMINI (*q.v.*) places over them an entirely new officer, the "canonical widow," "presbytera," or "*vidua habens præcedentiam sedendo*," of whom there are only faint traces elsewhere. Although the order appears to have existed from the first in the East, where women were much secluded (the two *ministræ* tortured by Pliny, *Ep.* xcvi, may well have been deaconesses), it only spread elsewhere by degrees. It is not mentioned in Egypt till well on in the 3rd century, and does not appear in the West till about 400 A.D.,—first in Gaul and then in Italy. Even then it does not seem to have been a thriving institution. Some deaconesses are known to us of a strictly ministerial kind, but more frequently they are of a monastic or *quasi*-monastic character; and the institution died away by about the 11th century. In the East they throve better: they are well known to us in the writings of St Chrysostom and other fathers, synods made regulations respecting them, and their position before the law is clearly laid down in the Civil Law. Nevertheless, here also they passed away by degrees; first the office came to be held by the heads of communities of women, then the name came to be given to abbesses in general, and by about the 13th century deaconesses were practically extinct. Several mediæval and Protestant sects, however, possessed a ministry of deaconesses, amongst whom may be mentioned the Cathari, Mennonites, United Brethren, and the early Independents. Moreover, the enlarged scope of women's work at the present day has led to the foundation of "deaconess institutions" of an entirely new kind. Such an institution was inaugurated at Kaiserwerth in 1833 by the Lutheran Dr Fleidner; others of the same kind followed, both abroad and in England (*e.g.*, at Tottenham and Mildmay Park); and they are now to be found in most parts of Europe. The members of these institutions, however, do not really represent the deaconesses of early days: they are not ministers of their churches in any real sense, but rather members of voluntary societies for common work. In fact they are Protestant sisters of charity rather than deaconesses. In recent days, however, there has been a movement in the churches of the Anglican communion for the revival of the order of deaconess on ancient lines. In 1861 Bishop Tait of London set apart Miss E. Ferard as a deaconess by laying on of hands, and she became the first head of the London Deaconess Institution. Similar institutions have since been founded at home and abroad, some on a "regular" and some on a "secular" basis; *i.e.*, in some cases the members are professed sisters, in others not. By degrees, too, they have received further recognition. In 1871 a body of "Principles and Rules" for deaconesses received the signature of the two English archbishops and eighteen bishops; in 1891 eight "Resolutions" on the subject were passed in the Convocation of Canterbury; and the Lambeth Conference of 1897 "recognizes with thankfulness the revival of the office of deaconess." Nevertheless, the revival cannot yet be considered complete: the deaconess is not yet more than a diocesan officer, who "may be released from her obligations by the bishop, if he thinks fit, upon cause shown"; her special functions are undetermined, and her status is still in many ways indefinite. No doubt, however, further development is only a question of time.

Deaconess CECILIA ROBINSON. *The Ministry of Deaconesses.* London, 1898.—*Church Quarterly Review*, vol. xlvii. p. 302 f., art. "On the Early History and Modern Revival of Deaconesses." London, 1899; and the works there referred to.—D. LATAS. Χριστιανική Ἀρχαιολογία, vol. i. pp. 163–171. Athens, 1883.—*Testamentum Domini*, ed. RAHMANI. Mainz, 1899.

(W. E. CO)

**Dead Sea,** a lake in Palestine, so called from the absence of animal life in its waters. It lies nearly north and south, in the deepest part of the Jordan-Araba depression. It has no outlet, and its surface is from 1289 to 1300 feet below that of the Mediterranean. At its northern end is the broad valley down which the Jordan flows; and beyond the marshy plain at its other extremity, the floor of the Araba rises southward to the watershed between the Dead and Red Seas (65½ miles from the Dead and 46½ miles from the Red Sea; altitude 660 feet). From the eastern shore the ground rises abruptly in terraces to the Moabite plateau (3100 feet); and from the western with almost equal abruptness to the hill country of Judah (3300 feet). The slopes on either side are deeply seamed by watercourses, through which winter torrents and, in some cases, perennial streams flow to the lake. The Dead Sea is about 47½ miles long, and its greatest width is 9½ miles; its area is about 340 square miles. It is divided into two unequal parts by a peninsula, el-Lisán, which breaks off on the west in a cliff about 300 feet high, and is connected with the Moabite shore by a narrow strip of marshy land. The peninsula is composed of white calcareous marl with beds of salt and gypsum, and, like Jebel Usdum, which it resembles in character and composition, it formed part of the bed of the lake when its waters stood at a higher level. North of the peninsula the lake has a maximum depth of 1278 feet. South of it the depth is only 3 to 12 feet, and some years ago it was fordable opposite el-Lisán. The marshy plain, es-Sebkha, at the south end is liable to inundation, and strewn with driftwood encrusted with salt; it extends southwards to a terrace 500 feet high, which marks the commencement of the 'Araba. At the south-west end of the lake is Jebel or Khashm Usdum, about 600 feet high, and 7 miles long, of which the lower part is formed of solid rock-salt. The principal affluents, including winter torrents, are, on the north, the Jordan and 'Ain es-Súeimeh; on the east, Wadies Ghuweir, Zerka Ma'ín, in which lie the hot sulphur springs of Callirrhöe, Mójib (Arnon), ed-Derá'a or el-Kerak, en-N'meirah, and el-Hesi or es-Sáfieh, which passes to the lake through the reed-thickets of es-Sebkha; on the south, Wadies et-Tafíleh, el-Jeib, and el-Fikreh; and on the west, Wadies Muhauwát and Seyál, 'Ain Jidi, W. el-Merabba or ed-Derajeh, 'Ain Ghuweir, W. en-Nár, and 'Ain Feshkha. It is estimated that these affluents pour more than six million tons of water into the Dead Sea daily, all of which passes off by evaporation.

The surface level of the lake varies with the season. In March 1865 it was 1292 feet below sea-level (Wilson): it is highest in February or March. The boiling-point of the water is 221° F. The density increases from north to south, and with the depth—rapidly to a certain point, after which it is more uniform. Its density at 300 *mètres* is 1·253, average 1·166. The solid matter at a depth of

300 m. is 27·8 per cent. of the weight, and consists of chlorides of calcium, magnesia, sodium, and potassium, and in smaller proportions of bromides and sulphates of the same substances. The richness in bromine is held to indicate greatly prolonged concentration. Eggs float in the water. Curative properties were attributed to it in Roman times; and according to Mukaddasi, A.D. 985, people assembled to drink it on a feast day in August. A bath in the lake is wholesome and refreshing. The oily sensation after bathing is due to the chloride of calcium; and the noisome, acrid taste to the chloride of magnesia. The chloride and bromide of magnesia are fatal to all animal life excepting certain microbes found in the mud by Ehrenberg and Lortet. Fish carried down by the Jordan, and small fish from brackish pools and streams near the shore, die at once in the water of the lake. The water strongly affects the eyes, and evaporation leaves a thick deposit of salt. The water is limpid and transparent, and under varying conditions is deep blue or green in colour. Its surface, far from being motionless, as some writers have supposed, is constantly rippled by breezes, or raised into waves by the strong northerly winds, and is sometimes veiled by light bluish clouds or haze produced by the evaporation. Molyneux, in 1847, and others since that date, have noticed a streak of white foam which sometimes stretches from the north-west end of the lake towards el-Lisán, following nearly the axis of the lake. From this Blanckenhorn concludes that there is a sub-lacustrine fissure which he considers to be thermal and asphaltic; but the phenomenon is possibly due to the current of the Jordan, which does not expend its force completely until it reaches el-Lisán. A recent traveller, Rev. P. Cady, writes of a strong current setting towards the north along the east coast; of oil floating on the water near the mouth of the Zerka Ma'în; and of disturbances of level that appear, like those to which the Lake of Geneva is subject, to be due to differences of barometric pressure at different points on the lake. The origin of these and other phenomena can only be ascertained by a thorough scientific examination of the lake and its basin. The shores are sterile and desolate from the absence of fresh water, and from the smallness of the rainfall, and not, as formerly supposed, from the poisonous nature of the air. The springs near the lake give life to thickets of willow, tamarisk, and acacia, which are frequented by birds; and wherever, as at Engedi, there is running water the vegetation is almost tropical in its luxuriance. The plain of Jericho is very fertile, and south of the lake the Arabs raise crops of wheat, dura, cotton, and tobacco. The climate in summer and autumn is very hot and unhealthy; but in winter it is good, with hot days and cool nights. The unhealthiness is due partly to the intense heat, and partly to the miasma from the swamps and lagoons at the southern end. The scenery is remarkable for the brilliancy of the colouring, and the varying effects of light and shade. The abrupt slopes on either side, the deep ravines on the eastern shore, and the intense colouring of the water combine to form a scene of grandeur and beauty which has been compared, not inaptly, with the aspect of some portions of the Lake of Geneva. Boats were employed on the lake in Roman, and possibly in much earlier, times (Tacitus, *Hist.* v. 6; Josephus, *Ant.* ix. 1, § 2; *B. J.* iv. 7, § 6); they are represented on it in the mosaic map at Medeba; and under the Latin Kingdom of Jerusalem the navigation dues formed part of the revenue of the Lords of Kerak. The use of boats died out when the Turks abandoned the country east of the Jordan to the Bedawín. During the 19th century boats have occasionally been used for exploration, and since the occupation of Moab and Edom by the Turks an attempt has been made to place small steamers on the lake.

*Name.*—In the Old Testament the Dead Sea is called "the sea," the "salt sea," the "sea of the Arabah," and "the eastern sea." The name "Dead Sea" appears in the Vulgate (Jos. iii. 16), and is used by Pausanias, Galen, Justin, and Eusebius. Diodorus Siculus, Pliny, and Josephus call it the "Asphaltic Lake," and others the "Sodomitish sea." It is now known to the Arabs as Bahr Lût, "the sea of Lot."

*Geology.*—The Jordan-Araba depression, in which the Dead Sea lies, was produced by subsidence along a line of faults or fractures during the terrestrial movements that accompanied the gradual elevation of the region out of the sea after the close of the Eocene period. As a result of the faulting, the formations on the opposite sides of the lake do not correspond. Whilst the hills on the western side are formed entirely of Cretaceous limestones, the abrupt face of the Moabite plateau is composed of a base of ancient volcanic rocks, upon which rest, in ascending order, red sandstones and conglomerates of the Carboniferous age, Carboniferous limestone, variegated sandstones (Nubian sandstone) of Lower Cretaceous age, and Cretaceous limestones. The deeply cut ravines of the Moabite plateau owe their origin to the same subsidence, but their features, and those of the hills east and west of the lake, were greatly modified by the heavy rainfall in the Pliocene and Pleistocene periods. Terraces of lacustrine deposits at different levels indicate that in Pleistocene times the Jordan valley was occupied by a lake 200 miles long, which had the same surface level as the Mediterranean; and that the water gradually subsided until, long before the dawn of history, the evaporation equalled the supply, and the lake assumed approximately its present level. The surface is liable to frequent fluctuations of level, which, though confined to narrow vertical limits, are sufficient to alter considerably the form and superficial extent of the lake. Such fluctuations are due to a succession of exceptionally dry or rainy seasons, to the greater or lesser activity of subaqueous springs, to landslips, to changes in the drainage, to the gradual silting up of the basin, and, possibly, to slight earth movements which escape detection. The annual rise and fall is estimated at from 6 to 10 feet, but there seems to be also prolonged periods of high and low level. The lines of driftwood and the marks on the rocks show the limits of rise which might occur under existing conditions, and a fall of 15 feet is quite possible after exceptional periods of dryness. Such a fall would dry up almost the whole of the lagoon south of el-Lisán, and effect great changes in the appearance of the lake. During the forty years 1860–1900 there was a gradual rise in the level of the surface, apparently coinciding in part with a succession of wet seasons, but accurate observations are wanting. A small island near the north end of the lake, which in 1858 was from 10 to 12 feet above the surface, and connected with the shore by a causeway, has been entirely submerged since 1892; and the track between Jebel Usdum and the lake has for several years been covered with water. Monthly measurements of the rise and fall of the lake, taken for the Palestine Exploration Fund during an exceptionally dry year, October 1900 to October 1901, showed a rise of 1 foot 3 inches up to 30th March 1901, and then a fall of 1 foot 9 inches to October. Thus the level of the lake was lowered 6 inches during the year. The asphalt or bitumen, so highly prized in ancient times, is supposed to be derived from subaqueous strata of bituminous limestone or marl, and to collect at the bottom of the lake until it is loosened by an earthquake and rises to the surface. The Arabs collect the bitumen which reaches the shore, and the salt of Jebel Usdum and of the Dead Sea has been carried to Jerusalem from the earliest times. But no systematic attempt has been made yet to turn the mineral wealth of the Dead Sea and its basin to account.

The following analysis of water taken from the north end of the lake, not near the Jordan, in March 1885, when the level was high, was made by Dr Bernays:—

Sp. gr. 1·1528 at 15·5 C.

| | Grs. |
|---|---|
| Calcium carbonate | 70·00 |
| Calcium sulphate | 163·39 |
| Magnesium nitrate | 175·01 |
| Potassium chloride | 1089·06 |
| Sodium chloride | 5106·00 |
| Calcium chloride | 594·46 |
| Magnesium chloride | 7388·21 |
| Magnesium bromide | 345·80 |
| Iron and aluminium oxides | 10·50 |
| | 14,942·43 |
| Organic matter, water of crystallization and loss | 317·57 |
| | 15,260·00 grains residue per gallon. |

This is not the place to discuss the theories respecting the destruction of the Cities of the Plain (Gen. xix.). The catastrophe was in no way connected with the formation of the Dead Sea. Some authorities place the cities at the south end of the lake; but it is clear from the statements in the Bible that they were situated in the Jordan valley to the north of the lake.

AUTHORITIES.—DUC DE LUYNES. *Voyage d'Exploration à la Mer Morte*, tome 3, *Géologie* par LOUIS LARTET, Paris, 1875.—FRAAS. *Aus dem Orient*.—WILSON, in *Ordnance Survey of Jerusalem, Notes* (for levels), and in P. E. F. *Qy. Stat.*, 1900.—HULL. *Memoir on the Geology and Geography of Arabia, Petræa, Palestine*, &c., P. E. Fund, 1889; *Mount Seir*, 1889.—G. A. SMITH. *Historical Geography of the Holy Land*, 1894.—LORTET, in *Zeitschrift des Deutschen Palastina Vereins*, xvii. 142.—BLANCKENHORN, in *Z.D.P.V.* xix. 157.—GAUTIER, *Autour de la Mer Morte*, 1901.—DE LAPPARENT. *Étude Géologique sur la Mer Morte* in *Revue Biblique*, vol. v. (1896).—GRAY HILL and PUTNAM CADY in P. E. F. *Qy. Stats.*, 1900, 1901. (C. W. W.)

**Deadwood,** capital of Lawrence county, South Dakota, U.S.A., in the northern part of the Black Hills, in 44° 23′ N. lat. and 103° 44′ W. long., in the cañon of Whitewood Creek, at an altitude of 4532 feet. Its site is hilly, and its street plan irregular. It has two railways, the Burlington and Missouri River, and the Fremont, Elkhorn, and Missouri Valley. It is the commercial and mining centre of the Black Hills. About it are several gold mines, characterized by the low grade of their ores, which range from $3 to $4 per ton, by their vast quantity and by the ease of mining and of extracting the metal. The ore contains free gold, which is extracted by the simple process of stamping and amalgamation. Several hundred tons of ore are treated thus in Deadwood and its environs daily, and its stamp mills are exceeded in size only by those of the Treadwell Mine in south-eastern Alaska. The annual gold product of this region is about $4,000,000. Population (1880), 3777; (1890), 2366; (1900), 3498, of whom 707 were foreign-born.

**Deal,** a municipal borough and bathing resort in the St Augustine's parliamentary division (since 1885) of Kent, England, 8 miles north-east by north of Dover by rail. The asphalted promenade is now nearly 4 miles long; the pier has been provided with a pavilion and enlarged. There are well-known golf links. Area, 1124 acres. Population (1881), 8500; (1901), 10,427. There is a parish of Deal.

**De Amicis, Edmondo** (1846——), Italian writer, was born at Oneglia 21st October 1846. After some schooling at Cuneo and Turin, he was sent to the Military School at Modena, from which he was appointed to a lieutenancy in the 3rd Regiment of the line in 1865. He fought at the battle of Custozza in 1866. In 1867 he became Director of the *Italia Militare*, Florence. In the following year he published his first book, *La Vita Militare*, which consisted of sketches of military life, and attained wide popularity. After the overthrow of the Pope's temporal power in 1870, De Amicis retired from the army and devoted himself to literature, making his headquarters at Turin. Always a traveller by inclination, he found opportunity for this in his new leisure, and some of his most popular books have been the product of his wanderings. Several of these have been translated into English and the other principal languages of Europe. The most important of these are his descriptions of Spain (1873), Holland (1874), Constantinople (1877), and Morocco (1879). These have gained him reputation as a brilliant depicter of scenery and the external aspects of life; solid information is not within their sphere; and much of their success is owing to the opportunities they afford for spirited illustration. Of late years De Amicis has greatly extended his fame as a novelist, especially by *Il Romanzo d'un Maestro* (1890). His poems consist principally of sonnets.

**De Bary, Anton** (1831–1888), German botanist, was of Belgian extraction, but his family had long been settled in Germany. He was born, January 26, 1831, at Frankfort-on-Main. From 1849 to 1853 he studied medicine at Heidelberg, Marburg, and Berlin. In 1853 he settled at Frankfort as a surgeon. In 1854 he became *privat-docent* for botany in Tübingen, and afterwards Professor of Botany at Freiberg (1859). In 1867 he migrated to Halle, and in 1872 to Strassburg, where he was the first rector of the newly constituted university. He died there January 19, 1888. In his earlier years he came under the influence of Mohl, Fresenius, A. Braun, Ehrenberg, and Johannes Müller, but his startling originality and ability soon brought him into prominence, and he became one of Germany's most distinguished biologists, remarkable for his broad and firm grip of the botanical problems of his day, and for the clear insight he brought to bear on investigations.

Although one of his largest and most important works was on the *Comparative Anatomy of Ferns and Phanerogams*, in which he produced an account of the tissues of vascular plants which has never been entirely superseded, his treatment of the epidermal system being especially good, and notwithstanding his admirable acquaintance with systematic and field botany generally, De Bary will always be remembered as the founder of modern Mycology. This branch of botany he completely revolutionized in 1866 by the publication of his celebrated *Morphologie und Physiologie d. Pilze*, &c., a classic which he rewrote in 1884, and which has had a world-wide influence on Biology. His clear appreciation of the real significance of *Symbiosis* and the dual nature of Lichens stands out as one of his masterpieces, and in many ways he showed powers of generalizing in regard to the evolution of organisms which would alone have made him a distinguished man. It was as an investigator of the then mysterious Fungi, however, that De Bary stands out first and foremost among the biologists of the 19th century. He not only laid bare the complex facts of the life-history of many forms, —*e.g.*, the Ustilagineæ, Peronosporeæ, Uredineæ, and many Ascomycetes,—treating them from the developmental point of view, in opposition to the then prevailing anatomical method of the Tulasnes, but he insisted on the necessity of tracing the evolution of each organism from spore to spore, and by his methods of culture and accurate observation brought to light numerous facts hitherto undreamt of. These his keen perception and insight continually employed as the basis for hypotheses, which he in turn tested with an experimental skill and critical faculty rarely equalled and probably never surpassed. One of his most fruitful discoveries was the true meaning of infection as a morphological and physiological process. He traced this step by step in *Phytophthora*, *Cystopus*, *Puccinia*, and other Fungi, and so placed before the world in a clear light the significance of parasitism. He then showed by numerous examples wherein lay the essential differences between a parasite and a saprophyte, a theme by no means clear in 1860–70, but which he himself had recognized as early as 1853, as is shown by his work, *Die Brandpilze*.

These researches led to the explanation of epidemic diseases, and De Bary's contributions to this subject were fundamental, as witness his classical work on the Potato Disease in 1861. They also led to his striking discovery of *heterœcism* (or *metœcism*) in the Uredineæ, the truth of which he demonstrated in Wheat Rust experimentally, and so clearly that his classical example (1863) has never been other than confirmed by subsequent observers, though we now know much more as to details. It is difficult to estimate the relative importance of De Bary's astoundingly accurate work on the sexuality of the Fungi. He not only described the phenomena of sexuality in Peronosporeæ

and Ascomycetes,—*Eurotium, Erysiphe, Peziza,* &c.,—but also established the existence of Parthenogenesis and Apogamy on so firm a basis that it is doubtful if all the combined workers who have succeeded him, and who have brought forward contending hypotheses in opposition to his views, have succeeded in shaking the doctrine he established before modern cytological methods existed. In one case, at least (*Pyronema confluens*), the most recent and skilful investigations, with every modern appliance, have shown that De Bary described the sexual organs and process accurately.

It is impossible here to mention all the discoveries made by De Bary. He did much work on the Chytridieæ, Ustilagineæ, Exoasceæ, and Phalloideæ, as well as on that remarkable group the Myxomycetes, or, as he himself termed them, *Mycetozoa*, almost every step of which was of permanent value, and started lines of investigation which have proved fruitful in the hands of his pupils. Nor must we overlook the important contributions to Algology contained in his earlier monograph on the Conjugatæ (1858), and investigations on Nostocaceæ (1863), *Chara* (1871), *Acetabularia* (1869), &c. De Bary seems to have held aloof from the Bacteria for many years, but it was characteristic of the man that, after working at them in order to include an account of the group in the second edition of his book in 1884, he found opportunity to bring the whole subject of Bacteriology under the influence of his genius, the outcome being his brilliant *Lectures on Bacteria* in 1886. De Bary's personal influence was immense. Every one of his numerous pupils was enthusiastic in admiration of his kind nature and genial criticism, his humorous sarcasm, and his profound insight, knowledge, and originality.

Memoirs of De Bary's life will be found in *Bot. Centralbl.* 1888, vol. xxxiv. p. 93, by Wilhelm; *Ber. d. d. bot. Ges.* vol. vi., 1888, p. viii, by Reess, each with a list of his works; *Bot. Zeitung*, 1889, vol. xlvii., No. 3, by Graf zu Sohms-Laubach. (H. M. W.)

**Debentures** and **Debenture Stock.**—An advantage incident in Great Britain to incorporation under the Companies Acts is found in the facilities which it affords a trading concern for borrowing on debentures or debenture stock. More than four hundred millions of money are now invested in these forms of security. Borrowing is not specifically dealt with by the Companies Acts at all, but that it was contemplated by the Legislature is evident from the provision in sect. 43 of the Act of 1862 for a company keeping a register of mortgages and charges. The policy of the Legislature in this, as in other matters connected with trading companies, was apparently to leave the company to determine whether borrowing should or should not be one of the objects defined expressly or by implication in the memorandum of association. A company cannot borrow unless it is expressly or impliedly authorized to do so by its memorandum. In the case of a trading company borrowing is impliedly authorized as a necessary incident of carrying on the company's business. Thus a company established for the conveyance of passengers and luggage by omnibuses, a company formed to buy and run vessels between England and Australia, and a company whose objects included discounting approved commercial bills, have all been held to be trading companies with an incidental power of borrowing as such to a reasonable amount. A building society, on the other hand, has no inherent power of borrowing, though a limited statutory power was conferred on such societies by the Building Societies Act, 1874; nor has a society formed not for gain but to promote art, science, religion, charity, or any other useful object. Public companies again, formed to carry out some undertaking of public utility, such as docks, water-works, or gas-works, and governed by the Companies Clauses Acts, have only limited powers of borrowing.

The indefiniteness of an implied power of borrowing, even when it attaches, has led to a general power of borrowing being usually inserted in a company's memorandum of association. It is left to the articles to define the amount to be borrowed, the nature of the security, and the conditions, if any, such as the sanction of a general meeting of shareholders, on which the power is to be exercised. Under the Companies Act, 1900, a company cannot exercise any borrowing power until it has fulfilled the conditions prescribed by the Act entitling it to commence business. A person who is proposing to lend money to a company must be careful to acquaint himself with any regulations of this kind, and to see (1) that the memorandum and articles of association authorize borrowing, and (2) that the borrowing limit is not being exceeded, for if it should turn out that the borrowing was in excess of the company's powers and *ultra vires*, the company cannot be bound, and the borrower's only remedy is against the directors for breach of warranty of authority, or to be surrogated to the rights of creditors paid out of the borrowed moneys. A company proposing to borrow usually issues a prospectus, similar to the ordinary share prospectus, stating the amount of the issue, the dates for payment, the particulars of the property to be comprised in the security, the terms as to redemption, and so on, and inviting the public to subscribe. Underwriting is also resorted to, as in the case of shares, to insure that the issue is taken up. There is no objection to a company issuing debentures or debenture stock at a discount, as there is to its issuing its shares at a discount. It must borrow on the best terms it can get. A prospectus inviting subscriptions for debentures or debenture stock comes within the terms of the Directors Liability Act, 1890, and persons who are parties to it have the onus cast upon them, should the prospectus contain any misstatements, of showing that, at the time when they issued the prospectus, they had reasonable grounds to believe, and did in fact believe, that the statements in question were true; otherwise they will be liable to pay compensation to any person injured by the misstatements.

The usual mode of borrowing by a company is either on debentures or debenture stock. Etymologically, debenture is merely the Latin word "*debentur*,"—the first word in a document in common use by the Crown in early times admitting indebtedness to its servants or soldiers. This was the germ of a security which has now, with the expansion of joint-stock company enterprise, grown into an instrument of considerable complexity.

*The Floating Debenture.*—The form of debenture chiefly in use at the present day is that known as the floating debenture. By it the company covenants to pay to the holder thereof the sum secured by the debenture on a specified day (usually ten or fifteen years after the date of issue), or at such earlier date as the principal moneys become due under the provisions of the security, and in the meantime to pay interest until repayment, or until the security becomes enforceable under the conditions; and the company further charges its undertaking and all its property and assets, including its uncalled capital, with the payment of the amount secured by the debentures. The word "property" by itself will not cover uncalled capital. This is the body of the instrument; on its back is endorsed a series of conditions, constituting the terms on which the debenture is issued. Thus the debenture-holders are to rank *pari passu* with one another against the security; the debenture is to be transferable free from equities between the company and the original holder; the charge is to be a floating charge, and is to be enforce-

able in certain events: for instance, if the interest is in arrear for three months, or if a winding up order is made against the company, or a resolution for winding up is passed. Other events are sometimes added accelerating payment. The conditions also provided for the mode and form of transfer of the debentures, the death or bankruptcy of the holder, the place of payment, &c. The term "floating charge" is used to distinguish it from one that is fixed. The charge attaches as soon as the debenture is issued, but it attaches to the assets for the time being only, *i.e.*, it leaves the company free (or, to put it otherwise, gives it a licence) to sell, mortgage, lease, and otherwise deal with such assets as if no charge existed. This licence is involved in the fact that the debenture-holders' charge is on the company's undertaking, which implies that the undertaking is to remain a going concern. The licence extends, however, only to dealings in *the ordinary course of business;* it does not entitle a company to sell the whole of its undertaking and assets. Payment by a company of its just debts is always in the ordinary course of business, but satisfaction by execution levied *in invitum* is not.

Every debenture must now, under the Companies Act, 1900, bear the registrar's certificate of registration. This floating form of security is found very convenient both to the borrowing company and to the lender. The company is not embarrassed by the charge, while the lender has a security covering the whole assets for the time being, and can intervene at any moment by obtaining a receiver if his security is imperilled, even though none of the events in which the principal moneys are made payable have happened. If any of them has happened, *e.g.*, default in payment of interest, or a resolution by the company to wind up, the payment of the principal moneys is accelerated, and a debenture-holder can at once commence an action to obtain payment and to realize his security. At times a proviso is inserted in the conditions endorsed on the debenture, that the company is not to create any mortgage or charge ranking in priority to or *pari passu* with that contained in the debentures without the consent of the debenture-holders.

*Trust Deeds.*—When the amount borrowed by a company is large, and it is not meant that it should be soon paid off, it is very common for the company to execute a Trust Deed by way of further security. The object of such a trust deed is twofold: (1) it conveys specific property to the trustees of the deed by way of legal mortgage (the charge contained in the debentures is only an equitable security), and charges all the remaining assets in favour of the debenture-holders, with appropriate provisions for enabling them, in certain events similar to those expressed in the debenture conditions, to enforce the security, and for that purpose to enter into possession and carry on the business, or to sell it and distribute the profits; (2) it organizes the debenture-holders and constitutes in the trustees of the deed a set of experienced and business-like men who can watch over the interests of the debenture-holders and take steps for their protection if necessary. In particular it provides machinery for the calling of meetings of debenture-holders by the trustees, and empowers a majority of (say) two-thirds or three-fourths in number and value at such meeting to bind the rest to any compromise or arrangement with the company which such majorities may deem beneficial. This is found a very useful power, and may save recourse to a scheme of arrangement under the machinery of the Joint-Stock Companies Arrangement Act, 1870.

*Registration of Mortgages and Charges.*—A company is bound, under the Companies Act, 1862, to keep a register of mortgages and charges, open for the inspection of creditors. It is also bound now, under the Companies Act, 1900, to register with the registrar of joint-stock companies at Somerset House all mortgages and charges of certain specified kinds made by the company, otherwise the security will be void.

*Debentures Registered and to Bearer.*—Debentures are usually of two kinds—(1) registered debentures, and (2) debentures to bearer. Registered debentures are transferable only in the books of the company. Debentures to bearer are negotiable instruments, and pass by delivery. Coupons are attached for interest. Sometimes debentures to bearer are made exchangeable for registered debentures, and *vice versâ.*

*Redemption.*—A company generally likes to reserve to itself a right of redeeming the security before the date fixed by the debenture for repayment; and accordingly a power for that purpose is generally inserted in the conditions. But as debenture-holders, who have got a satisfactory security, do not wish to be paid off, the right of redemption is usually qualified so as not to arise till (say) five years after issue, and a premium of 5 per cent. is made payable by way of bonus to the redeemed debenture-holder. The number of debentures to be redeemed each year is also limited. The selection is usually made by drawings held in the presence of the directors. A sinking fund is a convenient means often resorted to for redemption of a debenture debt. Such a fund is formed by the company setting apart a certain sum each year out of the profits of the company after payment of interest on the debentures.

*Debenture Stock.*—Debenture stock bears the same relation to debentures that stock does to shares. "Debenture stock," as Lord Lindley states (*Companies*, 5th ed. 195), "is merely borrowed capital consolidated into one mass for the sake of convenience. Instead of each lender having a separate bond or mortgage, he has a certificate entitling him to a certain sum, being a portion of one large loan." This sum is not uniform, as in the case of debentures, but variable. One debenture-stockholder, for instance, may hold £20 of the debenture stock, another £20,000. It is this divisibility of stock in fact, whether debenture or ordinary stock, into quantities of any amount, which constitutes its peculiar characteristic, and its convenience from a business point of view. It facilitates dealing with the stock, and also enables investors with only a small amount to invest to become stockholders. The property comprised in this security is generally the same as in the case of debentures. Debenture stock created by trading companies differs in various particulars from debenture stock created by public companies governed by the Companies Clauses Act. The debenture stock of trading companies is created by a contract made between the company and trustees for the debenture-stockholders, known as a debenture-stockholders' trust deed, analogous in its provisions to the trust deed above described as used to secure debentures. By this deed the company acknowledges its indebtedness to the trustees as representing the debenture-stockholders to the amount of the sum advanced, covenants to pay it, and conveys the subject matter by way of security to the trustees with all the requisite powers and provisions for enabling them to enforce the security on default in payment of interest by the company or the happening of certain specified events evidencing insolvency. The company further in pursuance of the contract enters the names of the subsisting stockholders in a register, and issues certificates for the amount of their respective holdings. A deed securing debenture stock requires an *ad valorem* stamp.

*Remedies.*—When debenture-holders' security becomes

enforceable there are a variety of remedies open to them. These fall into two classes—(1) remedies available without the aid of the Court; (2) remedies available only with the aid of the Court.

(1) If there is a trust deed, the trustees may appoint a receiver of the property comprised in the security, and they may also sell under the powers contained in the deed, or under § 25 of the Conveyancing Act, 1881. Sometimes similar powers—to appoint a receiver and to sell—are inserted in the conditions endorsed on the debenture.

(2) The remedies with the aid of the Court are—(*a*) an action by one or more debenture-holders on behalf of all for a receiver and to realize the security; (*b*) an originating summons for sale or other relief, under Rules of Supreme Court, 1883, O. 55, R. 5A; (*c*) an action for foreclosure where the security is deficient,—all the debenture-holders must be parties to this proceeding; (*d*) a winding-up petition. Of these modes of proceeding, the first is by far the most common and most convenient. The company is generally consenting, and the action comes on for judgment on agreed minutes, when the Court directs accounts and inquiries as to who are the holders of the debentures, what is due to them, what property is comprised in the security, and gives leave to any of the parties to apply in chambers for a sale. If the company has gone into liquidation, leave must be obtained to commence or continue the action, but such leave in the case of debenture-holders is *ex debito justitiæ*. The administration of a company's assets in such actions by debenture-holders (debenture-holders' liquidations, as they are called) has of late encroached very much on the ordinary administration of winding up. The chief sufferers from the floating security, when it comes to be enforced on winding up, are the company's unsecured creditors, who find that everything belonging to the company, uncalled capital included, has been pledged to the debenture-holders. The conventional answer is that such creditors might and ought to have inspected the company's register of mortgages and charges.

*Reconstruction.*—When a company reconstructs, as it often does in these days, the rights of debenture-holders have to be provided for. Reconstructions are mainly of two kinds—(1) by arrangement, under the Joint-Stock Companies Arrangement Act, 1870, and (2) by sale and transfer of assets, either under § 161 of the Companies Act, 1862, or under a power in the company's memorandum of association. Under the Joint-Stock Companies Act a petition for the sanction of the Court to a scheme is presented, and the Court thereupon directs meetings of creditors, including debenture-holders, to be held. A three-fourths majority in value of debenture-holders present at the meeting in person or by proxy binds the rest. Debenture-holders claiming to vote must produce their debentures at or before the meeting. Under the other mode of reconstruction—sale and transfer of assets—there is usually a novation, and the debenture-holders accept the security of the new company in the shape of debentures of equivalent value or—occasionally—of fully paid preference shares.

A point in this connexion, which involves some hardship to debenture-holders, may here be adverted to. It is a not uncommon practice for a solvent company to pass a resolution to wind up voluntarily for the purpose of reconstructing. The effect of this is to accelerate payment of the security, and the debenture-holders have to accept their principal and interest only, parting with a good security and perhaps a premium which would have accrued to them in a year or two. The company is thus enabled by its own act to redeem the reluctant debenture-holder on terms most advantageous to itself. To obviate this hardship, it is now a usual thing in a debenture-holders' trust deed to provide—the committee of the London Stock Exchange indeed require it—that a premium shall be paid to the debenture-holders in the event of the security becoming enforceable by a voluntary winding up with a view to reconstruction.

*Public Companies.*—Public companies, *i.e.*, companies incorporated by special Act of Parliament for carrying on undertakings of public utility, form a class distinct from trading companies. The borrowing powers of these companies, the form of their debenture or debenture stock, and the rights of the debenture-holders or debenture-stockholders, depend on the conjoint operation of the companies' own special Act and the Companies Clauses Acts, 1845, 1863, and 1869. The provisions of these Acts as to borrowing, being express, exclude any implied power of borrowing. The first two of the above Acts relate to mortgages and bonds, the last to debenture stock. The policy of the Legislature in all these Acts is the same, namely, to give the greatest facilities for borrowing, and at the same time to take care that undertakings of public utility which have received its sanction shall not be broken up or destroyed, as they would be if the mortgagees or debenture-holders were allowed the ordinary rights of mortgagees for realizing their security by seizure and sale. Hence the Legislature has given them only "the fruit of the tree," as Lord Cairns expressed it. The debenture-holders or the debenture-stockholders may take the earnings of the company's undertaking by obtaining the appointment of a receiver, but that is all they can do. They cannot sell the undertaking or disorganize it by levying execution, so long as the company is a going concern; but this protecting principle of public policy will not be a bar to a debenture-holder, in his character of creditor, presenting a petition to wind up the company, if it is no longer able to fulfil its statutory objects. Railway companies are affected by further special legislation, which will be found in the Railway Companies Powers Act, 1864, the Railways Construction Facilities Act, 1864, and the Railway Securities Act, 1866.

*Municipal Corporations and County Councils.*—These bodies are authorized to borrow for their proper purposes on debentures and debenture stock with the sanction of the Local Government Board. See the Municipal Corporations Act, 1882, the Local Authorities Loans Act, 1875, and the Local Government (England and Wales) Act, 1888.

*United States.*—In the United States there are two meanings of debenture—(1) a bond not secured by mortgage; (2) a certificate that the United States is indebted to a certain person or his assigns in a certain sum on an audited account, or that it will refund a certain sum paid for duties on imported goods, in case they are subsequently exported.

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**Debreczen,** a municipal town of Hungary, 114 miles east of Budapest, with (1900) 75,006 inhabitants. The country belonging to the town forms a vast plain 370 square miles in extent, on which are few dwelling-places, but where roam hundreds of thousands of cattle, horses, sheep, and pigs.

**Debu Lake.** See NIGER.

**Decatur,** capital of Macon county, Illinois, U.S.A., near the Sangamon river, at an altitude of 668 feet. Its site is level, its street plan regular, and it has a good water supply and well paved streets. Five railways meet here, making it a commercial point of much importance. Among its manufacturing establishments are flour-mills and car shops, and in its vicinity are coal-mines. Popula-

tion (1880), 9547; (1890), 16,841; (1900), 20,754, of whom 1939 were foreign-born and 620 negroes.

**Decazeville,** a town and railway station in the arrondissement of Villefranche, department of Aveyron, France, 22 miles in direct line north-west of Rodez. Coal and iron are worked in the vicinity, and supply the raw material for very important ironworks, first established in the year 1827 by the Duc Decazes, which have since grown to such magnitude that the town ranks as the chief centre of the coal and iron industry in the south-west of France. Free schools and various benevolent institutions for the workpeople are in operation. A statue commemorates the founder. Population (1881), 6793; (1896), 7434, (comm.) 9634; (1901), 11,536.

**Decimal System.** See Weights and Measures.

**Dédéagatch,** a seaport of Turkey, capital of the province of the same name, about 10 miles north-west of the mouth of the Maritza. Till 1871 it was a mere cluster of fishermen's huts. A new town then began to spring up, settlers being attracted by the prospect of opening up a trade in the products of a vast forest of Valonia oaks which grew near. In 1873 it was made the chief town of a *Kaza*, to which it gave its name, and a *Kaimakam* was appointed to it. In 1884 it was raised in administrative rank from a *Kaza* to a *Sandjak*, and the governor became a *Mutessarif*. In 1889 the Greek Archbishopric of Enos was transferred to Dédéagatch. On the opening, early in 1896, of the Constantinople-Salonica Railway, which has a station here, a large proportion of the extensive transit trade which Enos, situated at the mouth of the Maritza, had acquired was immediately diverted to Dédéagatch, and an era of unprecedented prosperity began; but when the railway connecting Burgas on the Black Sea with the interior was opened, in 1898, it lost all it had won from Enos. The Valonia trade, however, has steadily developed, and is supplemented by the export of a certain amount of timber and some almonds. But until the open roadstead is converted into a well-sheltered harbour it will be impossible for this place to become the entrepôt which its position otherwise eminently qualifies it to be. It has no manufacturing industry of any kind. Its population numbers about 4000 souls, of whom 2500 are Greeks. Austria-Hungary, France, Great Britain, Greece, and Russia have consular representatives at Dédéagatch, and Bulgaria has an agent there. In digging out the foundations of their houses, the settlers found many ancient tombs. Probably these are relics, not of the necropolis of the ancient Zone, but of a *Téké* of Dervishes, of the Dédé sect, which was established shortly after the conquest, and whose occupants gave to the place its name—Dédéagatch.

**Dedham,** capital of Norfolk county, Massachusetts, U.S.A., with an area of 23 square miles of quite level country. There are three villages in the town, known as Dedham, East Dedham, and Oakdale. The town is traversed by the New York, New Haven, and Hartford Railway. The chief industry is the manufacture of woollen goods. Population (1880), 6233; (1890), 7123; (1900), 7457, of whom 2186 were foreign-born and 65 negroes.

**Deer.**—The classification of the family Cervidæ has been much altered since the article in *Ency. Brit.* vol. vii. was written. Deer are now arranged as follows:—First, the Reindeer (*Rangifer tarandus*), with several local races, distinguished from all other forms by the presence of antlers in both sexes. Second, the Elks (*Alces*), in which the antlers diverge at right angles to the middle line of the skull. Third, the typical Deer (*Cervus*), characterized by the antlers diverging obliquely to the middle line of the skull, and having a brow-tine. They include the typical, or Red Deer group, containing the Red Deer (*C. elaphus*), Hangul (*C. cashmirianus*), Shou (*C. affinis*), Duke of Bedford's Deer (*C. xanthopygus*), and the Wapiti (*C. canadensis*), of which a variety is found in Central Asia. Also the Sika group (sub-genus *Pseudaxis*), as represented by the Japanese Deer (*C. sica*) and Pekin Deer (*C. hortulorum*). The Fallow Deer (*C. dama*) represents a group by itself. This is followed by the Oriental Rusine group (*Rusa*), with 3-tined antlers, as represented by the numerous races of the Sambar (*C. unicolor*), the Rusa (*C. hippelaphus*), the Chital (*C. axis*), and many smaller forms. The Swamp-Deer (*C. duvauceli*) and Thamin (*C. eldi*) are well-known members of the last, or Rucervine group, which is likewise Oriental. The five species of Muntjac constitute the fourth genus (*Cervulus*) of the family; while the fifth is formed by the Tufted Deer (*Elaphodus*) of North China and Tibet. Then follows the hornless Chinese Water-Deer (*Hydrelaphus*), which is succeeded by the Roes (*Capreolus*). These latter have no brow-tine, and the same is the case with the much larger Père David's Deer (*Elaphurus davidianus*), now known only in captivity. Allied to the last are the numerous species of American Deer (*Mazama*), of which the common species (*M. americana*) represents one group (*Odocoileus*), the Marsh-Deer (*M. dichotoma*) a second (*Blastoceros*), the Guemals (*M. bisulca* and *M. antisiensis*) a third (*Xenelaphus*), and the Brockets a fourth. Lastly, we have the diminutive American Pudus (*Pudua*), and the Musk-Deer (*Moschus*), which forms a subfamily apart. (R. L*.)

**Deés** or **Dés,** a corporate town of Eastern Hungary, 48 miles north-north-east of Kolozvár, on the river Szamos. Population (1900), 9888. Among several ancient buildings the most noteworthy is the Gothic Calvinist church, constructed in 1450. There is a large distillery in the town.

**Defiance,** capital of Defiance county, Ohio, U.S.A., on the Maumee river, at the mouth of the Auglaize, at an altitude of 695 feet. It has two railways, the Baltimore and Ohio, and the Wabash, and it is the seat of Defiance College. Population (1880), 5907; (1890), 7694; (1900), 7579, of whom 960 were foreign-born and 39 negroes.

**Degas, Hilaire Germain Edgard** (1834——), French painter, was born in Paris, 19th July 1834. Entering in 1855 the École des Beaux Arts, he early developed independence of artistic outlook, studying under Lamothe. He first exhibited in the Salon of 1865, contributing a "War in the Middle Ages," a work executed in pastel. To this medium he was ever faithful, using it for some of his best work. In 1866 his "Steeplechase" revealed him as a painter of the racecourse and of all the most modern aspects of life and of Parisian society, treated in an extremely original manner. He subsequently exhibited in 1867 "Family Portraits," and in 1868 a portrait of a dancer in the "Ballet of *La Source*." In 1869 and 1870 he restricted himself to portraits; but thenceforward he abandoned the Salons and attached himself to the Impressionists. With Manet and Monet he took the lead of the new school at its first exhibition in 1874, and repeatedly contributed to these exhibitions (in 1876, 1878, 1879, and 1880). In 1868 he had shown his first study of a dancer, and in numerous pastels he proclaimed himself the painter of the ballet, representing its figurantes in every attitude, with more constant aim at truth than grace. Several of his works may be seen at the Luxembourg Gallery, to which they were bequeathed, among a collection of impressionist pictures, by M. Caillebotte. In 1880 Degas showed his powers of observation in a set of "Portraits of Criminals," and he attempted modelling in a

"Danseuse sur la Scène." By Degas.

*(In the Luxembourg.)*

"Dancer," in wax. He afterwards returned to his studies of the sporting world, exhibiting in December 1884 at the Petit Gallery two views of "Races" which had a great success, proving the increasing vogue of the artist among collectors. He is ranked with Manet as the leader of the "impressionist school." At the eighth Impressionist Exhibition, in 1886, Degas continued his realistic studies of modern life, showing drawings of the nude, of work-women, and of jockeys. Besides his pastels and his paintings of genre and portraits—among these, several likenesses of Manet—Degas also handled his favourite subjects in etching and in aquatint; and executed several lithographs of "Singers at Cafés-concert," of "Ballet-girls," and indeed of every possible subject of night-life and incidents behind the scenes. Degas is reputed not to have striven for official recognition; but his work is to be seen not only at the Luxembourg but in many of the great private collections in Paris, as in those of M. Camondo and M. Manzi, in England and America. In the Centenary Exhibition of 1900 he exhibited "The Interior of a Cotton-Broker's Office at New Orleans" (belonging to the Museum at Pau) and "The Rehearsal."

See also G. Moore. "Degas, the Painter of Modern Life," *Magazine of Art,* 1890.—J. K. Huysmans. *Certains.* Paris, 1889.—G. Geffroy. *La vie Artistique.* (3e Serie.) Paris, 1894.

**Dehra,** a town of British India, headquarters of the Dehra Dun district. In 1881 the population was 18,959; in 1891 it was 25,684; the municipal income in 1897–98 was Rs.27,518; the death-rate in 1897 was 27·15 per thousand. It is the headquarters of the Trigonometrical Survey, and of the Forest Department, besides being a cantonment for a Gurkha regiment; it has an American Presbyterian mission.

**Dehra Dun,** a district of British India, in the Meerut division of the North-West Provinces. Its area is 1193 square miles. The population in 1881 was 144,070; in 1891 it was 168,135, giving an average density of 141 persons per square mile. In 1901 the population was 177,646, showing an increase of 6 per cent. The land revenue and rates were Rs.1,12,666, the incidence of assessment being R.0–5–9 per acre; the cultivated area in 1896–97 was 87,912 acres, of which 23,441 were irrigated; the number of police was 372; there were 22 vernacular schools, with 705 pupils; the death-rate in 1897 was 24·25 per thousand. A railway to Dehra from Hardwar, on the Oudh and Rohilkhand line (32 miles), was completed in 1900. Up to 1897–98 the capital outlay on the Dun canals was Rs.7,15,311; the net receipts in that year were Rs.68,151, showing a profit of 9·5 per cent. There are four printing-presses, issuing two English and one vernacular newspapers; and three breweries. Tea gardens cover an area of nearly 5000 acres.

**Deir,** or **Deir ez-Zor,** a town of Asiatic Turkey, on the right bank of the Euphrates, at an altitude of 806 feet. It is the capital of the Zor sanjak, which was formed in 1857, and includes Rás el-'Ain to the east, and Palmyra to the west of the river. The town is connected by a bridge with an island, whence there is a ferry to the left bank. The climate is healthy, but hot. Large numbers of sheep and camels are bred in the sanjak, and cereals are grown. Roads lead to Aleppo and Damascus, and, by Sinjar, to Mosul. The population of the sanjak is 100,000, chiefly nomads; of the town, 7000, including a few Christians and Jews.

**Dekalb,** a city of Dekalb county, Illinois, U.S.A., in the northern part of the state, at the intersection of two railways. Population (1890), 2579; (1900), 5904, of whom 1520 were foreign-born.

**Dekker, Edward Douwes** (1820–1887), the Dutch writer, commonly known as Multatuli, was born at Amsterdam on the 2nd of March 1820. His father, a ship's captain, intended his son for trade, but this humdrum prospect disgusted him, and in 1838 he went out to Java, and obtained a post in the Inland Revenue. He rose from one position to another, until, in 1851, he found himself assistant-resident at Amboyna, in the Moluccas. In 1857 he was transferred to Lebak, in the Bantam residency of Java. By this time, however, all the secrets of Dutch administration were known to him, and he had begun to protest against the abuses of the colonial system. In consequence he was threatened with dismissal from his office for his openness of speech, and, throwing up his appointment, he returned to Holland in a state of fierce indignation. He determined to expose in detail the scandals he had witnessed, and he began to do so in newspaper articles and pamphlets. Little notice, however, was taken of his protestations, until, in 1860, he published, under the pseudonym of "Multatuli," his romance entitled *Max Havelaar.* An attempt was made to ignore this brilliant and irregular book, but in vain; it was read all over Europe. The exposure of the abuse of free labour in the Dutch Indies was complete, although there were not wanting apologists who accused Dekker's terrible picture of being over-coloured. He was now fairly launched on literature, and he lost no time in publishing *Love Letters* (1861), which, in spite of their mild title, proved to be mordant satires of the most rancorous and unsparing kind. The literary merit of Multatuli's work was much contested; he received an unexpected and most valuable ally in Vosmaer. He continued to write much, and to faggot his miscellanies in uniform volumes called *Ideas,* of which seven appeared between 1862 and 1877. Douwes Dekker quitted Holland, shaking off her dust from his feet, and went to live at Wiesbaden. He now made several attempts to gain the stage, and one of his pieces, *The School for Princes,* 1875 (published in the fourth volume of *Ideas*), pleased himself so highly that he is said to have styled it the greatest drama ever written. It is a fine poem, written in blank verse, like an English tragedy, and not in Dutch Alexandrines; but it is undramatic, and has not held the boards. Douwes Dekker moved his residence to Nieder Ingelheim, on the Rhine, and there he died on the 19th of February 1887. Towards the end of his career he was the centre of a crowd of disciples and imitators, who did his reputation no service; he is now, again, in danger of being read too little. To understand his fame, it is necessary to remember the sensational way in which he broke into the dulness of Dutch literature forty years ago, like a flame out of the Far East. He was ardent, provocative, perhaps a little hysterical, but he made himself heard all over Europe. He brought an exceedingly severe indictment against the egotism and brutality of the administrators of Dutch India, and he framed it in a literary form which was brilliantly original. Not satisfied with this, he attacked, in a fury that was sometimes blind, everything that seemed to him falsely conventional in Dutch religion, government, society, and morals. He respected nothing, he left no institution untouched. Now that it is possible to look back upon Multatuli without passion, we see in him, not what Dutch enthusiasm saw,—"the second writer of Europe in the nineteenth century" (Victor Hugo being presumably the first),—but a great man who was a powerful and glowing author, yet hardly an artist, a reckless enthusiast, who was inspired by indignation and a burning sense of justice, who cared little for his means if only he could produce his effect. He is seen to his best and worst in *Max Havelaar*; his *Ideas,* hard, fantastic, and sardonic,

seldom offer any solid satisfaction to the foreign reader. But Multatuli deserves remembrance, if only on account of the unequalled effect his writing had in rousing Holland from the intellectual and moral lethargy in which she lay half a century ago. (E. G.)

**Delane, John Thaddeus** (1817–1879), editor of *The Times*, was born 11th October 1817, in London, being the second son of Mr W. F. A. Delane, a barrister who was employed by Mr Walter in *The Times* office. While still a boy he attracted Mr Walter's attention, and it was always intended that he should find work on the paper. He received a good general education at private schools and King's College, London, and also at Magdalen Hall, Oxford; and after taking his degree in 1839, he read for the Bar, being called in 1847. Meanwhile he had already begun work for *The Times* as a reporter; and in 1841, on the death of Mr Barnes, he succeeded him as editor, a post which he occupied for thirty-six years. He was not himself a writer, but he was the greatest newspaper editor of his time, and perhaps of any time. Though he went into society and had a position there such as no journalist had previously enjoyed, using his opportunities with a sure intuition for the way in which events would move, he had no liking for personal publicity, but was careful to preserve his impersonality as an editor, and to merge himself in the newspaper which he represented. His triumph was the triumph of *The Times*, which under his régime attained an influence which has never been surpassed. He was a man of many interests and great judgment; capable of long application and concentrated attention, with power to seize always on the main point at issue, and rapidly master the essential facts in the most complicated affair. His general policy was to keep the paper a national organ of opinion above party, but with a tendency to sympathize with the Liberal movements of the day. He admired Palmerston and respected Lord Aberdeen, and was of considerable use to both; and it was Lord Aberdeen himself who, in 1845, told him of the impending repeal of the Corn Laws, an incident round which many incorrect stories have gathered. The history, however, of the events during the thirteen administrations, between 1841 and 1877, in which *The Times*, and therefore Delane, played an important part cannot here be recapitulated. In 1877 his health gave way, and he retired from the editorship; and on 22nd November 1879 he died at Ascot. (H. CH.)

**De la Rue, Warren** (1815–1889), British astronomer and chemist, son of Thomas de la Rue, the founder of the large firm of stationers of that name in London, was born in Guernsey on 18th January 1815. Having completed his education in Paris, he entered his father's business, but in his leisure hours he devoted himself with success to chemical and electrical researches, and between 1836 and 1848 published several papers on these subjects. Towards the end of this period he was attracted to astronomy, and with the aid of a 13-inch reflecting telescope, the optical parts of which were made entirely by himself, he executed many drawings of the celestial bodies of singular beauty and fidelity. His name, however, will be chiefly remembered as one of the earliest and most successful pioneers in the application of the art of photography to astronomical research. In the year 1851 his attention was drawn to a daguerreotype of the moon by G. P. Bond, which was exhibited at the Great Exhibition of that year. Encouraged by this first attempt, and employing the more rapid wet-collodion process, he succeeded before long in obtaining exquisitely defined automatic pictures of the moon, which remained unsurpassed until the appearance of the Rutherfurd photographs in 1865. In 1854 he turned his attention to solar physics, and for the purpose of obtaining a daily photographic representation of the state of the solar surface he devised the photoheliograph. This instrument is described in his report to the British Association, "On Celestial Photography in England" (1859), and in his Bakerian Lecture (*Phil. Trans. Roy. Soc.* vol. clii. pp. 333–416). Regular work with this instrument was inaugurated at Kew by De la Rue in 1858, and was carried on there for fourteen years; since 1872 it has been continued at the Royal Observatory, Greenwich. The results obtained in the years 1862–1866 are discussed in two memoirs published by De la Rue, in conjunction with Professor Balfour Stewart and Mr B. Loewy, in the *Phil. Trans.* (vol. clix. pp. 1–110, and vol. clx. pp. 389–496), entitled "Researches on Solar Physics." In the year 1860 De la Rue took the photoheliograph to Spain for the purpose of photographing the total eclipse of the sun, which occurred on July the 18th of that year. This expedition formed the subject of the Bakerian Lecture already referred to. The photographs obtained on that occasion proved beyond doubt the solar character of the prominences, or red flames, seen around the limb of the moon during a solar eclipse. In 1873 De la Rue gave up active work in astronomy, and presented most of his astronomical instruments to the University Observatory, Oxford. Subsequently, in the year 1887, he provided the same observatory with a 13-inch refractor to enable it to take part in the International Photographic Survey of the Heavens. In conjunction with Dr Hugo Müller, he published several papers of a chemical character between the years 1856 and 1862. He was twice President of the Chemical Society, and also of the Royal Astronomical Society (1864–1866). In 1862 he received the gold medal of the latter society, and in 1864 a Royal medal from the Royal Society, for his observations on the total eclipse of the sun in 1860, and for his improvements in astronomical photography. He died on 19th April 1889. (A. A. R*.)

**Delaware.**—One of the Middle Atlantic States of the American Union, and next to Rhode Island the smallest in extent, Delaware is situated on the Atlantic seaboard, and forms part of the peninsula between the Chesapeake and Delaware Bays. Its total land surface is approximately 1960 square miles. The population in 1870 was 125,015, of whom 102,221 were white and 22,794 coloured; in 1880 it was 146,608, of whom 120,160 were white, 26,442 coloured, 5 civilized Indians, and 1 Chinese. In 1890 it was 168,493, of whom 140,066 were white, 28,386 coloured, 37 Chinese, and 4 civilized Indians. In 1900 the population was 184,735, of whom 153,997 were white, 30,677 negroes, 51 Chinese, 1 Japanese, and 9 Indians. Out of 54,018 males 21 years of age and over, 7538 were illiterate (unable to write), of whom 3945 were white and 3593 coloured. Of the total population 94,158 (51 per cent.) were males, and 90,557 (49 per cent.) females; 170,925 (92·5 per cent.) were native-born, and 13,810 (7·5 per cent.) foreign-born. The increase in population from 1890 to 1900 was 9·6 per cent., and the number of inhabitants per square mile in 1900 was 94·2. There were 35 incorporated cities and towns. The largest city was Wilmington, with 76,508 inhabitants. The city next in size, Newcastle, had a population of but 3380, while the largest town, Dover, the State capital, had 3329. In Indian River Hundred, Sussex county, there lives a race of persons, nearly white, called "Indians" or "Moors," whose origin is unknown, although local tradition says they are the descendants of some Moorish sailors who were cast ashore years ago in a shipwreck. They do not associate with

persons of negro descent; and they maintain separate churches and schools, the latter receiving State aid. Delaware is an agricultural and manufacturing State. Much of it is in a high state of cultivation. Besides wheat, maize, and other grain, peaches are grown in immense quantities and sent over the country. Strawberries, raspberries, and other small fruits are raised for transportation. Increased attention has lately been given to dairy products. The canning of fruits, vegetables, meats and poultry, is carried on extensively. The kaolin mines were among those first worked in the United States, the product in 1899 being 10,500 tons, valued at $91,500. The forests, which afforded excellent timber, including white oak for the building of ships, have been greatly reduced by constant cutting. In the northern part of the State there are numerous and important manufactories. Wilmington and its suburbs have large machine shops, whose products, including marine engines and boilers and paper and pulp machines, are justly renowned; cotton, cotton-finishing, paper, morocco, patent leather, vulcanized fibre, car-wheel, carriage, and silk factories; rolling-mills and bridge works. Cars, for steam and street railways, are manufactured on a large scale. Upwards of 400 iron steamships have been built in Wilmington, exceeding in number and in aggregate tonnage those constructed in any other American city. The flour-mills on the Brandywine, founded in 1762, are famous, and the Dupont Gunpowder Works, 6 miles from Wilmington, are the oldest and largest in the country. There is a petroleum refinery at Marcus Hook.

According to the census of 1900, the number of manufacturing establishments in the State (excluding 169 having an annual product of less than $500 each) was 1417, in which was invested a total capital (including land, buildings, machinery, tools, &c., but not including capital stock) of $41,203,239. There were 1327 salaried employées receiving salaries amounting to $1,422,831, and an average number of 22,203 wage-earners receiving $9,263,661 in wages. The cost of materials used, including mill supplies, freight, fuel, &c., was $26,652,601, and the miscellaneous expenses (including rent, taxes, &c., but not including interest on capital invested) $2,158,350. The added values of the products in the different establishments amounted to $45,387,630. If from this gross value be deducted, in order to avoid duplication, the value ($15,849,388) of materials purchased in a partly manufactured form—where the finished product of one industry is used later as the raw material for another—the net value is found to be $29,538,242. If the steel and rolling-mills, car shops, foundry and machine shops, and shipbuilding be grouped as the iron and steel industry, there were in this industry fifty-three establishments having a capital of $14,929,935, employing 8536 wage-earners, paying $4,265,670 as wages, and having a gross product of $13,953,379. The leather industry ranks next in importance, with twenty establishments, a capital of $5,178,804, 2457 wage-earners receiving $1,044,903, and gross product of $9,400,504.

The Delaware and Chesapeake Canal connects the Delaware and Chesapeake Bays, and affords water transit for produce between Philadelphia and Baltimore. The Philadelphia, Wilmington, and Baltimore Railroad, and the Baltimore and Philadelphia Railroad run through the northern part of the State; the Wilmington and Northern Railroad communicates with the Pennsylvania coal region; the Delaware Railroad runs through the whole length of the State below Wilmington, connecting with various railways that reach either the Atlantic Ocean or the Chesapeake Bay; while another line, running directly across the lower part of the State, connects, at Queenstown, Maryland, with steamers for Baltimore.

The financial condition of the State is excellent, the assets, in bonds, railway mortgages, and bank stocks, exceeding the liabilities. Besides the income from assets, the State revenues are derived from taxes on licences, on commissions to public officers, on railway and banking companies, and to a slight extent from taxes on collateral inheritances, and on investments, as bonds, mortgages, notes and stocks, the investment tax yielding in 1899 only $1,311.35. There are county taxes, on land and live-stock, for the care of the roads and the poor; local taxes, levied on the rental value of land and on live-stock, towards the support of the public schools; town taxes, and, in same places, ditch taxes.

The vital statistics of the State are of little value, not having been systematically kept. A State Board of Health was organized in 1879, and there are now local boards in various towns. There is in each county a jail and an almshouse. Under recent legislation there is to be established in Newcastle county a workhouse, where persons under sentence must labour for eight hours each secular day, pay being allowed for overwork, and credit given, by reduction of sentence, for good behaviour. There is a State hospital for the insane. A certain number of persons are maintained out of the State School fund at outside institutions, such as the Pennsylvania Institution for the Deaf and Dumb, and the Pennsylvania Training School for Feeble-Minded Children. There are various private charities, particularly in the city of Wilmington.

Education exhibits progress. Delaware College, at Newark, with the support of Federal grants, steadily increases in efficiency. The maintenance of a system of public schools is rendered compulsory by the State Constitution. The State School fund, ranging from about $130,000 to $140,000 a year, is apportioned among the school districts, and is used exclusively for teachers' salaries and free text-books. In the apportionment no discrimination is allowed on account of race or colour; but separate schools for white and coloured children must be provided, and there is a State college for coloured students. Besides the State Board of Education, there is in each county a School Commission and a Superintendent of Public Schools, and in each district a School Committee chosen by the voters of the district, with power to levy taxes. At school elections women as well as men may be qualified to vote.

The Constitution now in force was framed in 1897, superseding the Constitution of 1831. Following the precedent recently set elsewhere, it was published and put into operation by authority of a resolution of the Constitutional Convention, without submission to the people. In the General Assembly the number of Representatives is raised from 21 to 35, and of Senators from 9 to 17, equal county representation being done away with.

The State is divided into 35 representative districts, Newcastle county having 15, and Kent and Sussex each 10; and 17 senatorial districts, Newcastle having 7, and Kent and Sussex each 5. Of the 15 Newcastle Representatives, Wilmington has 5; of the 7 Senators, 2. The sessions of the General Assembly, held at Dover, the State capital, are still biennial. The members receive an allowance for each day of the session not exceeding sixty, after which they get no compensation. At a special session the daily allowance is limited to thirty days. Legislative divorces are prohibited. The Governor's appointments to office must, except in certain cases, be confirmed by the Senate. He has a suspensory veto on legislation. Certain State officers, including the Attorney-General, and various county officers, formerly appointed by the Governor, are now elected. The judges are still appointed, but only for terms of twelve years. All persons coming of age, or becoming citizens of the United States, after 1st January 1900, must, in order to vote, be able to read the State Constitution in English and write their names. The payment of a poll-tax as a prerequisite to voting is abolished, and all eligible persons are registered on payment of a fee of one dollar. Persons charged with bribery at elections are triable by the court on information and without a jury. A Board of Pardons, consisting of the Chancellor and certain administrative officers, is created, and no reprieve for more than six months, or commutation of sentence, or pardon, can be granted by the Governor unless on the written recommendation of a majority of this Board. There is also established a State Board of Agriculture.

The Judicial power of the State is vested in a Supreme Court, a Superior Court, a Court of Chancery, an Orphans' Court, a Court of Oyer and Terminer, a Register's Court, and Justices of the Peace. There are six State judges, namely, a Chancellor, a Chief Justice, and four Associate judges. The Chancellor, Chief Justice, and one of the Associates may be appointed from and reside in any part of the State; the other three Associates may be appointed from any part of the State, but must reside one in each county. The five law judges compose the Superior Court, Court of General Sessions, and Court of Oyer and Terminer, but not

more than three of them can sit together in any one of those courts, though three must do so whenever practicable. Two constitute a quorum, save in the Court of Oyer and Terminer, where three are required. The Supreme Court consists, on error or appeal from a law court, of the Chancellor, who presides, and such of the five law judges as did not sit below; on appeal from the Court of Chancery, of the five law judges, three of whom constitute a quorum.

In *politics*, since the close of the Civil War in 1865, the State has generally been Democratic. But, in 1889, a Republican was elected to the United States Senate; and candidates of the same party were, in 1894, 1898, and 1900, chosen to the National House of Representatives, and, in 1894 and 1900, to the Governorship. In 1895, 1899, and 1901, the Legislature, being then Republican, was, because of a division in the party as to candidates, unable to elect a United States Senator, so that the State had, from 4th March 1895 till 1897, and from 4th March 1899 till 4th March 1901 only one United States Senator, and none at the special session of the Senate in March 1900. In 1896 and 1900, Mr M'Kinley, the Republican candidate for the Presidency, partly because of the attitude of the Gold Democrats, carried the State by large majorities. General Grant obtained, as the Republican candidate in 1872, a small majority. (J. B. M*.)

**Delaware,** capital of Delaware county, Ohio, U.S.A., on the Olentangy river, at an altitude of 902 feet. It has three railways, the Cleveland, Cincinnati, Chicago, and St Louis, the Columbus, Sandusky and Hocking, and the Hocking Valley. The Ohio Wesleyan University, located here, had, in 1899, 53 professors and instructors, and 1055 students, one-third of whom were women. Its property was valued at over $1,300,000, and its income was $62,000. Population (1880), 6894; (1890), 8224; (1900), 7940, of whom 572 were foreign-born and 432 negroes.

**Delaware River,** a river of the eastern United States, rises in the Catskill Mountains, in south-eastern New York, and flows south-west to the north-east corner of Pennsylvania; thence, with a south-east course, it forms the boundary between New York and Pennyslvania, and farther down, with a course alternating between south-east and south-west, it forms the boundary between New Jersey on the east and Pennsylvania and Delaware on the west. It has no well-defined mouth, but gradually widens into Delaware Bay. It is navigable to Trenton, where are falls, a distance from the capes of the Delaware of 128 miles. Its entire length from its head to the capes at the entrance to Delaware Bay is upwards of 400 miles and its drainage basin comprises 12,012 square miles. In its upper course, after leaving the Catskills, it flows alternately through the valleys between the Appalachian ridges and across these ridges through water-gaps. The most picturesque and best known of these is Delaware Water-Gap. The falls at Trenton, which have been utilised for power, are produced by the passage of the river over a fault-line from hard granite rocks to soft Tertiary beds.

**Delbrück, Martin Friedrich Rudolf,** Prussian statesman (1817-——), was born at Berlin on 16th April 1817. On completing his legal studies he entered the service of the State in 1837; and after holding a series of minor posts, was transferred in 1844 to the Ministry of Commerce, which was to be the sphere of his real life's work. Both Germany and Austria had realized the influence of commercial upon political union. Delbrück in 1851 induced Hanover, Oldenburg, and Schaumburg-Lippe to join the Zollverein; and the southern States, which had agreed to admit Austria to the union, found themselves forced in 1853 to renew the old union, from which Austria was excluded. Delbrück now began, with the support of Bismarck, to apply the principles of Free Trade to Prussian fiscal policy. In 1862 he concluded an important commercial treaty with France, which he succeeded in inducing the southern States to accept. After the Prussian victories of 1866, a Zollbundesrath or Federal Council was constituted, in which Delbrück, who became the first President of the Bundeskanzleramt or Federal Chancellery (1867), represented Bismarck in political as well as commercial questions. In 1868 he became a Prussian Minister without portfolio. In October 1870, when the political union of Germany under Prussian headship became a practical question, Delbrück was chosen to go on a mission to the South German States, and contributed greatly to the agreements concluded at Versailles in November. In 1871 he became President of the newly constituted Reichskanzleramt. Delbrück now, however, began to feel himself uneasy under Bismarck's leanings towards Protection and State control. On the introduction of Bismarck's plan for the acquisition of the railways by the State, Delbrück resigned office, nominally on the ground of ill-health (1st June 1876). In 1879 he opposed in the Reichstag the new protectionist tariff, and on the failure of his efforts retired definitely from public life.

**Delcassé, Théophile** (1852-——), French statesman, was born at Pamiers, in the department of Ariège, on 1st March 1852. He wrote articles on foreign affairs for the *République Française* and *Paris*, and in 1888 was elected Conseiller Général of his native department, standing as "un disciple fidèle de Gambetta." In the following year he entered the Chamber as deputy for Foix. He was appointed Under Secretary for the Colonies in the second Ribot Cabinet (January to April 1893), and retained his post in the Dupuy Cabinet till its fall in December 1893. It was largely owing to his efforts that the French Colonial Office was made a separate department with a Minister at its head, and to this office he was appointed in the second Dupuy Cabinet (May 1894 to January 1895). He gave a great impetus to French colonial enterprise, especially in West Africa, where he organized the newly acquired colony of Dahomey, and despatched the Liotard mission to the Upper Ubangi. While in opposition, he devoted special attention to naval affairs, and in speeches that attracted much notice declared that the function of the French navy was to secure and develop colonial enterprise, deprecated all attempts to rival the British fleet, and advocated the construction of commerce-destroyers as France's best reply to England. On the formation of the second Brisson Cabinet in June 1898 he succeeded M. Hanotaux at the Foreign Office, and retained that post under the subsequent premierships of MM. Dupuy and Waldeck-Rousseau. In 1898 he had to deal with the delicate situation caused by Captain Marchand's occupation of Fashoda, for which, as he admitted in a speech in the Chamber on 23rd January 1899, he accepted full responsibility, since it arose directly out of the Liotard expedition, which he had himself organized while Minister for the Colonies; and in March 1899 he concluded an agreement with Great Britain by which the difficulty was finally adjusted, and France consolidated her vast colonial empire in North-West Africa. In the same year he acted as mediator between the United States and Spain, and brought the peace negotiations to a successful conclusion. He introduced greater cordiality into the relations of France with Italy: at the same time he adhered firmly to the alliance with Russia, and in August 1899 made a visit to St Petersburg, which he repeated in April 1901. In June 1900 he concluded an important agreement with Spain, fixing the long-disputed boundaries of the French and Spanish possessions in West Africa.

**Delft,** a town in the province of South Holland, Netherlands, 10 miles north-west of Rotterdam by rail. Formerly it rivalled Rotterdam in the importance of its shipping and commerce, but it is now only the market for the butter and cheese of the fertile district around. There is still

considerable industry in earthenware ("New Delft"), gun-construction, distilling, and the manufacture of salad oil and oil-cakes. The "Phœnix," or old clubhouse of the students, which was burned down in 1872, has been replaced by a handsome erection in Renaissance style. A bronze statue of Hugo Grotius was raised in 1886. The population in 1900 was 31,582.

**Delhi,** or DILLI, a city of British India, the former capital of the Mughal Empire, now giving its name to a district and a division in the Punjab. It is situated on the right bank of the river Jumna, 954 miles from Calcutta by rail. In 1881 it had a population of 173,393, and in 1891 of 192,579. In 1901 the population was 208,385, showing a continuous increase. The municipal income in 1897–98 was Rs.4,57,182; the death-rate in 1897 was 34 per thousand. Delhi, as the centre of the railway system of Northern India, is now regaining much of the importance it lost at the time of the Mutiny. It is the terminus of three main lines—the East Indian, the North-Western, and the Rajputana; while the Delhi-Umballa-Kalka and the Northern Punjab companies also have stations here. The principal manufactures are gold and silver filigree-work and embroidery, jewellery, muslins, shawls, glazed pottery, and wood-carving. Since 1890 three cotton mills have been established, with 351 looms and 47,000 spindles, employing 1800 hands. There are also three flour-mills, several iron foundries, and a brush factory. A filtered water supply and sewerage works have been provided by the municipality out of a loan of Rs.8,00,000, and a further loan of Rs.1,80,000 for improving the water supply is proposed. The institutions include St Stephen's College, which teaches up to the M.A. degree; five high schools; Government normal school; native school of medicine subsidized by the municipality; S.P.G., Roman Catholic, and Baptist missions; sixty-four printing-presses, issuing twenty-one newspapers and periodicals; institute and reading room; Mahommedans and Hindu religious associations.

The DISTRICT OF DELHI has an area of 1290 square miles. The population in 1881 was 643,515 and in 1891 was 638,689, being the only case in the Punjab of a decrease; the average density was 495 persons per square mile. In 1901 the population was 688,979, showing an increase of 8 per cent. The land revenue and rates were Rs.8,90,644, the incidence of assessment being R.1–0–8 per acre; the cultivated area was 432,209 acres, of which 178,782 were irrigated, including 68,072 from Government canals; the number of police was 1031; the number of schools in 1897–98 was 237, attended by 8192 boys, being 13·8 per cent. of the boys of school-going age; the death-rate in 1897 was 33·34 per thousand. There are four factories for ginning and pressing cotton. Its northern portion is traversed by the Delhi-Umballa-Kalka Railway, and crossed by the Rajputana and Southern Punjab lines; total length, 74 miles. A new line, on the East Indian system, is now (1891) being constructed from Delhi southward to Agra through Muttra.

The DIVISION OF DELHI stretches from Simla to Rajputana, and is much broken up by native states. It comprises the seven districts of Hissar, Rohtak, Gurgaon, Delhi, Karnal, Umballa, and Simla. Its total area is 15,530 square miles, and in 1891 the population was 3,435,886.

**Delibes, Clément Philibert Léo** (1836–1891), French composer, was born at Saint Germain du Val on February 21, 1836. He studied at the Paris Conservatoire under Adolphe Adam, through whose influence he became accompanist at the Théâtre Lyrique. Towards the same period he began writing for the theatre, and during several years he produced a number of operettas. *Alger*, a cantata from his pen, was heard at the Opera in 1865. Having become second chorus-master at the Grand Opera, he wrote the music of a ballet entitled *La Source* for this theatre, in collaboration with Minkous, a Russian composer. *La Source* was produced with great success in 1866. The composer returned to the operetta style with *Malbrouk s'en va-t-en guerre*,—written in collaboration with Georges Bizet, Emile Jonas, and Legouix, and given at the Théâtre de l'Athénée in 1867. Two years later came *L'Ecossais de Chatou*, a one-act piece, and *La Cour du Roi Pétaud*, a three-act opera-bouffe. The ballet *Coppélia* was produced at the Grand Opera on 25th May 1870 with enormous success. Delibes's first important dramatic work was *Le Roi l'a dit*, a charming "opéra comique," heard for the first time on 24th May 1873 at the Opéra Comique Theatre. Three years later, on 14th June 1876, *Sylvia*, a ballet in three acts, one of the composer's most delightful works, was produced at the Grand Opera. This was followed by *Jean de Nivelle*, a three-act opera brought out at the Opéra Comique on 8th March 1880, and *Lakmé*, in three acts produced at the same theatre on 14th April 1883, which has remained his most popular opera. The composer died in Paris on the 17th January 1891, leaving *Kassya*, a four-act opera, in an unfinished state. This work was completed and scored by Massenet, and produced at the Opéra Comique Theatre on 24th March 1893. Léo Delibes was a typically French composer. His music is light, graceful, and refined. He excelled in ballet music, and *Sylvia* may well be considered a masterpiece of the *genre*. His operas are constructed on a conventional pattern. The harmonic texture, however, is modern, and the melodic invention abundant, while the orchestral treatment is invariably excellent.

(A. HE.)

**Delisle, Léopold Victor** (1826– ——), French historian and head of the Bibliothèque Nationale et Paris, was born at Valognes (Manche) on 24th October 1826. In 1847 he became a student at the École des Chartes, where his career was remarkably brilliant. In 1832 he was appointed an assistant in the Manuscript Department of the Bibliothèque Nationale, and after being for some time conservator of that department, succeeded M. Taschereau as head of the entire establishment in 1874. He produced many valuable official reports, and a still greater amount of memoirs and monographs on points connected with palæography, and the study of history and archæology. Among his services was the acquisition for France of a portion of the Ashburnham manuscripts, including many that, before M. Delisle's time, had been purloined from the Bibliothèque Nationale. In 1897 he commenced the publication of what is intended to be a nearly complete printed catalogue of the books in the Bibliothèque—a great enterprise destined to occupy many years in its completion.

**Delius, Nicolaus** (1813–1888), German philologist and Shakespearean scholar, was born at Bremen on 19th October 1813. He was educated at Bonn and Berlin, and took his Doctor's degree in 1838. After travelling for some time in England, France, and Germany, he returned to Bonn in 1846. In 1855 he was appointed Professor of Sanscrit, Provençal, and English Literature at Bonn University, a post he held until his death, which took place at Bonn, 18th November 1888. His greatest literary achievement was his scholarly edition of Shakespeare (1854–61). He also edited Wace's *St Nicholas* (1850) and a volume of Provençal songs (1853), and published a *Shakspere-Lexikon* (1852). His original works include: *Ueber das englische Theaterwesen zu Shakspere's Zeit* (1853), *Gedichte* (1853), *Der Sardinische Dialekt des*

*dreizehnten Jahrhunderts* (1868), and *Abhandlungen zu Shakspere* (2 series, 1878 and 1888). As a critic of Shakespeare's text he stands in the first rank. (R. F. S.)

**Delmenhorst,** a town of Germany, grand duchy of Oldenburg, 8 miles by rail west from Bremen, on the river Delme, was protected by a strong castle from 1247 to 1679, when it was destroyed by the French. Carries on cork-cutting, jute spinning and weaving, brewing, iron-founding, and making of boxes. Population (1885), 3842; (1900), 16,569.

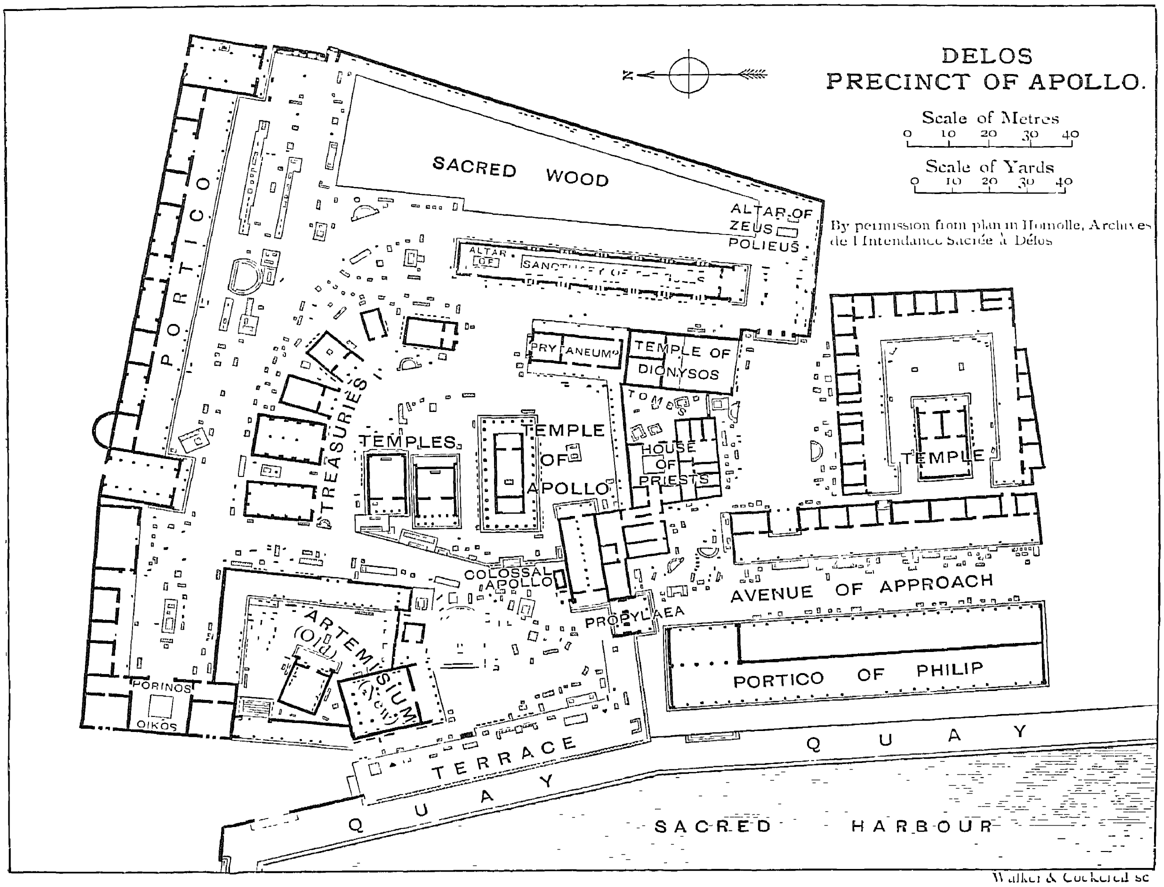
**De Long, George W.** (1844–1881), American explorer, was born in New York City on 22nd August 1844. He graduated at the U.S. Naval Academy in 1865, and spent the next fourteen years in the service in various parts of the world. In 1873 he sailed on the *Juniata* expedition in search of the Arctic exploring steamer *Polaris*, and was detailed to the command of the launch which was sent out by the *Juniata* from Upernivik, Greenland. On his return to New York the same year he proposed to Mr James Gordon Bennett, of the *New York Herald*, that the latter should fit out a Polar expedition, but it was not until 1879 that final arrangements were made. The *Pandora*, a private yacht which had been previously used in a number of Arctic expeditions, was purchased and rechristened the *Jeanette*, and strengthened and fitted out for the voyage. By Act of Congress the expedition was placed under the authority of the Secretary of the U.S. Navy, although all the expenses were borne by Mr Bennett. On 8th July 1879 the *Jeanette*, with 33 men on board, set sail from San Francisco for Siberian waters. On 5th September 1879 the vessel was enclosed in the ice-pack, and after a long drift was finally crushed by the ice on the 12th of June 1881 in 77° 15′ N. lat. and 155° E. long. The members of the expedition journeyed by sledge and boat 150 miles to the New Siberian Islands, and thence set out by boat in three parties for the mainland. The crew of one boat was lost in a gale; that of another, under the command of Chief-Engineer George W. Melville, reached a village on the Lena. The third party, under the command of De Long, succeeded in landing at the mouth of the Lena, and pushed forward up the river by land. All of De Long's party perished except two who had been sent forward to seek relief. The dead bodies and the records of the expedition were found in the following March by Melville, only 25 miles distant from a Siberian settlement. De Long was the last survivor. His journal, in which he made regular entries up to the day on which he died, has been edited by his wife and published under the title *Voyage of the "Jeanette."* An account of the search for De Long and his comrades was also published by G. W. Melville in his book entitled *In the Lena Delta.*

**Delos.**—Excavations have been made by the French School at Athens upon the island of Delos since 1877, chiefly by M. Th. Homolle. They have proceeded slowly but systematically, and the method adopted, though scientific and economical, has left the site in some apparent confusion, the débris being heaped up into piles or thrown into already excavated portions, instead of being removed bodily as at Olympia and at Delphi. The complete plan of the sacred precinct of Apollo has been recovered, as well as those of a considerable portion of the commercial quarter of Hellenistic and Roman times, of the theatre, of the temples of the foreign gods, of the temples on the top of Mount Cynthus, and of several very interesting private houses. Numerous works of sculpture of all periods have been found, and also a very extensive series of inscriptions, some of them throwing much light upon the subject of temple administration in Greece.

The most convenient place for landing is protected by an ancient mole; it faces the channel between Delos and Rheneia, and is about opposite the most northerly of the two little islands now called Ῥευματιάρι. From this side the sacred precinct of Apollo is approached by an avenue flanked by porticoes, that upon the seaside bearing the name of Philip V. of Macedon, who dedicated it about 200 B.C. This avenue must have formed the usual approach for sacred embassies and processions; but it is probable that the space to the south was not convenient for marshalling them, since Nicias, on the occasion of his famous embassy, built a bridge from the island of Hecate (the Greater Rhevmatiari) to Delos, in order that the imposing Athenian procession might not miss its full effect. Facing the avenue were the propylæa that formed the chief entrance of the precinct of Apollo. They consisted of a gate faced on the outside with a projecting portico of four columns, on the inside with two columns *in antis.* Through this one entered a large open space, filled with votive offerings and containing a large exedra. The sacred road continued its course from the north-east corner of this open space, with the precinct of Artemis on its west side, and, on its east side, a terrace on which stood three temples. The southernmost of these was the temple of Apollo, but only its back was visible from this side. Though there is no evidence to show to whom the other two were dedicated, the fact that they faced west seems to imply that they were either dedicated to heroes or minor deities, or that they were treasuries. Beyond them a road branches to the right, sweeping round in a broad curve to the space in front of the temple of Apollo. The outer side of this curve is bounded by a row of treasuries, similar to those found at Delos and Olympia, and serving to house the more costly offerings of various islands or cities. The space to the east and south of the temple of Apollo could also be approached directly from the propylæa of entrance, by turning to the right through a passage-like building with a porch at either end. Just to the north of this may be seen the basis of the colossal statue of Apollo dedicated by the Naxians, with its well-known archaic inscription; two large fragments of the statue itself may still be seen a little farther to the north.

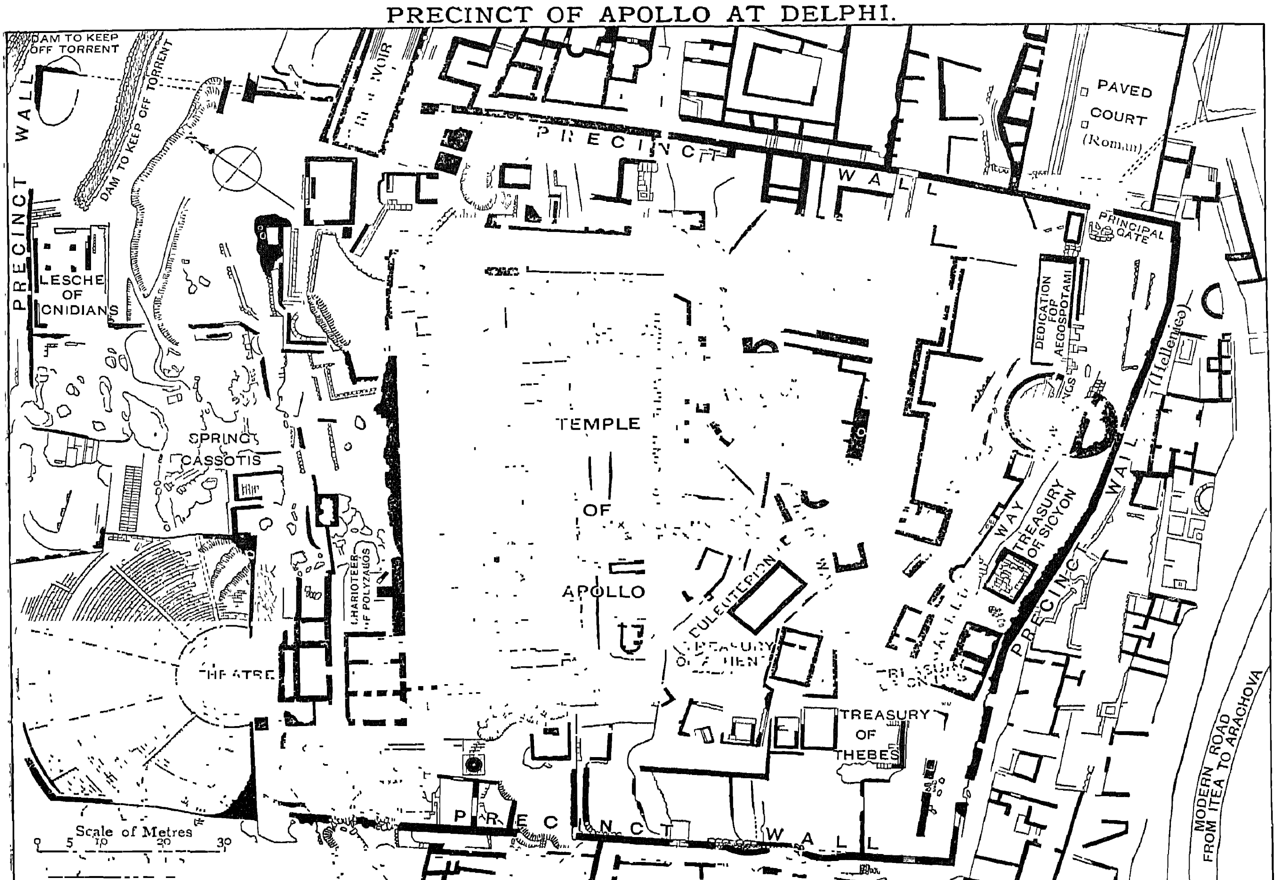
The temple of Apollo forms the centre of the whole precinct, which it dominates by the height of its steps as well as of the terrace already mentioned; its position must have been more commanding in ancient times than it is now that heaps of earth and débris cover so much of the level. The temple was of Doric style, with six columns at the front and back and thirteen at the sides; it was built early in the 4th century B.C.; little if any traces have been found of the earlier building which it superseded. Its sculptural decoration appears to have been but scanty; the metopes were plain. The groups which ornamented, as acroteria, the two gables of the temple have been in part recovered, and may now be seen in the National Museum at Athens; at the one end was Boreas carrying off Orithyia, at the other Eos and Cephalus, the centre in each case being occupied by the winged figure that stood out against the sky—a variation on the winged Victories that often occupy the same position on temples.

To the east of the space in front of the temple was an oblong building of two chambers, with a colonnade on each side but not in front; this may have been the Prytaneum or some other official building; beyond it is the most interesting and characteristic of all the monuments of Delphi. This is a long narrow hall, running from north to south, and entered by a portico at its south end. At the north end was the famous altar, built out of the horns of the victims, which was reckoned among the seven wonders of the world. The rest of the room is




Walker & Cockerell sc

PRECINCT OF APOLLO AT DELPHI.

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taken up by a paved space, surrounded by a narrow gangway; and on this it is supposed that the famous γέρανος or stork-dance took place. The most remarkable architectural feature of the building is the partition that separated the altar from this long gallery; it consists of two columns between *antæ*, with capitals of a very peculiar form, consisting of the fore parts of bulls set back to back; from these the whole building is sometimes called the sanctuary of the bulls. Beyond it, on the east, was a sacred wood filling the space up to the wall of the precinct; and at the south end of this was a small open space with the altar of Zeus Polieus.

At the north of the precinct was a broad road, flanked with votive offerings and exedræ, and along the boundary were porticoes and chambers intended for the reception of the θεωρίαι or sacred embassies; there are two entrances on this side, each of them through extensive propylæa.

At the north-west corner of the precinct is a building of limestone, the πώρινος οἶκος often mentioned in the inventories of the treasures of the Delian shrine. South of it is the precinct of Artemis, containing within it the old temple of the goddess; her more recent temple was to the south of her precinct, opening not into it but into the open space entered through the southern propylæa of the precinct of Apollo. The older temple is mentioned in some of the inventories as "the temple in which were the seven statues"; and close beside it was found a series of archaic draped female statues, which was the most important of its kind until the discovery of the finer and better preserved set from the Athenian Acropolis.

Within the precinct there were found many statues and other works of art, and a very large number of inscriptions, some of them giving inventories of the votive offerings and accounts of the administration of the temple and its property. The latter are of considerable interest, and give full information as to the sources of the revenue and its financial administration.

Outside the precinct of Apollo, on the south, was an open place; between this and the precinct was a house for the priests, and within it, in a kind of court, a set of small structures that may perhaps be identified as the tombs of the Hyperborean maidens. Just to the east was the temple of Dionysus, which is of peculiar plan, and faces the open place; on the other side of it is a large rectangular court, surrounded by colonnades and chambers which served as offices, the whole forming a sort of commercial exchange; in the middle of it was a temple dedicated to Aphrodite and Hermes.

To the north of the precinct of Apollo, between it and the sacred lake, there are very extensive ruins of the commercial town of Delos; these have been only partially cleared, but have yielded a good many inscriptions and other antiquities. The most extensive building is a very large court surrounded by chambers, a sort of club or exchange. Beyond this, on the way to the east coast, are the remains of the new and the old palæstra, also partially excavated.

The shore of the channel facing Rhenea is lined with docks and warehouses, and behind them, as well as elsewhere in the island, there have been found several private houses of the 2nd or 3rd century B.C. Each of these consists of a single court surrounded by columns and often paved with mosaic; various chambers open out of the court, including usually one of large proportions, the ἀνδρών or dining-room for guests.

The theatre, which is set in the lower slope of Mount Cynthus, has the wings of the auditorium supported by massive substructures. The most interesting feature is the *scena*, which is unique in plan; it consisted of an oblong building of two storeys, surrounded on all sides by a low portico or terrace reaching to the level of the first floor. This was supported by pillars, set closer together along the front than at the sides and back. An inscription found in the theatre showed that this portico, or at least the front portion of it, was called the proscenium or logeum, two terms of which the identity was previously disputed.

On the summit of Mount Cynthus, above the primitive cave-temple which has always been visible, there have been found the remains of a small precinct dedicated to Zeus Cynthius and Athena Cynthia. Some way down the slope of the hill, between the cave-temple and the ravine of the Inopus, is a terrace with the temples of the foreign gods, Isis and Serapis, and a small odeum.

Numerous articles in the *Bulletin de Correspondence Hellénique* record the various discoveries at Delos as they were made. See also Th. Homolle, *Les archives de l'intendance sacrée a Délos* (with plan). The best consecutive account is given in the *Guide Joanne*, *Grèce*, vol. ii. p. 443–464. For works of art found at Delos see ARCHÆOLOGY.

See also GREECE, IONIAN ISLANDS. (E. GR.)

**Delphi.**—The site of Delphi was bought by the French Government in 1891, and the peasant proprietors expropriated and transferred to the new village of Castri, a little farther to the west. Work began in the spring of 1892, and the site was rapidly cleared of earth by means of a light railway. The plan of the precinct is now easily traced, and with the help of Pausanias many of the buildings have been identified.

The ancient wall running east and west, commonly known as the Hellenico, has been found extant in its whole length, and the two boundary walls running up the hill at each end of it, traced. In the eastern of these was the main entrance by which Pausanias went in along the Sacred Way. This paved road is easily recognized as it zigzags up the hill, with treasuries and the bases of various offerings facing it on both sides. It mounts first westwards to an open space, then turns eastwards till it reaches the eastern end of the terrace wall that supports the temple, and then turns again and curves up north and then west towards the temple. Above this, approached by a stair, are the Lesche and the theatre, occupying respectively the north-east and north-west corner of the precinct. On a higher level still, a little to the west, is the stadium. There are several narrow paths and stairs that cut off the zigzags of the Sacred Way.

In describing the monuments discovered by the French excavators, the simplest plan is to follow the route of Pausanias. Outside the entrance is a large paved court of Roman date, flanked by a colonnade. On the north side of the Sacred Way, close to the main entrance, stood the offering dedicated by the Lacedæmonians after the battle of Ægospotami. It was a large quadrangular building of conglomerate, with a back wall faced with stucco, and stood open to the road. On a stepped pedestal facing the open stood the statues of the gods and the admirals, perhaps in rows above one another.

The statues of the Epigoni stood on a semicircular basis on the south side of the way. Opposite them stood another semicircular basis which carried the statues of the Argive kings, whose names are cut on the pedestal in archaistic characters, reading from right to left. Farther west was the Sicyonian treasury on the south of the way. It was in the form of a distyle Doric temple *in antis*, and had its entrance on the east. The present foundations are built of architectural fragments, probably from an earlier building of circular form on the same site. The sculptures from this treasury are in the museum, as are the other sculptures found on the site. These sculptures, which are in rough limestone, most likely belong to the earlier building, as their surface is in a better state of

preservation than could be possible if they had been long exposed to the air. The earlier treasury was probably destroyed either by earthquake or by the percolation of water through the terracing.

The Cnidian treasury stands on the south side of the way farther west. This building was originally surmised by the excavators to be the Siphnian treasury, but further evidence led them to change their opinion. The treasury was raised on a quadrangular structure, supported on its south side by the Hellenico, and built of tufa. The lower courses are left rough and were most likely hidden. A small distyle Ionic temple of marble stood on this substructure. The sculpture from this treasury, which ornamented its frieze and pediment, is of great interest in the history of the development of the art, and the fragments of architectural mouldings are of great delicacy and beauty. The whole work is perhaps the most perfect example we possess of the transitional style of the early 5th century. Standing back somewhat from the path just as it bends round up the hill is the Theban treasury. Farther north, where the path turns again, is the Athenian treasury. This structure, which was in the form of a small Doric temple *in antis*, appears to have suffered from the building above it having been shaken down by an earthquake. There can be no doubt about the identity of the building, for the basis on which it stands bears the remains of the dedicatory inscription, stating that it was erected from the spoils of Marathon. Almost all the sculptured metopes are in the museum, and are of the highest interest to the student of archaic art. The famous inscriptions with hymns to Apollo accompanied by musical notation were found on stones belonging to this treasury.

Above the Athenian treasury is an open space, in which is a rock which has been identified as the Sibyl's rock. It has steps hewn in it, and has a cleft. The ground round it has been left rough like the space on the Acropolis at Athens identified as the ancient altar of Athena. Here too was placed the curious column, with many flutes and an Ionic capital, on which stood the colossal sphinx, dedicated by the Naxians, that has been pieced together and placed in the museum.

A little farther on, but below the Sacred Way, is another open space, of circular form, which is perhaps the ἅλως or sacred threshing-floor on which the drama of the slaying of the Python by Apollo was periodically performed. Opposite this space, and backed against the beautifully jointed polygonal wall which has for some time been known, and which supports the terrace on which the temple stands, is the colonnade of the Athenians. A dedicatory inscription runs along the face of the top step, and has been the subject of much dispute. Both the forms of the letters and the style of the architecture show that the colonnade cannot date, as Pausanias says, from the time of the Peloponnesian War; M. Homolle now assigns it to the end of the 6th century. The polygonal terrace wall at the back, on being cleared, proves to be covered with inscriptions, most of them concerning the manumission of slaves.

After rounding the east end of the terrace wall, the Sacred Way turns northward, leaving the Great Altar, dedicated by the Chians, on the left. After passing the altar, it turns to the left again at right angles, and so enters the space in front of the temple. Remains of offerings found in this region include those dedicated by the Cyrenians and by the Corinthians. The site of the temple itself carries the remains of successive structures. Of that built by the Alcmæonids in the 6th century B.C. considerable remains have been found, some in the foundations of the later temple and some lying where they were thrown by the earthquake. The sculptures found have been assigned to this building, probably to the gables, as they are archaic in character, and show a remarkable resemblance to the sculptures from the pediment of the early temple of Athena at Athens. The existing foundations are these of the temple built in the 4th century. They give no certain information as to the sacred cleft and other matters relating to the oracle. Though there are great hollow spaces in the structure of the foundations, these appear merely to have been intended to save material, and not to have been put to any religious or other use. Up in the north-eastern corner of the precinct, standing at the foot of the cliffs, are the remains of the interesting Cnidian Lesche or Clubhouse. It was a long narrow building accessible only from the south, and the famous paintings were probably disposed around the walls so as to meet in the middle of the north side. Some scanty fragments of the lower part of the frescoed walls have survived; but they are not enough to give any information as to the work of Polygnotus.

At the north-western corner of the precinct is the theatre, one of the best preserved in Greece. The foundations of the stage are extant, as well as the orchestra, and the walls and seats of the auditorium. There are thirty-three tiers of seats in seven sets, and a paved diazoma. The sculptures from the stage front, now in the museum, have the labours of Heracles as their subject. The date of the theatre is probably early 2nd century B.C.

The stadium lies, as Pausanias says, in the highest part of the city to the north-west. It stands on a narrow plateau of ground supported on the south-east by a terrace wall. The seats have been cleared, and are in a state of extraordinary preservation. A few of those at the east end are hewn in the rock. No trace of the marble seats mentioned by Pausanias has been found, but they have probably been carried off for lime or building, as they could easily be removed. An immense number of inscriptions have been found in the excavations, and many works of art, including a bronze charioteer, which is one of the most admirable statues preserved from ancient times.

Provisional accounts of the excavations have appeared during the excavations in the *Bulletin de Correspondence Hellénique*. A summary is given in Frazer, *Pausanias*, vol. v. For the works of art discovered see ARCHÆOLOGY. (E. GR.)

**Delyannis, Theodore** (1826-——), Greek statesman, was born at Kalavrytra, Peloponnesus, in 1826. He studied law at Athens, and in 1843 entered the Ministry of the Interior. In 1862 he began to take an important part in politics after the deposition of King Otho. In 1867 he was Minister at Paris. On his return to Athens he became a member of successive cabinets in various capacities, and rapidly collected a party round him consisting of those who opposed his great rival, Tricoupis. In the so-called "Œcumenical Ministry" of 1877 he voted for war with Turkey, and on its fall he entered the cabinet of Koumoundoros as Minister for Foreign Affairs. He was a representative of Greece at the Berlin Congress in 1878. From this time forward, and particularly after 1882, when Tricoupis again came into power at the head of a strong party, the duel between these two statesmen was the leading feature of Greek politics (see GREECE, *History*). Delyannis first formed a cabinet in 1885, and his warlike policy resulted in the intervention of the Powers, who eventually blockaded the Piræus and other ports, and this brought about his downfall. He returned to power in 1890, with a radical programme, but his failure to deal with the financial crisis produced a conflict between him and the king, and his disrespectful attitude resulted in his summary dismissal in 1892. Delyannis, by his demagogic behaviour, evidently expected the public to side with him; but at the elections he was badly beaten. In 1895, how-

ever, he again became Prime Minister, and was at the head of affairs during the Cretan crisis and the opening of the war with Turkey in 1897. The humiliating defeat which ensued—though Delyannis himself had been led into the disastrous war policy to some extent against his will—caused his fall in April 1897, the king again dismissing him from office when he declined to resign. Delyannis kept his own seat at the election of 1899, but his following dwindled to small dimensions.

**Demotica,** a town of Turkey in Europe, in the sanjak and province of Adrianople, situated on the right bank of the Kizil-deli, near its junction with the Maritza, and on the Maritza Valley or Dédéahgatch-Kuleli-Bourgas Railway, about 35 miles south of Adrianople. It is of some industrial importance, the chief exports being pottery, for which it has some repute, linen, silk, cocoons, and grain. The population is about 12,000.

**Denbigh,** a maritime county of North Wales, is bounded N. by the Irish Sea, N.E. by Flint and Cheshire, S.E. by Flint and Shropshire, S. by Montgomery and Merioneth, and W. by Carnarvon.

*Area and Population.*—The area of the ancient county is 423,477 acres or 662 square miles. The population in 1881 was 111,957, and 117,872 in 1891, of whom 59,569 were males and 58,303 females; the number of persons per square mile being 178, and of acres to a person 3·59. In 1901 the population was 129,935. The area of the administrative county, as given in the census returns of 1891, was 424,435 acres, with a population of 118,843, but since then certain alterations have been made in the administrative area. In 1897 the part of the parish of Nanerch in Denbigh was transferred to Flint, and the part of the parish of Llanarmon yn Vale in Flint, and part of the parish of Erbistock were transferred from Flint to Denbigh. The area of the registration county is 386,416 acres, with a population in 1891 of 116,698. Within this area the increase of population between 1881 and 1891 was 3·29 per cent. The excess of births over deaths between 1871 and 1881 was 11,172, and the actual increase of population was 5716. The following table gives the numbers of marriages, births, and deaths, with the number and percentage of illegitimate births, for 1880, 1890, and 1898:—

| Year. | Marriages. | Births. | Deaths. | Illegitimate Births. | |
|---|---|---|---|---|---|
| | | | | No. | Per cent. |
| 1880 | 738 | 3535 | 2394 | 239 | 6·7 |
| 1890 | 871 | 3262 | 2313 | 173 | 5·3 |
| 1898 | 881 | 3572 | 2369 | 184 | 4·9 |

In 1891 there were in the county 554 natives of Scotland, 819 natives of Ireland, and 171 foreigners; while 38,310 persons could speak English, 37,195 Welsh, and 35,030 English and Welsh.

*Constitution and Government.*—The ancient county is divided into two parliamentary divisions, and it also includes the Denbigh district of parliamentary boroughs, consisting of Denbigh, Holt, Ruthin, and Wrexham. There are three municipal boroughs, Denbigh, Ruthin, and Wrexham. The following are urban districts—Abergele and Pensarn, Colwyn Bay and Colwyn, Llangollen, and Llanrwst. Denbighshire is in the North Wales Circuit, and assizes are held at Ruthin. The boroughs of Denbigh and Wrexham have separate commissions of the peace, but no separate court of quarter sessions. The ancient county, which is in the diocese of St Asaph's, contains 75 entire ecclesiastical parishes and districts, and part of one other.

*Education.*—The number of elementary schools on 31st August 1899 was 122, of which 48 were board and 74 voluntary schools, the latter including 70 National Church of England schools, 2 Roman Catholic, and 3 "British and other." The average attendance at board schools was 9288 and at voluntary schools 8258. The total school board receipts for the year ended 29th September 1899 were over £38,495. The income under the Technical Instruction Act was £69; that under the Agricultural Rates Act was over £1384.

*Agriculture.*—More than three-fifths of the total area of the county is under cultivation, and of this nearly three-fifths is in permanent pasture. There are also over 80,000 acres of mountain pasture grazed by sheep, and over 18,000 acres under woods. Only about 220 acres are under orchards. The acreage under corn crops has considerably decreased, the decrease being chiefly in the acreage under wheat, which now occupies about one-seventh of the corn crop acreage, barley occupying about two-sevenths, and oats nearly four-sevenths. Nearly three-fourths of the green crop area are occupied by turnips, and nearly one-fourth by potatoes.

*Industries and Trade.*—According to the annual report for 1898 of the chief inspector of factories (1900), the number of persons employed in factories and worshops in 1897 was 4690, as compared with 5359 in 1896. Non-textile factories employed 3379 persons, workshops 1150, the majority being engaged in the clothing industries. The total number of persons employed in connexion with mines and quarries in 1899 was 11,138. Coal-mining is the most important industry, Of the less valuable minerals there were raised (in 1899) 264,982 tons of clay, 204,599 tons of limestone, 23,042 tons of sandstone, and 28,840 tons of igneous rocks. Iron ore has almost ceased to be raised. The following table gives the productions of coal, lead, and zinc in 1890 and 1899:—

| Year. | Coal. | | Lead. | | Zinc. | |
|---|---|---|---|---|---|---|
| | Tons. | Value. | Tons. | Value. | Tons. | Value. |
| 1890 | 2,221,497 | £916,367 | 1416 | £12,821 | 6593 | £41,104 |
| 1899 | 2,512,104 | 973,440 | 1983 | 20,150 | 3273 | 25,976 |

See WILLIAMS and UNDERWOOD. *The Village Churches of Denbighshire, illustrated by geometrical, perspective, and detail drawings.* Denbigh, 1872. (T. F. H.)

**Denbigh,** a municipal and contributory parliamentary borough (uniting with Holt, Ruthin, and Wrexham), market-town, and county town of Denbighshire, Wales, 25 miles west of Chester. There are three Established, Roman Catholic, Baptist, Presbyterian, Methodist, and Congregationalist churches; also a new county school under the Welsh Intermediate Education Act, a Blue Coat school (both of old foundation), a school for 50 orphan girls maintained from funds left to the Drapers' Company, and, in the neighbourhood, the North Wales Asylum. The chief industries are tanning, boot-making, and slate-quarrying. Area of borough, 8868 acres. Population (1901), 6439.

**Denia,** a Mediterranean seaport of Spain, in the province, and 45 miles north-east of the town, of Alicante. Population (1897), 11,401. There are manufactures of woollen and linen cloths and esparto grass rugs. The export trade in fruit is considerable, the figures for raisins in 1898 being: to Great Britain, 13,000 tons; elsewhere, 12,000 tons; 150,000 barrels of grapes were also exported, exclusively to English ports. Of onions, 81,400 crates were despatched, practically all to North America. A breakwater, 1485 yards long, is in course of construction. 426 vessels of 165,246 tons entered in 1898, and 427 of 165,511 tons cleared. About half of these were small vessels engaged in the coasting trade, carrying agricultural produce. The chief imports were timber from the Baltic and coal from England.

**Denison, George Anthony** (1805–1896), English Churchman, brother of Mr Speaker Denison (Lord Ossington: 1800–1873), was born at Ossington, Notts, 11th December 1805, and educated at Eton and Christ Church, Oxford. In 1828 he was elected fellow of Oriel; and after a few years there as a tutor, during which he was ordained and acted as curate at Cuddesdon, he became rector of Broadwindsor, Dorset, and married (1838) the daughter of Mr Henley, M.P. In 1843 he was preferred by his brother, the Bishop of Salisbury, to the valuable living of East Brent, Somerset, and in 1851 was made Archdeacon of Taunton. For many years Archdeacon Denison represented the extreme High Tory party not only in politics but in the Church, regarding all "progressive" movements in education or theology as abomination, and vehemently repudiating the "higher criticism" from the days of *Essays and Reviews* (1860) to those of *Lux Mundi* (1890). In 1853 his views on the doctrine of the Real Presence subjected him to a suit for heresy on the complaint of a neighbouring parson, and after various complications he was condemned by the Archbishops' Court at Bath; but

on appeal the Court of Arches and the Privy Council quashed this judgment on a technical plea. The result was to make Archdeacon Denison a keen champion of the Ritualistic school. Until the end of his life he remained a protagonist in theological controversy and a keen fighter against latitudinarianism and liberalism; but the sharpest religious or political differences never broke his personal friendships and his Christian charity. Among other things for which he will be remembered was his origination of Harvest Homes. He died 21st March 1896.

**Denison,** a city of Grayson county, Texas, U.S.A., on the south bank of the Red river, at an altitude of 723 feet. It is regularly laid out on a level site, and has four wards. It has three railways, the Houston and Texas Central, the Missouri, Kansas, and Texas, and the Texas and Pacific, and is an important point in the collection and shipment of cotton. Population (1880), 3975; (1890), 10,958; (1900), 11,807, of whom 604 were foreign-born and 2251 negroes.

**Denizli,** chief town of a sanjak of the Aidin viláyet of Asia Minor, altitude 1167 ft. It is beautifully situated at the foot of Baba Dagh (Mt. Salbakus), on a tributary of the Churuk Szz (Lycus), and is connected by a branch line with the Smyrna-Dineir Railway. It took the place of Laodicea when that town was deserted during the wars between the Byzantines and Seljúk Turks, probably between 1158 and 1174. It had become a large and fine Moslem city in the 14th century, and was then called Ladík. The delightful gardens of Denizli have obtained for it the name of the Damascus of Anatolia. Population, 17,000 (Moslems, 14,500; Christians, 2500).

See RAMSAY. *Cities and Bishoprics of Phrygia*, vol. i. Oxford, 1895.—MURRAY. *Asia Minor Handbook.* 1895.

# DENMARK.

DENMARK, in the strictest geographical sense, comprises the northern portion of the Cimbric Peninsula called Jutland (Jylland) and the Danish Islands, which are situated mostly to the south-east of Jutland, between the southern part of the Cimbric Peninsula and the southern part of Sweden. Jutland lies between lat. 55° 16′ and lat. 57° 45′, whilst the islands are situated between lat. 54° 33′ and lat. 56° 8′. The westernmost point of Jutland is in long. 8° 4′ 54″, the easternmost point of the islands (apart from Bornholm) is in long. 12° 47′ 25″. The last-named island is situated in the Baltic, 76 miles east of the rest of Denmark, but in the same latitude as the southernmost of the other islands. According to the latest measurements, the total area of Denmark proper is 14,829 square miles, of which 9753 square miles fall to the share of Jutland, including the small islands belonging to it. The islands together cover 5076 square miles, and may be divided into four groups: the westernmost group, of which Fyen[1] is the largest, covers 1324 square miles; whilst Sealand [2] (Sjælland), with some adjacent smaller islands, occupies 2856 square miles; Lolland and Falster, which are to the south of Sealand, and separated from each other only by a very narrow channel, cover 671 square miles; Bornholm, finally, has an area of 225 square miles. Denmark is almost entirely surrounded by the sea, as it is connected with the Continent only at the southern frontier of Jutland, in which place the width of the peninsula is only about 37 miles. The west and north-west coasts of Jutland, from Blaavandshuk to the Scaw, are destitute of harbours, and girt by sandbanks very dangerous to shipping. In many places the sea has encroached very considerably; even in the 19th century entire villages were destroyed, but during the last twenty years of the century systematic efforts were made to secure the coast by groynes and embankments. A belt of sand dunes, from 500 yards to 7 miles wide, stretches along the whole of this coast for about 200 miles. The east coast of Jutland is of quite a different description, a series of long fjords entering deep into the country from the Cattegat. The longest of these is the Limfjord, which reaches the western coast of Jutland, and since 1825 has been in communication with the North Sea, so that the northern portion of Jutland is really an island; but the waters of the Limfjord, particularly in the western part, are so shallow that it offers no facility for navigation except to small craft. The Cattegat itself is full of sandbanks and difficult of navigation; in the winter it is often obstructed by drifting ice. From the Cattegat three passages lead to the Baltic, of which they form the outlet, namely, the Little Belt, the Great Belt, and the Sound (see BALTIC SEA). South of Copenhagen the passage is narrowed by the islands of Amager and Saltholm; and the channels on both sides of these islands have in their shallowest parts only 23 feet of water, besides being difficult to navigate. On the west coast of Jutland the ordinary tides of the North Sea are experienced, but in the Cattegat the difference between high and low water gradually diminishes towards the south. In the Belts and in the Sound the changes become almost imperceptible, and are obscured by the effects of winds and currents. In the Baltic there are no tides. No hill in Denmark exceeds 550 feet in height. Gudenaa in Jutland, the largest river in Denmark, has a course of 80 miles. Small lakes abound, but there are none of considerable size.

***Physical characteristics.***

The surface in Denmark is almost everywhere formed by the so-called Boulder Clay and what the Danish geologists call the Boulder Sand. The former, as is well known, owes its origin to the action of ice on the mountains of Norway in the Glacial period. It is unstratified; but by the action of water on it, stratified deposits have been formed, some of clay, containing remains of arctic animals, some. and very extensive ones, of sand and gravel. This boulder sand forms almost everywhere the highest hills, and besides, in the central part of Jutland, a wide expanse of heath and moorland apparently level, but really sloping gently towards the west. The deposits of the boulder formation rest generally on limestone of the Cretaceous period, which in many places comes near the surface and forms cliffs on the seacoast, of which the most interesting is the "Klint," on the island of Möen. But in the south-western parts a succession of strata, described as the Brown Coal or Lignite formations, intervenes between the chalk and the boulder clay; its name is derived from the deposits of lignite which occur in it. It is only on the island of Bornholm that older formations come to light. This island agrees in geological structure with the southern part of Sweden, and forms, in fact, the southernmost portion of the Scandinavian system. There the boulder clay lies immediately on the primitive rock, except in the south-western corner of the island, where a series of strata appear belonging to the Cambrian, Silurian, Jurassic, and Cretaceous formations, the true Coal formation, &c., being absent. Some parts of Denmark are supposed to have been finally raised out of the sea towards the close of the Cretaceous period; but as a whole the country did not appear above the water till about the close of the Glacial period. The upheaval of the country, a movement common to a large part of the Scandinavian peninsula, still continues, though slowly, north-east of a line drawn in a south-easterly direction from Nissumfjord on the west coast of Jutland, across the island of Fyen, a little south of the town of Nyborg. Ancient seabeaches, marked by accumulations of seaweed, rolled stones, &c., have been noticed

[1] "Fühnen" is German, not Danish.

[2] This spelling of the English name is nearer to the Danish and less liable to misunderstanding than that of Zealand, which is properly the name of a well-known island in Holland.

as much as 20 feet above the present level. But the upheaval does not seem to affect all parts equally. Even in historic times it has vastly changed the aspect and configuration of the country. It will easily be understood from the foregoing that the mineral products of Denmark are insignificant. Coal is found in Bornholm, several seams cropping out amongst the strata belonging to the Jurassic system. But the Bornholm coal is too hygroscopic to bear transport, and its heating power falls far short of that of English coal. The mines which have at different times been opened have proved failures, and their produce is only used for domestic purposes on the island itself. There is in Bornholm a deposit of kaolin of good quality, from which the Copenhagen porcelain factories take their supply. The Flora and Fauna of Denmark offer no peculiarities worthy of notice here. In ancient times extensive pine and fir forests existed, of which abundant remains are found in the peat bogs; but they have disappeared long ago, and at the present time firs and pines occur in Denmark only in plantations. The forests of Denmark consist of oak and beech, of which the latter is gradually getting the upper hand. The elm is comparatively rare in Denmark. The peat bogs are numerous, and supply a large proportion of the fuel used in the country. The sea fisheries are of importance, and a not inconsiderable quantity of fresh fish is exported to the interior of the Continent. Oysters are still found in some places, but have disappeared from many localities, where their abundance in ancient times is proved by the shell mounds on the coast. Such mounds occur in other countries too, but it was in Denmark that they were first recognized as being but the accumulated remains of the meals of the ancient population, which largely fed on oysters. Gudenaa is the only salmon river in Denmark. The climate of Denmark does not differ materially from that of Great Britain in the same latitude; but whilst the summer is a little warmer, the winter is colder, so that most of the evergreens which adorn an English garden in the winter cannot be grown in the open in Denmark. During 30 years the annual mean temperature varied from 43·88° to 46·22° in different years and different localities, the mean average for the whole country being 45·14°. The islands have, upon the whole, a somewhat warmer climate than Jutland. The mean temperature of the four coldest months, December to March, is 33·26°, 31·64°, 31·82°, and 33·98° respectively, or for the whole winter 32·7°; that of the summer, June to August, 59·2°, but considerable irregularities occur. Frost occurs on an average on 20 days in each of the four winter months, but only on a couple of days in either October or May. A fringe of ice generally lines the greater part of the Danish coasts on the eastern side for some time during the winter, and both the Sound and the Great Belt are at times impassable on account of ice. In some winters the latter is sufficiently firm and level to admit of sledges passing between Copenhagen and Malmö. The annual rainfall varies between 21·58″ and 27·87″ in different years and different localities. It is highest on the west coast of Jutland; the small island of Anholt in the Cattegat has an annual rainfall of only 15·78″. More than half the rainfall occurs from July to November, the wettest month being September, with an average of 2·95″; the driest month is April, with an average of 1·14″. Thunderstorms are frequent in the summer. South-westerly winds prevail from January to March, and from September to the end of the year. In April the east wind, which is particularly searching, is predominant, while westerly winds prevail from May to August.

**Population.** According to the census taken on 1st February 1901, the total population of Denmark was 2,449,540, as compared with 929,001 on the same date in 1801, showing an increase during the century in the proportion of 100 : 263. As compared with the total in 1890, namely, 2,172,380, the returns for 1901 are 12·76 per cent. higher, corresponding to an average annual increase of 1·09 per cent. during the ten years. The first four years of the decade were, however, far from favourable, owing to a great increase of mortality and at the same time of emigration, which latter cause reduced the increase which should have followed from the excess of births over deaths by nearly one-half. The actual annual increase during these years varied only from 0·54 per cent. to 0·68 per cent. In 1901 the average density of the population of Denmark was at the rate of 165·2 to the square mile, but varied much in the different parts. Jutland, which represents three-fifths of the total area of Denmark, and in 1901 had a population of 1,063,792, showed an average of only 109 inhabitants per square mile, whilst on the islands, which had a total population of 1,385,537, the average stood at 272·95, owing, on the one hand, to the fact that large tracts in the interior of Jutland are almost uninhabited, and on the other to the fact that the capital of the country, with its proportionately large population, is situated on the island of Sealand. The latter had a population of 960,053, or 336·2 inhabitants to the square mile including Copenhagen (with the suburbs of Fredriksberg and Sundby), but without the capital only 169·2. Not reckoning Sealand, the density of the population on the islands was at the rate of 191·7 to the square mile. In 1901, 936,565 persons were living in towns in Denmark, *i.e.*, 38·24 per cent. of the total population, whilst 1,512,975, or 61·77 per cent., were living in purely rural districts. In 1890 the town population amounted to 735,554, or 33·86 per cent. of the total, leaving but 1,436,826, or 66·14 per cent., for the rural districts. The movement of the population to the towns which is indicated by these figures commenced about the middle of the 19th century, and increased until very near its end. It has been stronger on the islands, where the rural population has increased by 5·3 per cent. only in eleven years, whereas in Jutland the increase of the rural population between 1890 and 1901 amounted to 12·0 per cent. (But for some of the causes of this increase see JUTLAND.) During the same years the population of Copenhagen increased by 24·94 per cent., namely, to 476,876 (491,340 with the environs); and the population of the provincial towns above 10,000 inhabitants by 43·6 per cent.; but in the smaller towns the augmentation only amounted to 20·5 per cent.

According to the census of 1890, the population of Denmark was divided as follows according to occupation, the figures including dependants:—

| Occupation. | Number. | Per cent. of Population. | Occupation. | Number. | Per cent. of Population. |
|---|---|---|---|---|---|
| Agriculture | 882,336 | 40·6 | Professions | 135,790 | 6·1 |
| Trades | 534,428 | 24·6 | Capitalists | 34,974 | 1·6 |
| Commerce | 172,929 | 7·9 | Pensioners | 17,723 | 0·8 |
| General labour | 162,928 | 7·5 | Annuitants | 40,276 | 1·8 |
| Fisheries | 32,912 | 1·5 | No certain livelihood | 44,667 | 2·0 |
| Navigation | 26,082 | 1·29 | Paupers | 39,014 | 1 79 |
| Transport, posts, telegraphs, &c. | 42,730 | 1·9 | Prisoners | 1,822 | .. |
| | | | Insane | 3,753 | .. |

In 1901, 1,193,448, or 48·72 per cent., of the population of Denmark were males; 1,256,092, or 51·28 per cent., were females. The number of marriages has increased, with little oscillation, from 14,975 in 1891 to 18,499 in 1900, that is, in a considerably greater ratio than the population. The number of divorces in 1900 was 391. The birth-rate appears to have oscillated during the period in question between 29·3 and 38·8 per thousand, the highest number of children born alive being 72,141 in 1900. On an average, 51·3 per cent. of the children born annually are boys, and the male sex remains in excess until about the 20th year, from which age the female sex preponderates in increasing ratio with advancing age. Of all children born annually an average of 9·6 per cent. are illegitimate. In some rural districts the ratio is as low as 3·5 per cent., but in Copenhagen it reaches 20·2 per cent. 12 per cent. of the illegitimate children born alive had mothers who were under 20 years of age. The still-born numbered, in 1899, 2·47 per cent. of all births, but amongst them 12·8 per cent. were illegitimate. Between the middle and the end of the 19th century the rate of mortality decreased most markedly for all ages. The annual death-rate per thousand may be taken to have varied during 1890–1900 between 19·5 in 1891 and 15·1 in 1898 (17·4 in 1900). The annual number of suicides, which used to average 555, declined towards the close of the 19th century, and was 523 for the period 1896–1900.

Emigration, which for some time seriously affected the population of Denmark, diminished in the 'nineties. In 1892 the number of emigrants to Transatlantic places rose to 10,422, but in 1900 it was only 3570. The great bulk of them go to the United States; next in favour is Canada. In 1890 there were 70,900 persons, foreigners, living in Denmark, of whom 33,802 were born in Sweden, 20,824 were Schleswigers, 10,823 were natives of other parts of Germany, and 3385 were Norwegians. From 1891 to 1900 2525 foreigners were naturalized.

The Danish Parliament, called the "Rigsdag," consists of two chambers, the Folkething and the Landsthing, but the constitution contains no indication of any difference in their attributes. The Landsthing, however, is evidently intended to form the conservative element in the constitutional machinery. Whilst the 114 members of the Folkething are elected in the usual way by universal suffrage, 12 out of the 66 members of the Landsthing are life members nominated by the Crown. The remaining 54 members of the Landsthing are returned according to a method of proportionate representation by a body of deputy electors. Of these latter one-half are elected in the same way as members of the Folkething, without any property qualification for the voters; the other half of the deputy electors are chosen in the towns by those who during the last preceding year were assessed on a certain minimum of income, or paid at least a certain amount in rates and taxes. In the rural districts the deputy electors returned by election are supplemented by an equal number of those who have paid the highest amounts in taxes and county rates together. In this manner a representation is secured for fairly large minorities, and what is considered a fair share of influence on public affairs given to those who contribute the most to the needs of the State. The Faroes, which form an integral part of the kingdom of Denmark in the wider sense, are represented in the Danish Parliament, but not the other dependencies of the Danish Crown. For administrative purposes the country is divided into 18 so-called "Amts," or counties. The principal civil officer in each of them is the "Amtmand." Local affairs are managed by "Amtsraad" and "Sogneraad," corresponding to the English county council and parish council. These institutions date from 1841, but they have undergone several modifications since. The members of these councils are elected on a system similar to that applied to the elections for the Landsthing. The same is the case with the provincial town councils. That of Copenhagen is elected by those who are rated on an income of at least 400 crowns (£22). The burgomasters are appointed by the Crown, except in Copenhagen, where they are elected by the town council, subject to royal approbation.

*Government.*

For the administration of justice Denmark is divided into "Herreds" or Hundreds; as, however, they are mostly of small extent, several are generally served by one judge, "Herredsfoged"; the townships are likewise separate jurisdictions, each with a "Byfoged." There are 126 such local judges, each of whom deals with all kinds of cases arising in his district, and is also at the head of the police. There are two intermediary Courts of Appeal, one in Copenhagen, another in Viborg; the Supreme Court of Appeal sits at Copenhagen. In the capital the different functions are more divided. There is also a Court of Commerce and Navigation, on which leading members of the trading community serve as assessors. In the country, Land Commissions similarly constituted deal with many questions affecting agricultural holdings. A peculiarity of the Danish system is that, with few exceptions, no civil cause can be brought before a court until an attempt has been made at effecting an amicable settlement. This is mostly done by so-called Committees of Conciliation, but in some cases by the court itself before commencing formal judicial proceedings. In this manner three-fifths of all the causes are settled, and many which remain unsettled are abandoned by the plaintiffs. In 1897 the courts disposed of about 30,000 civil cases; 3689 persons (2838 males and 851 females) were convicted of various crimes; 3573 were punished for police offences; whilst 33,005 police cases were disposed of without formal judgment, on the defendant agreeing to pay a fine. Sanitary matters are under the control of a Board of Health. The whole country is divided into districts, in each of which a medical man is appointed with a salary, who is under the obligation to attend to poor sick and assist the authorities in medical matters, inquests, &c. The relief of the poor is well organized, mostly on the system of out-door relief. Many workhouses have been established for indigent persons capable of work. There are many almshouses and similar institutions.

*Justice.*

The National or State Church of Denmark is officially styled "Evangelically Reformed," but is popularly described as Lutheran. In 1890 its members numbered 2,136,329, or 98·44 per cent. of the total population. 10,624 belonged to free extra-parochial congregations of Lutherans. The members of other Christian communities numbered 14,502, of which 1252 were Calvinists, 137 Anglicans, 2301 Methodists, 4556 Baptists, 2609 Irvingites, and 3647 Roman Catholics. There were 4080 Jews, mostly in Copenhagen. 941 were returned as Mormons, and 2560 as not professing any positive religion. There are seven dioceses, the Primate being the Bishop of Sealand, who resides at Copenhagen, but his cathedral is at Roeskilde. There are 72 rural deaneries, and 988 pastorates, of which the greater part comprise more than one parish; the number of parish churches is 1721. The benefices are almost without exception provided with good residences and glebes, and the tithes, &c., generally afford a comfortable income. The bishops have fixed salaries in lieu of tithes appropriated by the State.

*Religion.*

Every child is bound to attend the parish school at least from the 7th to the 13th year, unless the parents can prove that it receives suitable instruction in other ways. The schools are under the immediate control of school boards appointed by the parish councils, but of which the incumbent of the parish is *ex-officio* member; superior control is exercised by the Amtmand, the rural dean, and the bishop, under the Minister for Church and Education. The instruction in primary schools is gratuitous. Secondary public schools are provided in towns, in which moderate school fees are paid. There are 13 public grammar schools. Nearly all schools are day-schools. There are only two public schools which, though on a much smaller scale, resemble the great English schools, namely, those of Soro and Herlufsholm, both founded by private munificence. Private schools are mostly more or less under public control. The number of children in Danish schools was, in 1898, 364,091, of whom 307,633 were in municipal schools, 6838 in grammar schools, and 49,620 in other schools, including infant schools, &c. The University, Copenhagen, which was founded in 1479, has 53 professors, besides a varying number of lecturers. Connected with it are an observatory, museums of national history, a botanical garden, various collections and laboratories, as well as a good library. The matriculations average 350 a year. Amongst the numerous other institutions for the furtherance of science and training of various kinds may be mentioned the large polytechnic schools; the High School for Agriculture and Veterinary Art, with 22 professors, besides lecturers; the Royal Library (500,000 vols., 20,000 MSS.); the Royal Society of Sciences; the Museum of Northern Antiquities; the Society of Northern Antiquaries, &c. &c. The art museums of Denmark are not considerable, except the Museum of Thorvaldsen, but much is done to provide first-rate training in the fine arts and their application to industry. The Royal Academy of Arts has 7 professors, besides assistant teachers, and its schools are frequented by about 200 students annually. Finally, it may be mentioned that comparatively much money is available from public funds and regular parliamentary grants for furthering science and arts by temporary subventions to students, authors, artists, and others of insufficient means, in order to enable them to carry out particular works, to profit by foreign travel, &c.

*Education.*

The following is a summary of the items of expenditure in the Danish Budget for 1900–01:—

*Finance.*

| | | | |
|---|---|---|---|
| Civil List | Kr. 1,000,000 | or | £55,555 |
| Appanages to the Royal Family | 203,200 | ,, | 11,289 |
| Parliament (payment of members, &c.) | 200,000 | ,, | 11,111 |
| Council of State (pay of Ministers, &c.) | 119,016 | ,, | 6,612 |
| Interest on Public Debt | 7,059,300 | ,, | 392,183 |
| Reduction of Debt | 1,802,731 | ,, | 100,152 |
| Pensions | 3,349,540 | ,, | 186,086 |
| Army | 11,022,419 | ,, | 612,357 |
| Navy | 7,787,310 | ,, | 432,629 |
| Civil Service | 26,957,512 | ,, | 1,497,639 |
| Iceland, annual grant | 76,564 | ,, | 4,254 |
| Public Works (new railways, &c.) | 10,370,907 | ,, | 576,161 |
| Loans and Advances | 2,229,950 | ,, | 123,886 |
| | Kr.72,178,449 | | £4,009,914 |

The items of estimated actual revenue for 1900–01 were as follow:—

| | | | |
|---|---|---|---|
| Customs | Kr.33,176,000 | or | £1,843,111 |
| Excise and Beer Tax | 9,170,000 | ,, | 509,444 |
| Land and House Tax | 10,577,500 | ,, | 587,639 |
| Stamps | 3,550,000 | ,, | 197,222 |
| Carry forward | Kr.56,473,500 | | £3,137,416 |

| | | | |
|---|---|---|---|
| Brought forward | Kr.56,473,500 | or | £3,137,416 |
| Death Duties . . | 1,400,000 | ,, | 77,778 |
| Tax on Transfers of Property . . . | 916,000 | ,, | 50,889 |
| Legal Fees (Patents, &c.) | 2,555,100 | ,, | 141,950 |
| State Railways . . | 2,958,916 | ,, | 164,384 |
| Post and Telegraphs . | 222,581 | ,, | 12,366 |
| State Lottery . . | 1,090,000 | ,, | 60,556 |
| Crown Lands, Forests, &c.) . . . | 893,424 | ,, | 49,635 |
| Interest on Reserve . | 643,000 | ,, | 35,722 |
| Interest on Debts to the State . . . | 841,127 | ,, | 46,729 |
| Sundry receipts . . | 1,221,517 | ,, | 67,862 |
| | Kr.69,215,165 | | £3,845,287 |

The amount of the internal debt on 1st April 1900, is estimated at Kr.77,708,810 or £4,317,156, bearing interest of 3½ per cent. (excepting some small amounts on which 3, 4, 4½, or 5 per cent. are paid), whilst that of the foreign debt is placed at Kr.138,512,250 or £7,695,125, bearing 3 per cent. interest, with the exception of a very small amount on which 4 per cent. is paid. The revenue and expenditure of the Faroes are included in the budget for Denmark proper, but Iceland and the West Indies have their separate budgets. The Danish Treasury receives nothing from these possessions; on the contrary, Iceland receives an annual grant, and the West Indian Islands have been heavily subsidized by the Danish finances to assist the sugar industry. The administration of Greenland entails an annual loss of Kr.156,273 or £8682, which is posted on the budget of the Ministry of Finance. The financial position of the municipalities in Denmark is generally good. The ordinary budget of Copenhagen amounts to about £1,100,000 a year.

***Industry.***

The main source of wealth in Denmark is agriculture. No information is available as to the average size of agricultural holdings in Denmark, but there are statistics from which their value may be estimated. Rates and taxes on land are mostly levied according to a uniform system of assessment, the unit of which is called a "Tönde Hartkorn." The Td. Htk., as it is usually abbreviated, has further subdivision, and is intended to correspond to the same value of land throughout the country. The Danish measure for land is a "Tonde Land" (Td. L.), which is equal to 1·363 statute acres. Of the best ploughing land a little over 6 Td. L., or about 8 acres, go to a Td. Htk., but of unprofitable land a Td. Htk. may represent 300 acres or more. On the islands and in the more fertile part of Jutland the average is about 10 Td. L., or 13½ acres. Woodland, tithes, &c., are also assessed to Td. Htk. for fiscal purposes, but the total assessment of agricultural land in Denmark is 369,161 Td. Htk., exclusive of the island of Bornholm, where the assessment is somewhat different, though the general state of agricultural holdings is the same as in other parts. The selling value of land has lately been declining, on account of the agricultural depression which has affected Denmark as well as England, but according to an official calculation based on the actual open sales which had taken place, it was, in 1895, Kr.5155 or £286 per Td. Htk. A homestead with land assessed less than 1 Td. Htk. is legally called a "Huus" or "Sted," *i.e.*, cottage, whilst a farm assessed at 1 Td. Htk. or more is called "Gaard," *i.e.*, farm. Most of the land in Denmark is freehold and cultivated by the owner himself, and comparatively little land is let on lease except very large holdings and glebe farms. Farms of between 1 and 12 Td. Hartkorn are called "Böndergaarde," or peasant farms, and are subject to the restriction that such a holding cannot lawfully be joined to or entirely merged into another. They may be subdivided, and portions may be added to another holding, but the homestead, with a certain amount of land, must be preserved as a separate holding for ever. According to the return of 1895, there were in Denmark (apart from the island of Bornholm) 73,889 "gaarde," of which 2031 were assessed at 12 Td. Htk. or more (not a few exceeding 100 Td. Htk.), their total assessment being 56,822 Td. Htk., or 15·4 per cent. of the total assessment of the country. Only 30 of these gaarde were not freehold. This class, of course, includes the "Herregaarde," or seats of the nobility and landed gentry. 12,858 holdings were "Böndergaarde," or peasant farms, and as the total assessment of this class of holdings amounts to 267,302 Td. Htk., it will be seen that the peasants in Denmark hold 72·9 per cent. of all the land according to its value. As regards their size, 44,557, or 30 per cent., were assessed at from 1 to 4 Td. Htk.; 23,638, or 32·9 per cent., were assessed at 4 to 8 Td. Htk.; the remainder at about 8 Td. Htk. In the rural districts there are, besides, 159,147 "Huse," or cottages with land, assessed at less than 1 Td. Htk., of which 141,439, or 89·1 per cent., were freehold and occupied by the owners. There were, besides, 32,946 cottages without land, of which 20,271, or 61·5 per cent., were freehold and occupied by the owners. Of late years an annual sum has been voted by the Rigsdag, out of which loans are granted to cottagers who desire to purchase small freehold plots. The total area of Denmark is 6,892,110 Td. Ld., or 9,393,945 statute acres, of which 5,097,357 Td. Ld., or 6,957,697 acres—that is, fully 74 per cent.—are agricultural land. Only 563,059 acres of this total are meadow land. In 1896 the ploughed land, 6,384,637 acres, was utilized as follows:—2,876,124 acres were sown with cereals, namely, wheat 85,001 acres, rye 718,228 acres, barley 691,181 acres, oats 1,085,847 acres, and mixed cereals 295,867 acres; 533,221 acres were sown with green fodder, potatoes, roots, and other minor crops; whilst 2,333,869 acres were under grass in rotation, and 621,423 acres were in fallow. The quantity of grain harvested in 1896 is stated to have been, in English quarters, 446,875 of wheat, 2,432,875 of rye, 2,574,500 of barley, 4,667,125 of oats, and 1,301,138 of mixed grain. There is, of course, a good deal of variation from year to year, but the above figures are near the average. During the last forty years of the 19th century dairy-farming was greatly developed in Denmark, and brought to a high degree of perfection by the application of scientific methods and the best machinery, as well as by the establishment of joint dairies. The Danish Government has assisted this development by granting money for experiments, and by a rigorous system of inspection for the prevention of adulteration. According to the latest returns (1898), 449,264 horses, 1,743,440 head of cattle, 1,178,514 swine, 1,074,413 sheep, were kept in Denmark, but only 31,803 goats and 139 donkeys. Rabbits, which are not found wild in Denmark, are bred for export, their number being given as 81,475. The garden land in Denmark amounted, in 1896, to 81,152 acres. The woods cover 665,584 acres, or fully 7 per cent. of the area, and their preservation is considered of so much importance that private owners are under strict control as regards cutting of timber. The woods consist mostly of beech, which is principally used for fuel, but pines were extensively planted during the 19th century. Efforts are being made to plant the extensive heaths in Jutland with pine trees (see JUTLAND). Peat bogs occupy 188,650 acres; heaths, moors, and other essentially waste lands, 909,795 acres.

The fishery along the coasts of Denmark is of some importance, both on account of the supply of food obtained thereby for the population of the country, and on account of the export; but the good fishing grounds, not far from the Danish coast, particularly in the North Sea, are mostly worked by the fishing vessels of other nations, which are so numerous that the Danish Government is obliged to keep gunboats stationed there in order to prevent encroachments on territorial waters.

The factories of Denmark supply mainly local needs. The Copenhagen china has a good reputation. In 1897 there were only 165 establishments employing each more than 100 hands; the largest are those engaged in the construction of engines and iron ships, of which there are 4, employing together about 3000 persons. Trade-unionism flourishes in Denmark, and strikes are of frequent occurrence.

***Commerce.***

The total value of Danish commerce has risen from £22,433,000 in 1874 to £51,132,000 in 1900, in which year the exports were valued at £21,865,000, the imports at £29,267,000. The commerce of Denmark is mainly based on home production and home consumption, but a certain quantity of goods is imported with a view to re-exportation, for which the free port and bonded warehouses at Copenhagen give facilities. The value of goods exported in 1900 and declared to be of foreign origin was £6,203,000. The main features of the trade of Denmark will be seen from the subjoined table for 1899, in which the different articles are classed as follows:—I. Live animals. II. Articles of animal food.

| | Import. | Export. | Balance. | Foreign Goods Exported. |
|---|---|---|---|---|
| | £ | £ | £ | £ |
| I. Live animals . | 123,800 | 1,080,500 | − 956,700 | 200 |
| II. Animal food . | 3,145,700 | 13,145,300 | −9,999,600 | 1,457,900 |
| III. Breadstuffs . | 6,205,100 | 1,158,400 | +5,046,700 | 553,400 |
| IV. Colonial produce . . | 2,214,000 | 711,500 | +1,502,500 | 660,600 |
| V. Alcoholic drinks . . | 413,700 | 206,800 | + 206,900 | 165,300 |
| VI. Textiles, &c. . | 3,659,800 | 848,600 | +2,811,200 | 684,400 |
| VII. Timber . . | 1,408,000 | 117,000 | +1,291,000 | 85,000 |
| VIII. Raw materials, vegetable and animal . | 2,913,400 | 1,454,400 | +1,459,000 | 815,200 |
| IX. Minerals and metal goods | 5,385,000 | 1,070,100 | +4,314,900 | 701,800 |
| X. Other goods . | 1,869,200 | 458,400 | +1,410,800 | 119,400 |
| | 27,337,700 | 20,251,000 | +7,086,700 | 5,243,200 |

III. Breadstuffs and foods for animals. IV. Colonial produce, conserves, &c. V. Alcoholic drinks. VI. Materials for spinning and weaving, woven fabrics and garments. VII. Timber and

wooden goods. VIII. Other raw materials of vegetable or animal origin, including all kinds of manures and oils. IX. Raw materials of mineral nature, and goods manufactured from them. X. All other goods. In the third column − indicates excess of export, + excess of import; the fourth column indicates the value of the foreign goods re-exported, which is included in the general figure for imports and exports.

In the first of the classes under which the articles have been summarized the most important is horned cattle, of which 37,736 head were exported in 1899, all home-bred; only 1130 head were imported. The trade in live sheep and swine, which was formerly important, has now mostly been converted into a dead-meat trade. In the second class, butter is the principal article, the export in 1899 amounting to 158,303,300 ℔ avoir., valued for export at £7,708,600, or 38·6 per cent. of the total value of Danish exports. Of this quantity 134,898,700 ℔, valued at £6,611,900, was home produce, whilst the remaining 23,404,600 ℔ (value £1,096,700) had been imported chiefly from Russia (also Siberia) and Sweden and re-exported as of foreign origin. In 1899 there was a further importation of butter for home consumption of 14,183,000 ℔ The production of margarine amounted in the year 1899–1900 to 35,849,054 ℔ besides which 5,622,290 ℔ were imported, but only 384,889 ℔ were exported, margarine being largely consumed in Denmark instead of the butter which is exported. Next to butter the most important article of Danish export is bacon, of which 164,667,953 ℔, valued at £3,083,620, were exported in 1899, all home produce excepting 5,782,349 ℔, which had been previously imported, together with 2,721,240 ℔ for home consumption. Eggs were exported in 1899 to the number of 302,994,800. The first two classes of articles, living animals and articles of food of animal origin, are the only ones of which the exportation exceeds the importation; with regard to all other goods, the reverse is the case: at the same time, from about 26 per cent. to 92 per cent. of the export in each of these classes consisted of foreign goods re-exported. Denmark had formerly a considerable net export of grain, but this is not the case now, owing partly to the increase of the population in wealth and number, and consequently to the greater consumption of breadstuffs, partly to the great development of dairy-farming and cattle-feeding. The proportionally large importation of timber is caused by the scarcity of native timber suitable for building purposes, the plantations of firs and pines being as yet insufficient to produce the quantity required, and the quality of the wood being inferior beyond the age of about 40 years. The large importation of minerals and metals and goods made from them is, of course, likewise caused by the natural poverty of the country in these respects. Coals were imported to the value of £1,953,700. Among the unclassified articles may be noted vessels built abroad, which in the statistics for 1899 figure with a value of £654,100 on the import side against £175,400 on the export side.

The value of the trade (1899) of Denmark with particular countries will be seen from the following table:—

| Countries. | Total. | Import. | Export. | Balance. |
|---|---|---|---|---|
| | £ | £ | £ | £ |
| Great Britain | 17,607,400 | 5,584,400 | 12,023,000 | − 6,438,600 |
| Germany . | 11,718,000 | 8,014,000 | 3,704,000 | + 4,310,000 |
| Sweden . | 4,804,500 | 2,868,000 | 1,936,500 | + 931,500 |
| United States | 4,722,100 | 4,341,400 | 380,700 | + 3,960,700 |
| Russia . . | 2,943,800 | 2,043,300 | 900,500 | + 1,142,800 |
| Norway . | 1,042,000 | 416,200 | 625,800 | − 209,600 |
| France . . | 697,300 | 619,300 | 78,000 | + 541,300 |
| Other countries | 4,053,600 | 3,451,100 | 602,500 | + 2,848,600 |
| Total . | 47,588,700 | 27,337,700 | 20,251,000 | + 7,086,700 |

The value of the trade of Denmark proper with the other parts of the Danish State, which is included in the category of "Other countries," was as follows in 1899:—

| | | | | |
|---|---|---|---|---|
| Faröes . . . . | Imports, | £19,400; | exports, | £35,300 |
| Iceland . . . . | ,, | 133,500 | ,, | 147,800 |
| Greenland . . . | ,, | 35,000 | ,, | 18,000 |
| Danish West Indies . . | ,, | 4,200 | ,, | 5,200 |
| Total . . | | £192,100 | | £206,300 |

***Shipping.*** The commercial fleet of Denmark comprised at the end of 1900, exclusive of small craft under 4 tons, 3017 sailing vessels, with a collective tonnage of 146,900 tons. Of these, 395 (tonnage in all, 98,799) each exceeded 100 tons register. The steamers numbered 483, with a total tonnage of 247,353, of which 312, with a collective tonnage of 242,770, each exceeded 100 tons. The total number of clearances to or from foreign ports in 1899 was 63,774, of which 32,889 were Danish vessels, 30,885 foreign vessels, but with this difference, that whilst the clearances of Danish steamers numbered 21,783, and those of Danish sailing vessels amounted only to 11,092, the reverse proportion held good for foreign vessels, of which 11,013 were steamers and 19,872 sailing vessels, chiefly Swedish. A large proportion of Danish vessels are engaged in the carrying trade between foreign ports; in 1899, 4703 clearances of Danish vessels so employed occurred in Great Britain, lesser number in other countries.

Denmark has long possessed a very complete set of excellent roads. The length of the railways, which for the most part are State property, was at the close of 1900, 1810 miles.

***Communications, posts, &c.*** In the course of 1900 about 20,000,000 of passengers were carried, travelling 587,500,000 miles, besides luggage, about 3,571,000 tons of goods were carried. There were in 1899, 274 post offices, 583 sub-offices, and 10,115 letter-boxes; 90,382,094 ordinary letters and 915,323 letters containing money were carried, of which respectively 17,228,427 and 69,157 for or from places abroad. 3,260,627 parcels were carried, of which 641,191 to or from places abroad. 83,499,502 newspapers and periodicals were carried, of which 2,789,143 to or from abroad. 2,628,616 postal orders passed through the post, of which 328,754 to or from abroad; finally, 983,457 different sums were collected for senders of parcels, of which 85,927 were in respect of parcels to or from places abroad. The telegraph service is carried on by the General Post Office. There were 480 stations; the length of the lines was 3850 miles. 2,056,613 telegrams were carried, of which 595,433 passed between Danish stations, 842,886 between Danish and foreign stations, whilst 618,294 passed through the Danish system between foreign stations. Of the second class, 257,562 were exchanged with Germany, 231,651 with Great Britain, 103,704 with Sweden, 83,404 with Norway, 53,026 with Russia, and 30,338 with America. There are 171 telephone stations in connexion with the State telegraph.

The principal bank of Denmark is the National Bank at Copenhagen, which is the only one authorized to issue notes. The total amount of these is £5,333,334; the notes are of the value of 10 kr. (1 krone = 1s. 1⅓d.), 50, 100, and 500 kr. Next in importance are the Danske Landmands Bank, the Handels Bank, and the Private Bank, all at Copenhagen. The provincial banks are very numerous; many of them are at the same time savings banks. This latter class numbered at the close of 1899, 532. The total of their deposits was £37,410,320, their rate of interest, with few exceptions, 3½ to 4 per cent.. There exists, besides, in Denmark 15 mutual loan associations (Kreditforeninger), whose business is the granting of loans on mortgage. The total of the money lent by these institutions was £46,121,780. Registration of mortgages is compulsory in Denmark, and the system is extremely simple, a fact which has been of the greatest importance for the improvement of the country. There are comparatively large institutions for insurance of all kinds in Denmark. The largest office for life insurance is a State institution. By law of 9th April 1891 a system of old-age pensions has been established for the benefit of persons over 60 years of age. The total number of those who in 1898 were in receipt of permanent and direct assistance was 40,759, of whom 27,629 were without encumbrance, whilst 13,130 were heads of families having in all 15,897 persons depending on them. Those assisted were fully 17 per cent. of all persons in Denmark above 60 years of age, but the number will of course increase. 69·15 per cent. lived in the rural districts.

The unit of the Danish monetary system is the krone (crown), equal to 1s. 1⅓d., which is divided into 100 öre; consequently 7½ öre are equal to one penny. Since 1873 gold has been the standard, and gold pieces of 20 and 10 kroner are coined, but not often met with, as the public prefers bank-notes.

As regards the dependencies and colonies of Denmark, see articles on Faröes, Greenland, Iceland, and St Thomas. Their areas and population are as follows:—

| | | | |
|---|---|---|---|
| Faröes (1900) . . . | Area, 511 sq. m.; | population, | 15,230 |
| Iceland (1890). . . | ,, 40,426 ,, | ,, | 70,927 |
| Danish West Indies (1900) | ,, 138 ,, | ,, | 30,504 |
| Greenland (1890) . | about 43,000 ,, | ,, | 10,576 |
| Total area (without Greenland), 41,075 sq. m. | | Total . | 127,237 |

The recent political history of Denmark offers very little of general interest. The country has not been engaged in the political struggles of Europe, and has been left in peace.

***Recent History.*** As long as Napoleon III. was on the throne, Denmark could still hope one day to recover the lost province of North Schleswig, and when war broke out in 1870 between France and Germany, public opinion inclined to an active sympathy with France. The rapid course of that campaign, however, compelled Denmark to observe neutrality. After its close any *rapprochement* to the new German Empire was distasteful to the people. In the circumstances, Austria and Germany agreed, in October 1878, to the abolition of clause 5 of the Treaty of Prague, which, to the great surprise of the Danes, was carried out at the very time the Danish Court was preparing to give expression to its anti-German

sentiments on the marriage of the Princess Thyra to the Duke of Cumberland. The most noticeable feature in the internal history of Denmark is the constitutional struggle which has been going on for many years between successive Governments and the Left party, which commands an overwhelming majority in the Folkething. No practical questions of great importance have been at the bottom of this disagreement save that of the fortification of Copenhagen. The Government considered this necessary, because without it the capital was exposed to a *coup de main* at any time, while the Left opposed it as a piece of aggressive militarism, which would be unnecessary if Denmark only proclaimed her neutrality in any war that might arise. For this reason the majority of the Folkething refused to sanction the outlay, but the Government, considering that the danger was real, and that the neutrality of a State cannot be secured by her own declaration but depends on the goodwill of her neighbours, which cannot be guaranteed, nevertheless carried out the work by means of a huge accumulated surplus. In the course of this conflict the majority in the Folkething even went the length of refusing supplies altogether; but under the Premiership of M. Estrup the Government collected the revenue nevertheless, and sought its justification in the approval of the Landsthing, whose political power according to the Charter is in every respect equal to that of the Folkething. This procedure met with no serious resistance in the country. The election in the spring of 1901 resulted in the return to the Folkething of 76 members of the Reform party of the Left, 16 members of the Moderate Left, 14 Social Democrats, and only 8 members of the Right, the party which had held the reins of power for so many years. Professor Deuntzer, one of the law professors in the University of Copenhagen, became the head of a Government composed of prominent men drawn from the different sections of his own side of the Folkething, and including amongst the number a simple peasant as Minister of Agriculture. The most prominent articles in the policy of the new Government were a reform of the customs, a readjustment of the system of taxation, a reform of the judicial procedure, a reform of primary education, and a reduction in the expenditure for military purposes.

Danish literature is dealt with below. As regards the intellectual life of the Danish nation in other respects during the last quarter of the 19th century, there is not much that calls for notice. During the earlier part of the century not a few men could be mentioned who enjoyed an exceptional reputation in various departments of science, but they have gradually died away, and their places have not been filled. Danish scientists, nevertheless, continue to contribute their full share to the advancement of knowledge, and a full account of what has been published would occupy considerable space. The Society of Sciences, that of Northern Antiquaries, the Natural History and the Botanical Societies, &c., still publish their transactions and proceedings, but the *Naturhistorisk Tidsskrift*, of which 14 volumes with 259 plates were published 1861–84, and which really was in the foremost rank in its department, ceased with the death in 1884 of the editor, the distinguished zoologist, I. C. Schiödte. Another extremely valuable publication of wide general interest, the *Meddelelser om Grönland* which is published by the Commission for the Exploration of Greenland, and of which 23 volumes, richly illustrated with maps, &c., have appeared, is still being continued. Amongst the works on the history of Denmark which have appeared, the most important is the *History of Denmark and Norway since 1720*, by E. Holm.

What may be called the modern "art" current, with its virtues and vices, is as strong in Denmark as in England (see SCHOOLS OF PAINTING). In architecture the prevailing fashion is a return to the style of the first half of the 17th century, called the Christian IV. Style.

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## DANISH LITERATURE.

The development of imaginative literature in Denmark became very closely defined during the latter half of the 19th century. The romantic movement culminated in several poets of great eminence, whose deaths prepared the way for a new school. In 1874 Bödtcher passed away, in 1875 Hans Christian Andersen (*q.v.*), in the last week of 1876 Winther (*q.v.*), and the greatest of all, Frederik Paludan-Müller (*q.v.*). The field was, therefore, left open to the successors of those idealists, and in 1877 the reaction began to be felt. The eminent critic, Dr Georg Brandes (*q.v.*), had long foreseen the decline of pure romanticism, and had advocated a more objective and more exact treatment of literary phenomena. Accordingly, as soon as all the great planets had disappeared a new constellation was perceived to have risen, and all the stars in it had been lighted by the enthusiasm of Brandes. The new writers were what he called Naturalists, and their sympathies were with the latest forms of exotic, but particularly of French literature. Among these fresh forces three immediately took place as leaders — Jacobsen, Drachmann, and Schandorph. In J. P. Jacobsen (1847–1885) (*q.v.*) Denmark was now taught to welcome the greatest artist in prose which she has ever possessed; his romance of *Marie Grubbe* led off the new school with a production of unexampled beauty. But Jacobsen died young, and the work was really carried out by his two companions. Holger Drachmann (*b.* 1846) (*q.v.*) began life as a marine painter; and a first little volume of poems, which he published in 1872, attracted slight attention. In 1877 he came forward again with one volume of verse, another of fiction, a third of travel; in each he displayed great vigour and freshness of touch, and he rose at one leap to the highest position among men of promise. He has known how, through many vicissitudes, to retain his place, and Drachmann is to-day, without rival, the leading imaginative writer in Denmark. For many years he made the aspects of life at sea his particular theme, and he contrived to rouse the patriotic enthusiasm of the Danish public as it had never been roused before. His various and unceasing productiveness, his freshness and vigour, and the inexhaustible richness of his lyric versatility, early brought Drachmann to the front and kept him there. Meanwhile prose imaginative literature was ably supported by Sophus Schandorph (1836–1901), who had been entirely out of sympathy with the idealists, and had taken no step while that school was in the ascendant. In 1876, in his fortieth year, he was encouraged by the change in taste to publish a volume of realistic stories, *Country Life*, and in 1878 a novel, *Without a Centre.* He has some relation with Guy de Maupassant as a close analyst of modern types of character, but he has more humour. He has been compared with such Dutch painters of low life as Teniers. His talent reached its height in the novel called *Little Folk*, 1880, a most admirable study of lower middle-class life in Copenhagen. He was for a while, without doubt, the leading living novelist, and he went on producing works of great force, in which, however, a certain monotony is apparent. The three leaders had meanwhile been joined by certain younger men who took a prominent position. Among these Karl Gjellerup and Erik Skram were the earliest. Gjellerup (*b.* 1857), whose first works of importance date from 1878, was long uncertain as to the direction of his powers; he was poet, novelist, moralist, and biologist in one; at length he settled down into line with the new realistic school, and produced in 1882 a satirical novel of manners which had a great success, *The Disciple of the Teutons.* Erik Skram (*b.* 1847) had in 1879 written a solitary novel, *Gertrude Coldbjörnsen*, which created a sensation, and was hailed by Brandes as exactly representing the "naturalism" which he desired to see encouraged; but Skram has written little else of importance. Other writers of reputation in the naturalistic school were Edvard Brandes (*b.* 1847) and Herman Bang (*b.* 1858). Peter Nansen (*b.* 1861) has come into wide notoriety as the author, in particularly beautiful Danish, of a series of stories of a pronouncedly sexual type, among which *Maria* (1894) has been the most successful. Meanwhile, several of the elder generation,

unaffected by the movement of realism, continued to please the public. Three lyrical poets, H. V. Kaalund (1818–1885), Carl Ploug (1813-1894), and Christian Richardt (1831–1892), of very great talent, were not yet silent, and among the veteran novelists were still active H. F. Ewald (*b.* 1821) and Thomas Lange (*b.* 1829). During the whole of this period the most popular writer of Denmark was J. C. C. Brosböll (1816–1900), who wrote, under the pseudonym Carit Etlar, a vast number of tales. The admirable prose-writer Meier Goldschmidt survived until 1887. Sophus Bauditz (*b.* 1850) has persevered in composing novels which attain a wide general popularity. Mention must be made also of the dramatist Christian Molbech (1821–1888) and of the miscellaneous writer Erik Bögh (1822–1899).

Between 1885 and 1892 there was a transitional period in Danish literature. Up to that time all the leaders had been united in accepting the naturalistic formula, which was combined with an individualist and a Radical tendency. In 1885, however, Drachmann, already the recognized first poet of the country, threw off his allegiance to Brandes, denounced the exotic tradition, declared himself a conservative, and took up a national and patriotic attitude. He was joined a little later by Gjellerup, while Schandorph remained staunchly by the side of Brandes. The camp was thus divided. New writers began to make their appearance, and, while some of these were staunch to Brandes, others were inclined to hold rather with Drachmann. Of the authors who came forward during this period of transition, the strongest has proved to be Henrik Pontoppidan (*b.* 1857), in 1902 perhaps the first living novelist of Denmark. In some of his books he reminds the reader of Tourgenieff. Pontoppidan published in 1898 the first volume of a great novel entitled *Lykke-Per*, the biography of a typical Jutlander named Per Sidenius, a work to be completed in eight volumes, of which four had appeared by 1901. Since 1893 no great features of a fresh kind have revealed themselves. The Danish public, grown tired of realism, and satiated with pathological phenomena, have returned to a study of their own national characteristics. The cultivation of verse, which was greatly discouraged in the 'eighties, has returned. Drachmann, who is really a talent of immense force, has persisted, and he is now supported by excellent younger poets of his school. J. J. Jörgensen (*b.* 1866), a Catholic decadent, is one of these who have been very prolific. Otto C. Fönss (*b.* 1853) has published seven little volumes of graceful lyrical poems in praise of gardens and of farm-life. Andreas Dolleris (*b.* 1850), of Vejle, published the same number of books between 1879 and 1901, and is an occasional poet of considerable merit. Alfred Ipsen (*b.* 1852) should also be mentioned as a poet and critic. Valdemar Rördam, whose *The Danish Tongue* was the lyrical success of 1901, must also be named. Some attempts have been made to transplant the theories of the symbolists to Denmark, but without signal success. On the other hand, something of a revival of naturalism is to be observed in the powerful studies of low life admirably written by Karl Larsen (*b.* 1860), of which *At Sixteen* was published in 1901.

The drama has long flourished in Denmark, and it has not ceased to do so within the last quarter of a century. The principal theatres are liberally open to fresh dramatic talent of every kind, and the great fondness of the Danes for this form of entertainment gives unusual scope for experiments in halls or private theatres; nothing is too eccentric to hope to obtain somewhere a fair hearing. Drachmann has produced with great success several romantic dramas founded on the national legends. Most of the novelists and poets already mentioned have essayed the stage, and to those names should be added these of Ernst von der Recke (*b.* 1848) and Gustav Wied (*b.* 1858).

In theology Denmark has not approached the preceding generation, in which such writers as Clausen (1793–1877), and still more Martensen (1808–84), lifted the prestige of Danish divinity to a high point. But in history the Danes have been very active. Jens Peter Trap (1810–1885) concluded his great statistical account of Denmark in 1879. The 16th century has been made the object of the investigations of Troels Lund (*q.v.*). About 1880 several of the younger historians formed the plan of combining to investigate and publish the sources of Danish history; in this the indefatigable Johannes Steenstrup (*b.* 1844) was prominent. The domestic history of the country began, about 1885, to occupy the attention of Holm, O. Nielsen, and the veteran Frederik Barfod (1811–1896). The naval histories of G. Lütken attracted much notice. Besides the names already mentioned, A. D. Jorgensen (1840–1897), Fridericia, and Mollerup have all distinguished themselves in the excellent school of Danish historians. Since 1896 a composite history of Denmark, on a very large scale, has been undertaken by some leading historians. In philosophy nothing has been published of the highest value. Martensen's *Jakob Böhme* (1881) really belongs to an earlier period. H. Höffding (*b.* 1843) has been the most prominent contributor to psychology, and an enthusiastic disciple of Mr Herbert Spencer. Alfred Lehmann (*b.* 1858) has, since 1896, attracted a good deal of attention by his sceptical investigation of psychical phenomena. F. Rönning has written on the history of thought in Denmark. In the criticism of art, Julius Lange (1838–1896), and later Karl Madsen, have done excellent service. In literary criticism that eminent master of thought and language Dr Georg Brandes (*b.* 1842) has been active and predominant throughout the whole of this period. His influence on his age has been greater than that of any other Dane. Thor Lange (*b.* 1851) has been an excellent critic and a useful translator. (E. G.)

**Denny** and **Dunipace,** a police burgh (1876) of Stirlingshire, Scotland, formed of two towns on opposite sides of the river Carron, 25¼ miles north-east of Glasgow by rail. The industries are iron-founding, paper-making, engineering, chemical manufacture, brick-making, and coal-mining. There is a cottage hospital and a public hall and library. The churches are Established, three United Free, and Roman Catholic. The Denny public school had an average attendance of 802 in 1898–99, Dunipace public school 176, and Denny Roman Catholic school 178. Population (1881), 4081; (1901), 5158.

**Dentistry.**—Dentistry is a special department of medical science, embracing the structure, function, and therapeutics of the mouth and its contained organs, together with their surgical and prosthetic treatment. As a distinct vocation it is first alluded to by Herodotus (500 B.C.). There are evidences that at an earlier date the Egyptians and Hindoos attempted to replace lost teeth by attaching wood or ivory substitutes to adjacent sound teeth by means of threads or wires, but the gold fillings reputed to have been found in the teeth of Egyptian mummies have upon investigation been shown to be superficial applications of gold leaf for ornamental purposes. The impetus given to medical study in the Grecian schools by the followers of Æsculapius and especially Hippocrates (500 to 400 B.C.) developed among the practitioners of medicine and surgery considerable knowledge of dentistry. Galen (A.D. 131) taught that the teeth were true bones existing before birth, and to him is credited the belief that the upper canine teeth receive branches from the nerve which supplies the eye, and hence should be called "eye-teeth." Albucasis (A.D. 1006?) describes the operation by which artificial

***Historical sketch.***

crowns are attached to adjacent sound teeth. Vesalius (1514), Ambroise Paré, Scaliger, Kerckring, Malpighi, and lesser anatomists of the same period contributed dissertations which threw some small amount of light upon the structure and functions of the teeth. The operation of transplanting teeth is usually attributed to John Hunter (1728–1793), who practised it extensively, and gave to it additional prominence by transplanting a human tooth to the comb of a cock, but the operation was alluded to by Ambroise Paré (1509–1590), and there is evidence to show that it was practised even earlier. Leeuwenhoek in 1678 described with much accuracy the tubular structure of the dentine, thus making the most important contribution to the subject which had appeared up to that time. Until the latter part of the 18th century extraction was practically the only operation for the cure of toothache.

The early contributions of France exerted a controlling influence upon the development of dental practice. Urbain Hémard, surgeon to the Cardinal Georges of Armagnac, whom Dr Blake (1801) calls an ingenious surgeon and a great man, published in 1582 his *Researches upon the Anatomy of the Teeth, their Nature and Properties.* Of Hémard, M. Fauchard says: "This surgeon had read Greek and Latin authors, whose writings he has judiciously incorporated in his own works." In 1728 Fauchard, who has been called the Father of Modern Dentistry, published his celebrated work, entitled *Le Chirurgien Dentiste ou Traité des dents.* The preface contains the following statement as to the existing status of dental art and science in France, which might have been applied with equal truth to any other European country:—"The most celebrated surgeons having abandoned this branch of surgery, or having but little cultivated it, their negligence gave rise to a class of persons who, without theoretic knowledge or experience, and without being qualified, practised it at hazard, having neither principles nor system. It was only since the year 1700 that the intelligent in Paris opened their eyes to these abuses, when it was provided that those who intended practising dental surgery should submit to an examination by men learned in all the branches of medical science, who should decide upon their merits." After the publication of Fauchard's work the practice of dentistry became more specialized and distinctly separated from medical practice, the best exponents of the art being trained as apprentices by practitioners of ability, who had acquired their training in the same way from their predecessors. Fauchard suggested porcelain as an improvement upon bone and ivory for the manufacture of artificial teeth, a suggestion which he obtained from Réaumur, the French savant and physicist, who was a contributor to the Royal Porcelain Manufactory at Sévres. Later, Duchateau, an apothecary of St Germain, made porcelain teeth, and communicated his discovery to the Academy of Surgery in 1776, but kept the process secret. Du Bois Chémant carried the art to England, and the process was finally made públic by M. Du Bois Foucou. M. Fonzi improved the art to such an extent that the Athenæum of Arts in Paris awarded him a medal and crown, 14th March 1808.

In Great Britain the 19th century brought the dawning of dental science. The work of Dr Blake in 1801 on the Anatomy of the Teeth was distinctly in advance of anything previously written on the subject. Joseph Fox was one of the first members of the medical profession to devote himself exclusively to dentistry, and his work is a repository of the best practice of his time. The processes described, though comparatively crude, involve principles in use at the present time. Thomas Bell, the successor of Fox as lecturer on the Structure and Disease of the Teeth at Guy's Hospital, published his well-known work in 1829. About this period numerous publications on dentistry made their appearance, notably those of Koecker, Johnson, and Waite, followed somewhat later by the admirable work of Alexander Nasmyth (1839). By this time Cuvier, Serres, Rousseau, Bertin, Herissant, and others in France had added to the knoweledge of human and comparative dental anatomy, while Retzius, of Sweden, and Weber, Rosenmüller, Schreger, Purkinje, Fraenkel, and Müller in Germany were carrying forward the same lines of research. The sympathetic nervous relationships of the teeth with other parts of the body, and the interaction of diseases of the teeth with general pathological conditions, were clearly established. Thus a scientific foundation was laid, and dentistry came to be practised as a specialty of medicine. Certain minor operations, however, such as the extraction of teeth and the stopping of caries in an imperfect way, were still practised by barbers, and the empirical practice of dentistry, especially of those operations which were almost wholly mechanical, had developed a considerable body of dental artisans who, though without medical education in many cases, possessed a high degree of manipulative skill. Thus there came to be two classes of practitioners, the first regarding dentistry as a specialty of medicine, the latter as a distinct and separate calling.

In America representatives of both classes of dentists began to arrive from England and France about the time of the Revolution. Among these were John Wooffendale (1766), a student of Robert Berdmore of Liverpool, surgeon-dentist to H.M. George III.; James Gardette (1778), a French physician and surgeon; and Joseph Lemaire (1781), a French dentist who went out with the army of Count Rochambeau. During the winter of 1781–82, while the Continental army was in winter quarters at Providence, R.I., Lemaire found time and opportunity to practise his calling, and also to instruct one or two persons, notably Josiah Flagg, probably the first American dentist. Dental practice was thus established upon American soil, where it has produced such fertile results.

**Course of training.**

Until well into the 19th century apprenticeship afforded the only means of acquiring a knowledge of dentistry. The profits derived from the apprenticeship system fostered secrecy and quackery among many of the early practitioners; but the more liberal minded and better educated of the craft developed an increasing opposition to these narrow methods. In 1837 a local association of dentists was formed in New York, and in 1840 a national assocation, "The American Society of Dental Surgeons," the object of which was "to advance the science by free communication and interchange of sentiments." The first dental periodical in the world, the *American Journal of Dental Science*, was issued in June 1839, and in November 1840 was established the Baltimore College of Dental Surgery, the first college in the world for the systematic education of dentists. Thus the year 1839–40 marks the birth of the three factors essential to professional growth in dentistry. All this, combined with the refusal of the medical schools to furnish the desired facilities for dental instruction, placed dentistry for the time being upon a footing entirely separate from general medicine. Since then the curriculum of study preparatory to dental practice has been systematically increased both as to its content and length, until in all fundamental principles it is practically equal to that required for the training of medical specialists, and in addition includes the technical subjects peculiar to dentistry. In England, and to some extent upon the Continent, the old apprenticeship system is retained as an adjunct to the college course, but it is rapidly dying out, as it has already done in America. Owing to the regula-

tion by law of the educational requirements, the increase of institutions devoted to the professional training of dentists has been rapid in all civilized countries, and during the past twenty years especially so in the United States. Great Britain possesses upwards of twelve institutions for dental instruction, France two, Germany and Switzerland six, all being based upon the conception that dentistry is a department of general medicine. In the United States there were in 1878 twelve dental schools, with about 700 students; in 1899 there were fifty-six schools, with 7633 students. Of these fifty-six schools, thirty-six are departments of universities or of medical institutions, and there is a growing tendency to regard dentistry from its educational aspect as a special department of the general medical and surgical practice.

Recent studies have shown that besides being an important part of the digestive system, the mouth sustains intimate relationship with the general nervous system, and is important as the portal of entrance for the majority of the bacteria that cause specific diseases. This fact has rendered more intimate the relations between dentistry and the general practice of medicine, and has given a powerful impetus to scientific studies in dentistry.

*Research.*

Through the researches of Tomes, Mummery, Hopewell Smith, Williams, and others in England, Hertwig, Weil, and Röse in Germany, Andrews, Sudduth, and Black in America, the minute anatomy and embryology of the dental tissues have been worked out with great fulness and precision. In particular, it has been demonstrated that certain general systemic diseases have a distinct oral expression. Through their extensive nervous connexions with the largest of the cranial nerves and with the sympathetic nervous system, the teeth frequently cause irritation resulting in profound reflex nervous phenomena, which are curable only by removal of the local tooth disorder. Gout, lithæmia, scurvy, rickets, lead and mercurial poisoning, and certain forms of chronic nephritis, produce dental and oral lesions which are either pathognomonic or strongly indicative of their several constitutional causes, and are thus of great importance in diagnosis. The most important dental research of modern times is that which was carried out by Professor W. D. Miller of Berlin (1884) upon the cause of caries of the teeth, a disease said to affect the human race more extensively than any other. Miller demonstrated that, as previous observers had suspected, caries is of bacterial origin, and that acids play an important rôle in the process. The disease is brought about by a group of bacteria which develop in the mouth, growing naturally upon the débris of starchy or carbohydrate food, producing fermentation of the mass, with lactic acid as the end product. The lactic acid dissolves the mineral constituent of the tooth structure, calcium phosphate, leaving the organic matrix of the tooth exposed. Another class of germs, the peptonising and putrefactive bacteria, then convert the organic matter into liquid or gaseous end products. The accuracy of the conclusions obtained from his analytic research was synthetically proved, after the manner of Koch, by producing the disease artificially. Caries of the teeth has been shown to bear highly important relation to more remote or systemic diseases. Exposure and death of the dental pulp furnishes an avenue of entrance for disease-producing bacteria, by which invasion of the deeper tissues may readily take place, causing necrosis, tuberculosis, actinomycosis, phlegmon, and other destructive inflammations, certain of which, affecting the various sinuses of the head, have been found to cause meningitis, chronic empyema, metastatic abscesses in remote parts of the body, paralysis, epilepsy, and insanity.

*Operative Dentistry.*—The art of dentistry is usually divided arbitrarily into *operative dentistry*, the purpose of which is to preserve as far as possible the teeth and associated tissues, and *prosthetic dentistry*, the purpose of which is to supply the loss of teeth by artifical substitutes.

***Filling or stopping.***

The filling of carious cavities was probably first performed with lead, suggested apparently by an operation recorded by Celsus (100 B.C.), who recommended that frail or decayed teeth be stuffed with lead previous to extraction, in order that they might not break under the forceps. The use of lead as a filling was sufficiently prevalent in France during the 17th century to bring into use the word *plombage*, which is still occasionally applied in that country to the operation of filling. Gold as a filling material came into general use about the beginning of the 19th century.[1] The earlier preparations of gold were so impure as to be virtually without cohesion, so that they were of use only in cavities which had sound walls for its retention. In the form of rolls or tape it was forced into the previously cleaned and prepared cavity, condensed with instruments under heavy hand pressure, smoothed with files, and finally burnished. Tin foil was also used to a limited extent and by the same method. Improvements in the refining of gold for dental use brought the product to a fair degree of purity, and, about 1855, led to the invention by Dr Robert Arthur of Baltimore of a method by which it could be welded firmly within the cavity. The cohesive properties of the foil were developed by passing it through an alcohol flame, which dispelled its surface contaminations. The gold was then welded piece by piece into a homogeneous mass by plugging instruments with serrated points. In this process of cold-welding, the mallet, hitherto in only limited use, was found more efficient than hand pressure, and was rapidly developed. The primitive mallet of wood, ivory, lead or steel, was supplanted by a mallet in which a hammer was released automatically by a spring condensed by pressure of the operator's hand. Then followed mallets operated by pneumatic pressure, by the dental engine, and finally by the electro-magnet, as utilized in 1867 by Bonwill. These devices greatly facilitated the operation, and made possible a partial or entire restoration of the tooth-crown in conformity with anatomical lines.

The dental engine in its several forms is the outgrowth of the simple drill worked by the hand of the operator. It is used in removing decayed structure and for shaping the cavity for inserting the filling. From time to time its usefulness has been extended, so that it is now used for finishing fillings and polishing them, for polishing the teeth, removing deposits from them and changing their shapes. Its latest development, *the dento-surgical engine*, is of heavier construction and is adapted to operations upon all of the bones, a recent addition to its equipment being the spiral osteotome of Cryer, by which, with a minimum shock to the patient, fenestra of any size or shape in the brain-case may be made, from a simple trepanning operation to the more extensive openings required in intra-cranial operations. The rotary power may be supplied by the foot of the operator, or by hydraulic or electric motors. The rubber dam invented by S. C. Barnum of New York (1864) provided a means for protecting the field of operations from the oral fluids, and extended the scope of operations even to the entire restoration of tooth-crowns with cohesive gold foil. Its value has been found to be even greater than was at first anticipated. In all operations involving the exposed dental pulp or the pulp-chamber and root-canals, it is the

[1] The filling of teeth with gold foil is recorded in the oldest known book on dentistry, *Artzney Buchlein*, published anonymously in 1530, in which the operation is quoted from Mesue (A.D. 857), physician to the Caliph Haroun al-Raschid.

only efficient method of mechanically protecting the field of operation from invasion by disease-producing bacteria.

The difficulty and annoyance attending the insertion of gold, its high thermal conductivity, and its objectionable colour have led to an increasing use of amalgam, gutta-percha, and cements of zinc oxide mixed with zinc chloride or phosphoric acid. Recently much attention has been devoted to restorations with porcelain. A piece of platinum foil of ·001 inch thickness is burnished and pressed into the cavity, so that a matrix is produced exactly fitting the cavity. Into this matrix is placed a mixture of powdered porcelain and water or alcohol, of the colour to match the tooth. The mass is carefully dried and then fused until homogeneous. Shrinkage is counteracted by additions of porcelain powder, which are repeatedly fused until the whole exactly fills the matrix. After cooling, the matrix is stripped away and the porcelain is cemented into the cavity. When the cement has hardened, the surface of the porcelain is ground and polished to proper contour. If successfully made, porcelain fillings are scarcely noticeable. Their durability remains to be tested.

**Dental therapeutics.**

Until recent times the exposure of the dental pulp inevitably led to its death and disintegration, and, by invasion of bacteria *viâ* the pulp canal, set up an inflammatory process which eventually caused the loss of the entire tooth. A rational system of therapeutics, in conjunction with proper antiseptic measures, has made possible both the conservative treatment of the dental pulp when exposed, and the successful treatment of pulp-canals when the pulp has been devitalized either by design or disease. The conservation of the exposed pulp is affected by the operation of capping. In capping a pulp, irritation is allayed by antiseptic and sedative treatment, and a metallic cap, lined with a non-irritant sedative paste, is applied under aseptic conditions immediately over the point of pulp exposure. A filling of cement is superimposed, and this, after it has hardened, is covered with a metallic or other suitable filling. The utility of arsenious acid for devitalizing the dental pulp was discovered by J. R. Spooner of Montreal, and first published in 1836 by his brother Shearjashub in his *Guide to Sound Teeth*. The painful action of arsenic upon the pulp was avoided by the addition of various sedative drugs,—morphia, atropia, iodoform, &c.,—and its use soon became universal. Of late years it is being gradually supplanted by immediate surgical extirpation under the benumbing effect of cocaine salts. By the use of cocaine also the pain incident to excavating and shaping of cavities in tooth structure may be controlled, especially when the cocaine is driven into the dentine by means of an electric current. To fill the pulp-chamber and canals of teeth after loss of the pulp, all organic remains of pulp tissue should be removed by sterilization, and then, in order to prevent the entrance of bacteria, and consequent infection, the canals should be perfectly filled. Upon the exclusion of infection depends the future integrity and comfort of the tooth. Numberless methods have been invented for the operation. Pulpless teeth are thus preserved through long periods of usefulness, and even those remains of teeth in which the crowns have been lost are rendered comfortable and useful as supports for artificial crowns, and as abutments for assemblages of crowns, known as bridge-work.

The discoloration of the pulpless tooth through putrefactive changes in its organic matter were first overcome by bleaching it with chlorine. Small quantities of calcium hypochlorite are packed into the pulp-chamber and moistened with dilute acetic acid; the decomposition of the calcium salt liberates chlorine *in situ*, which restores the tooth to normal colour in a short time. The cavity is afterwards washed out, carefully dried, lined with a light-coloured cement, and filled. More efficient bleaching agents of recent introduction are hydrogen dioxide in a 25 per cent. solution or a saturated solution of sodium dioxide; they are less irritating and much more convenient in application. Unlike chlorine, these do not form soluble metallic salts which may subsequently discolour the tooth. Hydrogen dioxide may be carried into the tooth structure by the electric current. In which case a current of not less than forty volts controlled by a suitable graduated resistance is applied with the patient in circuit, the anode being a platinum-pointed electrode in contact with the dioxide solution in the tooth cavity, and the cathode a sponge or plate electrode in contact with the hand or arm of the patient. The current is gradually turned on until two or three milliamperes are indicated by a suitable ammeter. The operation requires usually twenty to thirty minutes.

Malposed teeth are not only unsightly but prone to disease, and may be the cause of disease in other teeth, or of the associated tissues. The impairment of function which their abnormal position causes has been found to be the primary cause of disturbances of the general bodily health; for example, enlarged tonsils, chronic pharyngitis and nasal catarrh, indigestion, and malnutrition. By the use of springs, screws, vulcanized caoutchouc bands, elastic ligatures, &c., as the case may require, practically all forms of dental irregularity may be corrected, even such protrusions and retrusions of the front teeth as cause great disfigurement of the facial contour.

**Extraction.**

The extraction of teeth, an operation which until quite recent times was one of the crudest procedures in minor surgery, has been reduced to exactitude by improved instruments, designed with reference to the anatomical relations of the teeth and their alveoli, and therefore adapted to the several classes of teeth. The operation has been rendered painless by the use of anæsthetics. The anæsthetic generally employed is nitrous oxide, or laughing-gas, the use of which was discovered in 1844 by Horace Wells, a dentist of Hartford, Conn., U.S.A. Chloroform and ether, as well as other general anæsthetics, have been employed in extensive operations because of their more prolonged effect; but chloroform, especially, is dangerous, owing to its effect upon the heart, which in many instances has suddenly failed during the operation. Ether, while less manageable than nitrous oxide, has been found to be practically devoid of danger. The local injection of solutions of cocaine and allied anæsthetics into the gum-tissue is extensively practised; but is attended with danger, from the toxic effects of an overdose upon the heart, and the local poisonous effect upon the tissues, which lead in numerous cases to necrosis and extensive sloughing.

**Artificial teeth.**

*Dental Prosthesis.*—The fastening of natural teeth or carved substitutes to adjoining sound teeth by means of thread or wire preceded their attachment to base-plates of carved wood, bone, or ivory, which latter method was practised until the introduction of swaged metallic plates. Where the crown only of a tooth or those of several teeth were lost, the restoration was effected by engrafting upon the prepared root a suitable crown by means of a wooden or metallic pivot. When possible, the new crown was that of a corresponding sound tooth taken from the mouth of another individual; otherwise an artificial crown carved from bone or ivory, or sometimes from the tooth of an ox, was used. To replace entire dentures a base-plate of carved hippopotamus ivory was constructed, upon which were mounted the crowns of natural teeth, or later those of porcelain. The manufacture of a denture of this character was tedious and uncertain,

and required much skill. The denture was kept in place by spiral springs attached to the buccal sides of the appliance above and below, which caused pressure upon both jaws, necessitating a constant effort upon the part of the unfortunate wearer to keep it in place. Metallic swaged plates were introduced in the latter part of the 18th century. An impression of the gums was taken in wax, from which a cast was made in plaster of Paris. With this as a model, a metallic die of brass or zinc was prepared, upon which the plate of gold or silver was formed, and then swaged into contact with the die by means of a female die or counter-die of lead. The process is essentially the same to-day, with the addition of numerous improvements in detail, which have brought it to a high degree of perfection. The discovery, by Gardette of Philadelphia in 1800, of the utility of atmospheric pressure in keeping artificial dentures in place led to the abandonment of spiral springs. A later device for enhancing the stability is the vacuum chamber, a central depression in the upper surface of the plate, which when exhausted of air by the wearer, materially increases the adhesion. The metallic base-plate is used also for supporting one or more artificial teeth, being kept in place by metallic clasps fitting to, and partially surrounding, adjacent sound natural teeth, the plate merely covering the edentulous portion of the alveolar ridge. It may also be kept in place by atmospheric adhesion, in which case the palatal vault is included, and the vacuum chamber is utilized in the palatal portion to increase the adhesion.

In the construction usually practised, porcelain teeth are attached to a gold base-plate by means of stay-pieces of gold, perforated to receive the platinum pins baked in the body of the tooth. The stay-pieces or backings are then soldered to the pins and to the plate by means of high-fusing gold solder. The teeth used may be single or in sections, and may be with or without an extension designed in form and colour to imitate the gum of the alveolar border. Even when skilfully executed, the process is imperfect in that the jointing of the teeth to each other, and their adaptation to the base-plate, leaves crevices and recesses, in which food débris and oral secretions accumulate. To obviate these defects the enamelled platinum denture was devised. Porcelain teeth are first attached to a swaged base-plate of pure platinum by a stay-piece of the same metal soldered with pure gold, after which the interstices between the teeth are filled, and the entire surface of the plate, excepting that in contact with the palate and alveolar border, is covered with a porcelain paste called the body, which is modelled to the normal contour of the gums, and baked in a muffle furnace until vitrified. It is then enamelled with a vitreous enamel coloured in imitation of the colour of the natural gum, which is applied and fired as before, the result being the most artistic and hygienic denture known. This is commonly known as the continuous gum method. Originating in France in the early part of the 19th century, and variously improved by several experimenters, it was brought to its present perfection by Dr John Allen of New York about 1846–47. Dentures supported upon cast bases of metallic alloys and of aluminium have been employed as substitutes for the more expensive dentures of gold and platinum, but have had only a limited use, and are less satisfactory.

Metallic bases were used exclusively as supports for artificial dentures until in 1855–56 Charles Goodyear, jun., patented in England a process for constructing a denture upon vulcanized caoutchouc as a base. Several modifications followed, each the subject of patented improvements. Though the cheapness and simplicity of the vulcanite base has led to its abuse in incompetent hands, it has on the whole been productive of much benefit. It has been used with great success as a means of attaching porcelain teeth to metallic bases of gold, silver, and aluminium. It is extensively used also in correcting irregular positions of the teeth, and for making interdental splints in the treatment of fractures of the jaws. For the mechanical correction of palatal defects causing imperfection of deglutition and speech, which comes distinctly within the province of the prosthetic dentist, the vulcanite base produces the best-known apparatus. Two classes of palatal mechanism are recognized—the obturator, a palatal plate, the function of which is to close perforations or clefts in the hard palate, and the artificial velum, a movable attachment to the obturator or palatal plate, which closes the opening in the divided natural velum and, moving with it, enables the wearer to close off the naso-pharynx from the oral cavity in the production of the guttural sounds. Vulcanite is also used for extensive restorations of the jaws after surgical operations or loss by disease, and in the majority of instances wholly corrects the deformity.

For a time vulcanite almost supplanted gold and silver as a base for artificial denture, and developed a generation of practitioners deficient in that high degree of skill necessary to the construction of dentures upon metallic bases. The recent development of crown-and-bridge work has brought about a renaissance, so that a thorough training is more than ever necessary to successful practice in mechanical dentistry. The simplest crown is of porcelain, and is engrafted upon a sound natural tooth-root by means of a metallic pin of gold or platinum, extending into the previously enlarged root-canal and cemented in place. In another type of crown the point between the root-end and the abutting crown-surface is encircled with a metallic collar or band, which gives additional security to the attachment and protects the joints from fluids or bacteria. Crowns of this character are constructed with a porcelain facing attached by a stay-piece or backing of gold to a plate and collar, which has been previously fitted to the root-end like a ferule, and soldered to a pin which projects through the ferule into the root-canal. The contour of the lingual surface of the crown is made of gold, which is shaped to conform to the anatomical lines of the tooth. The shell-crown consists of a reproduction of the crown entirely of gold plate, filled with cement, and driven over the root-end, which it closely encircles. The two latter kinds of crowns may be used as abutments for the support of intervening crowns in constructing bridge-work. When artificial crowns are supported not by natural tooth-roots but by soldering them to abutments, they are termed dummies. The number of dummies which may be supported upon a given number of roots depends upon the position and character of the abutments, the character of the alveolar tissues, the age, sex, and health of the patient, the character of the occlusion or bite, and the force exerted in mastication. In some cases a root will not properly support more than one additional crown; in others an entire bridge denture has been successfully supported upon four well-placed roots. Two general classes of bridge-work are recognized, namely, the fixed and the removable. Removable bridge-work, though more difficult to construct, is preferable, as it can be more thoroughly and easily cleansed. When properly made and applied to judiciously selected cases, the bridge denture is the most artistic and functionally perfect restoration of prosthetic dentistry.

***Modern methods.***

The entire development of modern dentistry is comprised within the last century, and mainly within its latter half. Beginning with a few practitioners and no organized professional basis, educational system, or literature, its

practitioners are to be found in all civilized communities, those in Great Britain numbering about 5000; in the United States, 27,000; France, 1600, of whom 376 are graduates; German Empire, qualified practitioners (Zahnärzte), 1400; practitioners without official qualification, 4100. Its educational institutions are numerous and well equipped. It possesses a large periodical and standard literature in all languages. Its practice is regulated by legislative enactment in all countries the same as is medical practice. The business of manufacturing and selling dentists' supplies represents an enormous industry, in which millions of capital are invested.

AUTHORITIES.—W. F. LITCH. *American System of Dentistry.*—JULIUS SCHEFF, jun. *Handbuch der Zahnheilkunde.*—EDWARD C. KIRK. *American Text-Book of Operative Dentistry.*—CHARLES J. ESSIG. *American Text-Book of Prosthetic Dentistry.*—TOMES. *Dental Anatomy.*—TOMES. *Dental Surgery.*—W. D. MILLER. *Microorganisms of the Human Mouth.*—HOPEWELL SMITH. *Dental Microscopy.*—H. H. BURCHARD. *Dental Pathology, Therapeutics, and Pharmacology.*—F. J. S. GORGAS. *Dental Medicine.*—E. H. ANGLE. *Treatment of Malocclusion of the Teeth and Fractures of the Maxillæ.*—G. EVANS. *A Practical Treatise on Artificial Crown-and-Bridge Work and Porcelain Dental Art.*—C. N. JOHNSON. *Principles and Practice of Filling Teeth.* (E. C. K.)

**Denton,** a township in the Gorton division of Lancashire, England, 4½ miles north-east from Stockport, with a station on a branch of the London and North-Western Railway. The township of Haughton was added to it in 1894, and it has since been governed by an urban district council. Public buildings include, besides churches and chapels, the free library, installed in new and spacious premises in 1898, and the Conservative and the Liberal club houses. In the township are reservoirs for the water supply of Manchester, with a capacity of 1860 millions of gallons. The manufacture of felt hats is the leading industry. Coal is extensively mined in the district. The population of the urban district in 1891 was 13,993; in 1901, 14,934.

**Denver,** the capital of the state of Colorado, U.S.A., and county seat of Arapahoe county, situated in lat. 39° 45′ N. and long. 105° W. It comprises an area of 49 square miles on the South Platte river, 15 miles east of the foot of the Rocky Mountains, at a mean elevation of 5280 feet above sea-level. The population in 1890 was 106,713, and in 1900 it was 133,859, of whom 25,301 were foreign-born and 3923 were negroes. Out of 42,712 males of voting age (21 years and over), only 716 were reported by the U.S. census enumerators in 1900 as illiterate (unable to write); of these 548 were foreign-born. The death-rate in 1890 was 23·0; in 1900 it was 18·6. The city is the junction of the Burlington and Missouri River, the Chicago Rock Island and Pacific, the Kansas Pacific, the Missouri Pacific, the Union Pacific, the Atchison, Topeka, and Santa Fe, the Denver and Rio Grande, the Colorado Midland, and the Colorado and Southern Railway systems. The street railways are owned by a private corporation using electrical motive-power. The public education is provided by 3 high schools, a manual training school, and 44 public schools, the total public school property being valued at $2,700,000. According to the census of 1900, the number of persons of school age (5 to 20 years inclusive) was 37,423. The University of Denver, Gross Medical College, and the College of the Sacred Heart are influential institutions. A public library, with 75,000 volumes, is supported by a tax of one-half of one mill upon the assessed valuation of the city, which, for 1900, was $69,550,115 on a basis of about one-third actual value. The city has 12 parks, with a total area of 550 acres. The water supply is derived from mountain streams and carried to the city by gravity. Its daily capacity is 60,000,000 gallons. The factories in 1900 employed an average number of 10,926 wage-earners, with total wages amounting to $6,824,003, the total value of the manufactured products being $41,368,698. The city has four national banks, three savings banks, three State banks, and a branch of the United States mint. In 1858 placer gold was discovered at the junction of Cherry Creek with the South Platte river at 39° 47′ N. lat. and 105° W. long., which led to a small settlement called Auraria. In 1859 Denver (named after General James Denver, then Governor of Kansas Territory) was laid out on the east side of Cherry Creek, and shortly afterwards the two settlements were united. The city is the centre of the wealth and influence of the increasing mineral, agricultural, and stock-raising interests of the Rocky Mountain region. (J. H. PE.)

**Deogarh,** a town of British India, in the Sonthal Parganas district of Bengal. Situated in 24° 29′ N. lat. and 86° 44′ E. lat. Population, about 8000. It is famous for a group of twenty-two temples dedicated to Siva, the resort of numerous pilgrims. It is connected with the East Indian Railway by a steam tramway, 5 miles in length. In 1897 the net earnings were Rs.19,168, yielding a profit of 3·9 per cent. on a capital outlay of Rs.2,87,942.

**Depretis, Agostino** (1813–1887), Italian statesman, was born at Mezzana Corte, in the province of Stradella, 31st January 1813. Before 1848 he conspired with Mazzini, and was nearly captured by the Austrians while smuggling arms into Milan. Elected deputy in 1848, he joined the Left and founded the journal *Il Diritto*, but held no official position until appointed Governor of Brescia in 1859. In 1860 he went to Sicily on a mission to reconcile the policy of Cavour (who desired the immediate incorporation of the island in the kingdom of Italy) with that of Garibaldi, who wished to postpone the Sicilian *plébiscite* until after the liberation of Naples and Rome. Though appointed pro-dictator of Sicily by Garibaldi, he failed in his attempt. Accepting the portfolio of Public Works in the Rattazzi Cabinet in 1862, he served as intermediary in arranging with Garibaldi the expedition which ended disastrously at Aspromonte. Four years later he entered the Ricasoli Cabinet as Minister of Marine, and, by maintaining Admiral Persano in command of the fleet, contributed to the defeat of Lissa. Upon the death of Rattazzi in 1873, Depretis became leader of the Left, prepared the advent of his party to power, and was called upon to form the first Cabinet of the Left in 1876. Overthrown by Cairoli in March 1878 on the grist-tax question, he succeeded, in the following December, in defeating Cairoli, became again Premier, but on 3rd July 1879 was once more overturned by Cairoli. In November 1879 he, however, entered the Cairoli Cabinet as Minister of the Interior, and in May 1881 succeeded to the Premiership, retaining that office until his death on 29th July 1887. During the long interval he recomposed his Cabinet four times, first throwing out Zanardelli and Baccarini in order to please the Right, and subsequently bestowing portfolios upon Ricotti, Robilant, and other Conservatives, so as to complete the political process known as "*trasformismo.*" A few weeks before his death he repented of his transformist policy, and again included Crispi and Zanardelli in his Cabinet. During his long term of office he abolished the grist tax, extended the suffrage, completed the railway system, aided Mancini in forming the Triple Alliance, and initiated colonial policy by the occupation of Massawa; but, at the same time, he vastly increased indirect taxation, corrupted and destroyed the fibre of parliamentary parties, and, by extravagance in public works, impaired the stability of Italian finance. Shrewdness and unscrupulous political

ability assured him a long lease of power, but his influence upon Italian public life has been permanently deleterious.

(H. W. S.)

**Deptford,** a town of England, in the county of London, partly in Kent and partly in Surrey, at the junction of the Ravensbourne with the Thames, 3½ miles east of London Bridge, 5 miles from Charing Cross by rail. The parish of Deptford St Paul has been formed into the new metropolitan borough of Deptford. There are two open spaces, namely, Deptford Park, consisting of the site of the gardens of old Sayes Court (11 acres), and Telegraph Hill (9½ acres). The Trinity House was founded at Deptford, and the old hall was pulled down in 1787. A new building was erected, which was used by the corporation until the Trinity House on Tower Hill was ready for occupation, and occasionally for many years afterwards. The population of Deptford St Nicholas (now included in the metropolitan borough of Greenwich) was (1881), 7901; (1896), 7722; of Deptford St Paul (1881), 76,752; (1901), 110,513.

**Dera Ghazi Khan,** a town and district of British India, in the Derajat division of the Punjab. In 1881 the town had a population of 22,309, and in 1891 of 27,886; the municipal income in 1897–98 was Rs.1,57,532. There are several handsome mosques in the native quarter. The cantonment accommodates one cavalry and two infantry regiments of the Punjab Frontier Force. There is an efficient high school.

The DISTRICT OF DERA GHAZI KHAN contains an area of 5606 square miles. The population in 1891 was 404,031, being 72 persons per square mile, an increase since 1881 of 11 per cent. Classified according to religion, Mahommedans numbered 349,587, largely Baluchis; Hindus, 52,903; Sikhs, 1424; Christians, 117, of whom 73 were Europeans. In 1901 the population was 445,163, showing a further increase of 10 per cent. The total amount of land revenue and rates was returned as Rs.6,83,807, the incidence of assessment being 3 annas per acre; the number of police was 514. In 1896–97, out of a total cultivated area of 443,749 acres, 230,074 were irrigated, mostly from Government canals and wells. The exports are wheat and indigo. The only manufactures are for domestic use. There is no railway in the district, and only 25 miles of metalled road. The Indus, which is nowhere bridged, is navigable by native boats throughout its course of 239 miles. Education is making some progress. There are three Mahommedan institutions and one Hindu for religious instruction. In 1896–97 there were altogether 233 schools, with 5784 pupils, the proportion of boys at school to those of school-going age being 11·9 per cent. The registered death-rate in 1897 was 36 per thousand; the rainfall in 1897 was 5·41 inches.

**Dera Ismail Khan,** a town and district of British India, in the Derajat division of the Punjab. The town is situated near the right bank of the Indus, here crossed by a bridge of boats during half the year. In 1881 it had a population of 22,164, and in 1891 of 26,884; the municipal income in 1897–98 was Rs.54,889. It takes its name from Ismail Khan, a Beluchi chief who settled here towards the end of the 15th century, and whose descendants ruled for 300 years. The old town was swept away by a flood in 1823, and the present town stands 4 miles back from the permanent channel of the river. The native quarters are well laid out, with a large bazaar for Afghan traders. It is the residence of many Mahommedan gentry. The cantonment accommodates a force of all arms. There are several efficient schools, one missionary. A vernacular newspaper is issued. There is considerable through trade with Afghanistan by the Gomal Pass, and there are manufactures of scarves and inlaid wood-work. Here is the tomb of Sir Henry Durand, Lieutenant-Governor of the Punjab.

The DISTRICT OF DERA ISMAIL KHAN contains an area of 9440 square miles. The population in 1891 was 486,201, being 52 persons per square mile—much the lowest density in the province. Since 1881 the increase had been at the rate of 10 per cent. According to religion, Mahommedans numbered 420,189; Hindus, 62,961; Sikhs, 2840; Christians, 204, including 108 Europeans; "others," 7. In 1901 the population was 527,705, showing a further increase of 9 per cent. The total amount of land revenue and rates was returned as Rs.6,02,437, the incidence of assessment being about 1½ annas per assessed acre, but nearly 15 annas per cultivated acre; the number of police was 627. In 1896–97, out of a total cultivated area of 588,413 acres, 159,849 were irrigated from private canals and wells. Wheat and wool are exported. There are manufactures of cotton cloth. The North-Western Railway runs through the Cis-Indus portion of the district for 93 miles. In the other portion there are 108 miles of metalled roads for military purposes. The Indus is navigable by native boats throughout its course of 120 miles within the district. Education is making fair progress, particularly in the English-teaching schools at the towns. In 1896–97 there were altogether 441 schools, attended by 7714 boys. The proportion of boys at recognized schools was 13·5 per cent. of those of school-going age. The death-rate in 1897 was 50 per thousand; the rainfall in 1897 was 9·77 inches.

**Derajat,** the name of a division or commissionership of British India, in the west of the Punjab, consisting of the four districts of Dera Ismail Khan, Dera Ghazi Khan, Bannu, and Muzaffargarh, the last having been recently transferred to it. It contains a total area of 22,315 square miles, and a population (1891) of 1,643,703, being 74 persons per square mile.

**Derbent.** See DAGHESTAN.

**Derby,** the county town and a municipal (extended 1877), parliamentary, and county borough of Derbyshire, England, on the Derwent, 15¾ miles west by south of Nottingham, and 127 miles north-west by north of London. It is the central station of the Midland Railway system. The enlarged parliamentary borough was in 1885 identified with the municipal borough, which was created a county borough in 1888, and is governed by a mayor, 16 aldermen, and 48 councillors. In 1898 the civil parishes within the borough were constituted one parish, though still ecclesiastically distinct. The water-works of the town, costing over £350,000, became in 1880 the property of the corporation. Electric works, lighting the principal streets, were erected in 1893. There are 17 churches, 2 Roman Catholic churches, and over 30 dissenting chapels. Derby school was in 1879 reconstituted as a first grade school. Among recent erections are a free library and museum, an art gallery, a mechanics' institute, a Midland Railway institute, a grand theatre, an infirmary, and an infectious hospital. The Midland Railway storehouses, workshops, and engine and carriage factory employ altogether over 10,000 men. In Little Chester are chemical and steam boiler works. In 1891 there were 3375 engaged in iron and steel manufactures, 1031 in the manufacture of silk, 963 in the making of carriages, and 290 in the manufacture of china and porcelain. There are two daily newspapers. Area, 3450 acres. Population (1881), 81,168; (1891), 94,146; (1901), 105,785.

**Derby,** a city of New Haven county, Connecticut, U.S.A., on the eastern bank of the Housatonic, at the

mouth of the Naugatuck river. It is on the New York, New Haven, and Hartford Railway, and was chartered in 1894. Population (1890), 5969; (1900), 7930 (2635 foreign-born and 159 negroes).

**Derby, Edward Henry Stanley,** 15TH EARL OF (1826–1893), was the eldest son of the fourteenth earl, the "Rupert of Debate." He was educated at Rugby and Trinity College, Cambridge, where he took a high degree and became a member of the society known as "The Apostles." In March 1848 he unsuccessfully contested the borough of Lancaster, and then made a long tour in the West Indies, Canada, and the United States. During his absence he was elected member for King's Lynn, which he represented till October 1869, when he succeeded to the peerage. No one ever prepared himself more assiduously or with a stronger sense of duty for the great position to which his birth had called him. When he took his seat in the House of Commons he wrote to a Rugby friend (the Rev. W. Philpot) to say, half proudly, half in sorrow, that he had put on the armour which he would never be able to take off again until he died; and he kept his word. He took his place, as a matter of course, among the Conservatives, and delivered his maiden speech in May 1850 on the Sugar Duties. Just before, he had made a very brief tour in Jamaica and South America. In 1852 he went to India, and while travelling in that country he was appointed Under-Secretary for Foreign Affairs in his father's first Administration. From the outset of his career he was known to be a most Liberal Conservative, and in 1855 Lord Palmerston offered him the post of Colonial Secretary. He was much tempted by the proposal, and hurried down to Knowsley to consult his father, who called out when he entered the room, "Hallo, Stanley! what brings you here?—Has Dizzy cut his throat, or are you going to be married?" When the object of his sudden appearance had been explained, the Conservative chief received the courteous suggestion of the Prime Minister with anything but favour, and the offer was declined. In his father's second Administration Lord Stanley held, at first, the office of Secretary for the Colonies, but became President of the Board of Control on the resignation of Lord Ellenborough. He had the charge of the India Bill of 1858 in the House of Commons, became the first Secretary of State for India, and left behind him in the India Office an excellent reputation as a man of business. After the revolution in Greece and the disappearance of King Otho, the people most earnestly desired to have Queen Victoria's second son, Prince Alfred, for their king. He declined the honour, and they then took up the idea that the next best thing they could do would be to elect some great and wealthy English noble, not concealing the hope that although they might have to offer him a Civil List he would decline to receive it. Lord Stanley was the prime favourite as an occupant of this bed of thorns, and it has been said that he was actually offered the crown. That, however, is not true; the offer was never formally made. After the fall of the Russell Government in 1866 he became Foreign Secretary in his father's third Administration. He compared his conduct in that great post to that of a man floating down a river and fending off from his vessel, as well as he could, the various obstacles it encountered. He thought that that should be the normal attitude of an English Foreign Minister, and probably under the circumstances of the years (1866–68) it was the right one. He arranged the Collective Guarantee of the Neutrality of Luxemburg in 1867, negotiated a convention about the *Alabama*, which, however, was not ratified, and most wisely refused to take any part in the Cretan troubles. In 1874 he again became Foreign Secretary in Mr Disraeli's Government. He acquiesced in the purchase of the Suez Canal shares, a measure then considered dangerous by many people, but ultimately most successful; he accepted the Andrassy Note, but declined to accede to the Berlin Memorandum. His part in the later phases of the Russo-Turkish struggle has never been fully explained, for with equal wisdom and generosity he declined to gratify public curiosity at the cost of some of his colleagues. A later generation will know better than his contemporaries what were the precise developments of policy which obliged him to resign. He kept himself ready to explain in the House of Lords the course he had taken if those whom he had left challenged him to do so, but from that course they consistently refrained. Already in October 1879 it was clear enough that he had thrown in his lot with the Liberal party, but it was not till March 1880 that he publicly announced this change of allegiance. He did not at first take office in the second Gladstone Government, but became Secretary for the Colonies in December 1882, holding this position till the fall of that Government in the summer of 1885. In 1886 the old Liberal party was run on the rocks and went to pieces. Lord Derby became a Liberal Unionist, and took an active part in the general management of that party, leading it in the House of Lords till 1891, when Lord Hartington became Duke of Devonshire. In 1892 he presided over the Labour Commission, but his health never recovered an attack of influenza which he had in 1891, and he died at Knowsley on 21st April 1893.

During a great part of Lord Derby's life he was deflected from his natural course by the accident of his position as the son of the leading Conservative statesman of the day. From first to last he was at heart a moderate Liberal. After making allowance, however, for this deflecting agency, it must be admitted that in the highest quality of the statesman, "aptness to be right," he was surpassed by none of his contemporaries, or—if by anybody—by Sir George Cornewall Lewis alone. He would have been more at home in a state of things which did not demand from its leading statesman great popular power; he had none of those "isms" and "prisms of fancy" which stood in such good stead some of his rivals. Byron in a famous passage speaks of those

> "Madmen who have made men mad
> By their contagion, conquerors and kings,
> Sophists, bards, statesmen, all unquiet things
> Which stir too strongly the soul's secret springs
> And are themselves the fools to those they fool!"

Lord Derby was emphatically not the kind of statesman mentioned in that passage. He had another defect besides the want of popular power. He was so anxious to arrive at right conclusions that he sometimes turned and turned and turned a subject over till the time for action had passed. One of his best lieutenants said of him in a moment of impatience: "Lord Derby is like the God of Hegel: 'Er setzt sich, er verneint sich, er verneint seine Negation.'" Like many Englishmen, he loved business for its own sake, and more than he knew. That fact must be borne in mind when we remember the answer he gave to a friend who expressed his surprise at his serving so much as chairman of Private Bill Committees. "I do it," he said, "because I come in that way across the great interests of the country better than I otherwise could." His knowledge, acquired both from books and by the ear, was immense, and he took every opportunity of increasing it. He retained his old university habit of taking long walks with a congenial companion, even in London, and although he cared but little for what is commonly known as society—the society of crowded rooms and fragments of sentences—he very much liked conversation. During the many

years in which he was a member of "The Club" he was one of its most assiduous frequenters, and his loss was acknowledged by a formal resolution. His talk was generally grave, but every now and then was lit up by dry humour. The late Lord Arthur Russell once said to him, after he had been buying some property in Southern England: "So you still believe in land, Lord Derby." "Hang it," he replied, "a fellow must believe in something!" It was to the same companion that he said, when, looking one evening for a book at Knowsley and passing his candle along the shelves, he came to the poems of William Morris: "If I had known that he was going to turn Socialist I wouldn't have gone to the expense of binding him in red morocco!" He did an immense deal of work outside politics. He was Lord Rector of the University of Glasgow from 1868 to 1871, and later held the same office in that of Edinburgh. From 1875 to 1893 he was President of the Royal Literary Fund, and attended most closely to his duties then. He succeeded Lord Granville as Chancellor of the University of London in 1891, and remained in that position till his death. He lived much in Lancashire, managed his enormous estates with great skill, and did a great amount of work as a local magnate. He married in 1870 Maria Catharine, daughter of the fifth Earl De la Warr, and widow of the second marquess of Salisbury. The best account of Lord Derby which exists is that which was prefixed by Mr Lecky, who knew him very intimately, to the edition of his speeches outside Parliament, which was published in 1894. Mr Lecky brings out extremely well what almost every page of these two volumes confirms, that he was most strongly attracted by all questions which related to the condition of the mass of the people. He once wrote to Lord Shaftesbury: "We are both public men deeply interested in the condition of the working class, and for my own part I would rather look back on services such as you have performed for that class than receive the highest honours in the employment of the State." (M. G. D.)

**Derbyshire,** a north midland county of England, bounded W. by Stafford and Cheshire, N.W. by Cheshire, N. by York, E. by Nottingham, and S.E. and E. by Leicester.

*Area and Population.*—The area of the ancient and administrative county (including the county borough of Derby), as given in the census returns, is 658,876 acres or 1029 square miles. The population in 1881 was 461,746, and in 1891 was 528,033, of whom 266,011 were males and 262,022 females, the number of persons per square mile being 513, and of acres to a person 1·25. In 1901 the population was 620,196. Since 1891 the administrative area has undergone various alterations. In 1895 the part of the parish of Pinxton in Nottingham, and a part of the parish of Kirkby-in-Ashfield in the same county, were transferred to Derby, and two parts of the parish of Pinxton were transferred from Derby to Nottingham; in the same year part of the parish of Croxall in Derby was transferred to Stafford; and in 1897 the parishes of Nether Seal and Over Seal, part of the parish of Ashby Woulds, and part of the township of Blackfordby were transferred from Leicester to Derby; while the parishes of Appleby, Oakthorp, and Donisthorpe and Willesley, and the townships of Chilcote, Measham, and Shetton-en-le-Fields, were transferred from Derby to Leicester. The area of the registration county is 557,768 acres, with a population in 1891 of 432,414, of which 252,931 were urban and 179,483 rural. Within this area the increase of population between 1881 and 1891 was 11·87 per cent. Between 1881 and 1891 the excess of births over deaths was 63,103, and the increase in resident population 45,878.

The following table gives the number of marriages, births, and deaths, with the number of illegitimate births, for 1880, 1890, and 1898:—

| Year. | Marriages. | Births. | Deaths. | Illegitimate Births. | |
|---|---|---|---|---|---|
| | | | | Males. | Females. |
| 1880 | 2672 | 13,965 | 7250 | 340 | 364 |
| 1890 | 3229 | 13,261 | 7831 | 286 | 294 |
| 1898 | 3725 | 14,802 | 7987 | 352 | 348 |

The number of marriages in 1899 was 3885, of births 14,663, and of deaths 7921.

The following table shows the marriage, birth, and death rates per 1000 of the population, with the percentage of illegitimate births, for a series of years:—

| | 1870–79. | 1880. | 1880–89. | 1890. | 1888–97. | 1898. |
|---|---|---|---|---|---|---|
| Marriage-rate | 16·0 | 13·7 | 13·2 | 13·4 | 15·2 | 15·9 |
| Birth-rate | 37·8 | 36·5 | 33·9 | 30·8 | 32·1 | 31·7 |
| Death-rate | 21·0 | 18·9 | 17·9 | 18·3 | 17·5 | 17·1 |
| Percentage of illegitimate births | 5·4 | 5·0 | 4·8 | 4·4 | 4·4 | 4·7 |

The birth-rate is above the average, but the death-rate rather under it.

The number of Scots in the county in 1891 was 1872, of Irish 4234, and of foreigners 684.

*Constitution and Government.*—The ancient county is divided into seven parliamentary divisions, and it also includes the parliamentary borough of Derby, returning two members. The administrative county includes the municipal boroughs of Chesterfield (27,185), Derby (105,785), Glossop (21,526), and Ilkeston (25,383). Derby is a county borough. The following are urban districts:—Alfreton (17,505), Alvaston and Boulton (4526), Ashbourne (4039), Bakewell (2850), Baslow and Bubnell (797), Belper (10,934), Bolsover (6844), Bonsall (1360), Brampton and Walton (2698), Buxton (10,181), Claycross (8348), Dronfield (3809), Fairfield (2969), Heage (2889), Heanor (16,249), Long Eaton (13,045), Matlock (5980), Matlock Bath (1816), Newbold and Dunston (5986), Newmills (7773), North Darley (2756), Ripley (10,111), South Darley (788), Swadlincote (18,014), Whittington (9416), and Wirksworth (3807). Derbyshire is in the midland circuit, and assizes are held at Derby. The boroughs of Derby, Chesterfield, and Glossop have separate commissions of the peace, and Derby has also a separate court of quarter sessions. The ancient county, which is partly in the dioceses of Lichfield, Peterborough, and Southwell, contains 240 ecclesiastical parishes and districts, and parts of eleven others.

*Education.*—There is a residential college (Lichfield diocesan) for schoolmistresses at Derby, which also takes day students. At Derby there is also a royal institution for the deaf and dumb. The number of elementary schools in the county on 31st August 1899 was 422, of which 117 were board and 305 voluntary schools, the latter including 246 National Church of England schools, 12 Wesleyan, 16 Roman Catholic, and 31 "British and other." The average attendance at board schools was 41,358, and at voluntary schools 53,833. The total school board receipts for the year ended 29th September 1899 were £159,815. The income under the Technical Instruction Act was over £1689; that under the Agricultural Rates Act was over £2943.

*Agriculture.*—About three-fourths of the total area of the county is under cultivation, and of this area as much as four-fifths is under permanent pasture, cattle rearing and dairy farming, including the manufacture of cheese, occupying the chief attention of the farmer. Less than 39,000 acres are in hill pasture, and nearly 26,000 acres are under woods. Wheat and oats are the principal corn crops, and their acreage has within recent years greatly diminished. Turnips occupy more than half the area under green crops. The following table gives the larger main divisions of the cultivated area at intervals of five years from 1880:—

| Year. | Total Area under Cultivation. | Corn Crops. | Green Crops. | Clover. | Permanent Pasture. | Fallow. |
|---|---|---|---|---|---|---|
| 1880 | 512,368 | 63,135 | 21,026 | 28,774 | 388,966 | 10,453 |
| 1885 | 514,660 | 56,293 | 22,081 | 24,889 | 405,680 | 5,717 |
| 1890 | 514,573 | 53,297 | 20,144 | 25,947 | 410,320 | 4,460 |
| 1895 | 503,185 | 48,498 | 19,714 | 25,093 | 406,487 | 2,822 |
| 1900 | 494,716 | 46,923 | 18,169 | 24,697 | 401,830 | 2,541 |

The following table gives particulars regarding the principal live stock for the same years:—

| Year. | Total Horses. | Total Cattle. | Cows or Heifers in Milk or in Calf. | Sheep. | Pigs. |
|---|---|---|---|---|---|
| 1880 | 21,847 | 134,786 | 64,324 | 228,445 | 29,704 |
| 1885 | 21,631 | 155,308 | 73,888 | 204,925 | 35,143 |
| 1890 | 22,357 | 143,232 | 71,186 | 202,897 | 36,190 |
| 1895 | 27,105 | 136,111 | 68,806 | 176,998 | 40,919 |
| 1900 | 26,722 | 143,609 | 70,723 | 171,364 | 34,108 |

*Manufactures and Minerals.*—According to the report for 1898 of the chief inspector of factories (issued 1900) the total number of persons employed in factories and workshops in 1897 was 67,848, as compared with 68,774 in 1896. Of these nearly a third (20,324)

were employed in textile factories, there being an increase between 1895 and 1896 of 10·4 per cent., but a decrease between 1896 and 1897 of 8·4 per cent. About one-half (10,701) were employed in the cotton industry, while lace employed 4667, hosiery (chiefly cotton and silk) 2530, and silk 1092. Non-textile factories employed 43,630 persons, there being an increase between 1895 and 1896 of 13·9 per cent., and between 1896 and 1897 of 2·9 per cent. Those employed in the manufacture of machines, appliances, conveyances, and tools numbered 13,990; the founding and conversion of metals employed 10,027; the making of earthenware, etc., 3884; print (calico), bleach, and dye works, 3813; and papermaking, printing, &c., 3186. In workshops only 3894 persons were employed, the majority (2263) in the clothing industries. The total number of persons employed in mining in 1899 was 48,578. In its limestone production the county stands next to Durham, the amount raised in 1899 being 1,761,270 tons. In the same year 519,208 tons of clay were raised, including 71,244 tons of fireclay valued at £21,373 (the total value of the clays being £43,648), 165,366 tons of sandstone, and 30,218 tons of gravel and sand. But the principal mineral is coal. Ironstone is not extensively wrought, but on account of the abundant supply of coal, large quantities are imported for smelting purposes. The amount of pig-iron produced in 1885 was 368,863 tons, in 1890, 387,760 tons, in 1895, 413,454 tons, and in 1899 (including Nottingham, the production in which county is, however, small) 511,994 tons. The furnaces are situated in Alfreton, Chesterfield, Derby, and Ilkeston. Zinc is mined to a small extent. The following table gives particulars regarding the production of coal, gypsum, iron ore, and lead in 1890 and 1898:—

| Year. | Coal. | | Gypsum. | | Iron Ore. | | Lead. | |
|---|---|---|---|---|---|---|---|---|
| | Tons. | Value. | Tons. | Value. | Tons. | Value. | Tons. | Value. |
| | | £ | | £ | | £ | | £ |
| 1890 | 10,445,974 | 4,705,188 | 67,571 | 30,407 | 23,732 | 8306 | 4026 | 30,195 |
| 1899 | 14,594,424 | 5,047,238 | 11,557 | 5,778 | 3,526 | 1534 | 4266 | 31,995 |

Authorities.—Davies. *A New Historical and Descriptive View of Derbyshire.* Belper, 1811.—Maunder. *Derbyshire Miners' Glossary.* Bakewell, 1824.—Bateman. *Vestiges of the Antiquities of Derbyshire.* London, 1848.—Jewitt. *Ballads and Songs of Derbyshire.* London, 1867.—Cox. *Notes on the Churches of Derbyshire.* Chester, 1875.—Pendleton. *History of Derbyshire* (Popular County Series). London, 1886.—Cox. *Three Centuries of Derbyshire Annals* (2 vols.). London, 1890.—Mello. *Handbook to the Geology of Derbyshire.* London, 1891.—Payne. *Derbyshire Churches, Old and New.* Derby, 1893.—See also *Notts and Derbyshire Notes and Queries.* (T. F. H.)

**Dereham** (East), a market town and railway station in the Mid parliamentary division of Norfolk, England, 15 miles west by north of Norwich. The ancient church of St Nicholas contains interesting memorials, and the Congregational chapel stands on the site of the house where the poet Cowper spent his last days. Dereham is an important agricultural centre with works for agricultural implements. Area of civil parish (an urban district), 5313 acres; population (1881), 5640; (1901), 5545.

**Déroulède, Paul** (1846-——), French author and politician, was born in Paris on 2nd September 1846. He made his first appearance as a poet in the pages of the *Revue nationale*, under the pseudonym of Jean Rebel, and in 1869 produced at the Théâtre Français a one-act drama in verse entitled *Juan Strenner*. On the outbreak of the Franco-German war he enlisted as a private, was wounded and taken prisoner at Sedan, and sent to Breslau, but effected his escape. He then served under Chanzy and Bourbaki, took part in the latter's disastrous retreat to Switzerland, and fought against the Commune in Paris. After attaining the rank of lieutenant, he was forced by an accident to retire from the army. He now published a number of patriotic poems (*Chants du soldat*), which enjoyed unbounded popularity. In 1877 he produced a drama in verse called *L'Hetman*, which derived a passing success from the patriotic fervour of its sentiments. For the Exhibition of 1878 he wrote a hymn, *Vive la France*, which was set to music by Gounod. In 1879 his drama in verse, *La Moabite*, which had been accepted by the Théâtre Français, was forbidden by the censor on religious grounds. In 1882 M. Déroulède founded the *Ligue des Patriotes*, with the object of furthering France's "revanche" against Germany. He was one of the first advocates of a Franco-Russian alliance, and as early as 1883 undertook a journey to Russia for the furtherance of that object. On the rise of General Boulanger, M. Déroulède attempted to use the *Ligue des Patriotes*, hitherto a non-political organization, to assist his cause, but was deserted by a great part of the League and forced to resign his presidency. Nevertheless he used the section of the League that remained faithful to him with such effect that the Government found it necessary in 1889 to decree its suppression. In the same year he was elected to the Chamber as member for Angoulême. He did not stand at the elections of 1893, but was re-elected in 1898, and distinguished himself by his violence as a Nationalist and anti-Dreyfusard. After the funeral of President Faure, on 23rd February 1899, he endeavoured to persuade General Roget to lead his troops upon the Elysée. For this he was arrested, but on being tried for treason was acquitted (31st May). On 12th August he was again arrested and accused, together with André Buffet, Jules Guérin, and others, of conspiracy against the Republic. After a long trial before the High Court, he was sentenced, on 4th January 1900, to ten years' banishment from France, and retired to San Sebastian. In 1901 he was again brought prominently before the public by a quarrel with his Royalist allies, which resulted in an abortive attempt to arrange a duel with M. Buffet in Switzerland. Besides the works already mentioned, he has published *Le Sergent*, in the "Théâtre de campagne" (1880); *De l'éducation nationale* (1882); *Monsieur le Uhlan et les trois couleurs* (1884); *Le premier grenadier de France, La Tour d'Auvergne* (1886); *Refrains militaires* (1889); *Histoire d'amour* (1890); a pamphlet entitled *Désarmement?* (1891); *Poésies militaires* and *Messire du Guesclin, Drame en vers* (1896); *La Mort de Hoche. Cinq actes en prose* (1897); *La plus belle fille du monde, conte dialogué en vers libres* (1898).

**Des Moines,** capital and largest city of Iowa, U.S.A., and capital of Polk county, in 41° 36′ N. lat. and 93° 38′ W. long., on Des Moines river, at an altitude of 800 feet. It has a regular street plan, is supplied with water from the Raccoon river, a branch of the Des Moines, by the Holly pumping system, its streets are partly paved with brick, and it is divided into seven wards. Among the fine buildings are the new State Capitol, erected at a cost of $3,000,000, the United States Post Office, the City Hall, and the Grand Opera House. There are two public libraries, the larger of which, the State Library, contains 46,000 volumes. There are two institutions for higher education, Drake University and Des Moines College. The former under the Christian denomination had, in 1899, 54 instructors and 722 students; the latter, 10 instructors and 157 students. Des Moines is an important railway centre. It is the meeting-point of five great systems, the Chicago, Burlington, and Quincy, the Chicago and North-Western, the Chicago Great Western, the Chicago, Rock Island, and Pacific, and the Wabash, which give it a large commerce. In 1900 there were 494 manufacturing establishments, with a capital of $7,911,764, with 4557 hands, and a product valued at $10,488,189. The assessed valuation of property, real and personal, was, in 1900, $13,871,430; the net debt (exclusive of school debt) was $727,777, and the tax rate (exclusive of school tax) $42.40 per $1000. The basis of assessment is very low (about one-fourth of full value). Population (1890), 50,093; (1900), 62,139, of whom 7946 were foreign-born and 1675 negroes.

**Desoto,** a city of Jefferson county, Missouri, U.S.A.,

on the St. Louis, Iron Mountain, and Southern Railway. Population (1890), 3960; (1900), 5611, of whom 332 were foreign-born and 364 negroes.

**Dessau,** a town of Germany, capital of duchy of Anhalt, 2 miles south of the Elbe and 38 miles by rail south-east from Magdeburg. A new town hall was built in 1899–1900. Other new buildings are St Paul's church (1890–92), a Roman Catholic church, the "magistrates' house" (1872–1874), containing a library and drawings by Dürer, Holbein, Cranach, and State law courts; there are monuments to Moses Mendelssohn (1890), the Emperor William I. (1892), W. Müller (1891), who was a native of Dessau, and a war monument (1874). There are a small ducal library, a geological collection, the Leopold home for impoverished men (1750), and a picture gallery in the Amelia Institute. The various industries produce sugar, cloth, machinery, woollen yarn, carpets, blinds; iron-founding and gardening are also carried on; an important corn market. Population (1885), 27,766; (1895), 42,375; (1900), 50,677.

**Desterro.** See Florianopolis.

**Destructors.**—The name destructors is applied by English municipal engineers to furnaces, or combinations of furnaces, constructed for the purpose of disposing by burning of town refuse, which is a heterogeneous mass of material, including, besides general household and ash-bin refuse, small quantities of garden refuse, trade refuse, market refuse, and often street sweepings. The mere disposal of this material is not, however, by any means the only consideration in dealing with it upon the destructor system. For many years past scientific experts, municipal engineers, and public authorities have been directing careful attention to the utilization of refuse as fuel for steam production, and such progress in this direction has been made of late that in many towns its calorific value is now being utilized daily in operating machinery. On the other hand, that proper degree of caution which is obtained only by actual experience must be exercised in the application of refuse fuel to steam-raising purposes. When its value as a low-class fuel was first recognized, the idea was disseminated that the refuse of a given population was of itself sufficient to develop the necessary steam-power for supplying that population with the electric light. The economical importance of a combined destructor and electric undertaking of this character naturally presented a somewhat fascinating stimulus to public authorities, and possibly has had much to do with the recent development both of the adoption of the principle of dealing with refuse by fire, and also of lighting towns by electricity. However true this phase of the question may be as the statement of a theoretical scientific fact, experience so far does not show it to be a basis upon which engineers may venture to calculate, although, as will be seen later, under certain circumstances of equalized load, which must be considered upon their merits in each case, a well-designed destructor plant can be made to perform valuable commercial service to an electric or other power-using undertaking. Further, when a system, thermal or otherwise, for the storage of energy can be introduced and applied in a trustworthy and economical manner, the degree of advantage to be derived from the utilization of the waste heat from destructors will be materially enhanced.

***Composition of refuse.***

The composition of house refuse, which must obviously affect its calorific value, varies considerably in different localities, according to the condition, habits, and pursuits of the people. From analyses it is found that average London ash-bin refuse contains the constituents in the average proportions given in the following table. In the northern towns, where the privy and ash-pit system is in use, excrementitious matter also occurs in the refuse.

| Average London Ash-bin Refuse. | | Manchester Refuse. | |
|---|---|---|---|
| Constituents. | Percentages by Weight. | Constituents. | Percentages by Weight. |
| Breeze (cinder and ashes) | 63·69 | Ashes and excreta in pails | 64·50 |
| Fine dust | 19·51 | Dust and cinders | 34·55 |
| Vegetable, animal, and various mineral matters | 4·61 | Fish and bones | ·15 |
| Waste paper | 4·28 | Animal refuse, as dogs, cats, hens, rabbits, &c. | ·05 |
| Straw, fibrous material, and rags | 3·61 | Boots, hats, rags, paper, &c. | ·05 |
| Bottles, crockery, and broken glass | 1·98 | Vegetable refuse | ·05 |
| Coal and coke | ·84 | Glass, pottery, bricks, &c. | ·60 |
| Tins and iron | 1·00 | Old iron and tin ware | ·05 |
| Bones | ·48 | | |
| Total | 100·00 | Total | 100·00 |

In London the quantity of house refuse amounts approximately to $1\frac{1}{4}$ million tons per annum, which is equivalent to from 4 cwt. to 5 cwt. per head per annum, or to from 200 to 250 tons per 1000 of the population per annum. Statistics, however, vary widely in different districts. In the vicinity of the metropolis the amount varies from 2·5 cwt. per head per annum at Leyton to 3·5 cwt. at Hornsey, and to as much as 7 cwt. at Ealing. In the north of England the total house refuse collected, exclusive of street sweepings, amounts on the average to 8 cwt. per head per annum. Speaking generally, throughout the country an amount of from 5 cwt. to 10 cwt. per head per annum should be allowed for. A cubic yard of ordinary house refuse weighs from $12\frac{1}{4}$ to 15 cwt. Shop refuse is lighter, frequently containing a large proportion of paper, straw, and other light wastes. It sometimes weighs as little as $7\frac{1}{4}$ cwt. per cubic yard. A load, by which refuse is often estimated, varies in weight from 15 cwt. to $1\frac{1}{2}$ tons.

***Disposal.***

The question how a town's refuse shall be disposed of must be considered both from a commercial and a sanitary point of view. Various methods have been practised. Sometimes the household ashes, &c., are mixed with pail excreta, or with sludge from a sewage farm, or with lime, and disposed of for agricultural purposes, and sometimes they are conveyed in carts or by canal to outlying and country districts, where they are shot on waste ground or used to fill up hollows and raise the level of marsh land. Such plans are economical when suitable outlets are available. To take the refuse out to sea in hopper barges and sink it in deep water, as is done, for example, at Liverpool and New York, is usually expensive and frequently unsatisfactory. At Bermondsey, for instance, the cost of barging is about 2s. 9d. a ton, while the material may be destroyed by fire at a cost of from 10d. to 1s. a ton, exclusive of interest and sinking fund on the cost of the works. In other cases, as at Chelsea and various dust contractors' yards, the refuse is sorted and its ingredients are sold; the fine dust may be utilized in connexion with manure manufactories, the pots and pans employed in forming the foundations of roads, and the cinders and vegetable refuse burnt to generate steam. In the Arnold system, carried out in Philadelphia and other American towns, the refuse is sterilized by steam under pressure, the grease and fertilizing substances being extracted at the same time; while in other systems, such as those of Weil and Porno, and of Defosse, distillation in closed vessels is practised. But the destructor system, in which the refuse is burned to an innocuous clinker in specially constructed furnaces, is that which must finally be resorted to, especially in districts which have become well built up and thickly populated. Various types of furnaces and apparatus have from time to time been designed, and the subject has been one of much experiment and many failures.

***Destructors.***

The principal towns in England which took the lead in the adoption of the refuse destructor system were Manchester, Birmingham, Leeds, Heckmondwike, Warrington, Blackburn, Bradford, Bury, Bolton, Hull, Nottingham, Salford, Ealing, and London. Ordinary furnaces, built mostly by dust contractors, were in use in London and in the north of England some forty years ago, but they were not scientifically adapted to the purpose, and necessitated the admixture of coal or other fuel with the refuse to ensure its cremation. The Manchester Corporation erected a furnace of this description about the year 1873, and Messrs Mead and Co. made an unsatisfactory attempt in 1870 to burn house refuse in closed furnaces at Paddington. In 1876 Mr Fryer erected his destructor at Manchester, and several other towns adopted this furnace shortly afterwards. Other furnaces were from time to time brought before the public, among which may be mentioned those of Pearce and Lupton, Pickard,

Healey, Thwaite, Young, Wilkinson, Burton, Hardie, Jacobs and Odgen. In addition to these the "Beehive" and the "Nelson" destructors became well known. The former was introduced by Stafford and Pearson of Burnley, and one was erected in 1884 in the parish yard at Richmond, Surrey, but the results being unsatisfactory, it was closed during the following year. The "Nelson" furnace, patented in 1885 by Messrs Richmond and Birtwistle, was erected at Nelson-in-Marsden, Lancashire, but being very costly in working, was abandoned. The principal types of destructors now in use are those of Fryer, Whiley, Horsfall, Warner, Meldrum, and Beaman and Deas.

***Fryer's.***

The general arrangement of the destructor patented[1] by Mr Alfred Fryer in 1876 is illustrated in Fig. 1. An installation upon this principle consists of a number of furnaces or cells, usually arranged in pairs back to back, and enclosed in a rectangular block of brickwork having a flat top, upon which the house refuse is tipped from the carts. Each cell measures internally

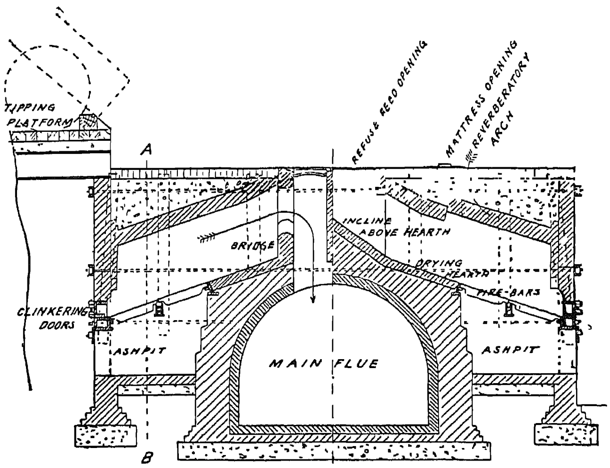


Fig. 1.—Fryer's Destructor.

about 9 feet by 5 feet, and is covered by a firebrick arch 3 feet 6 inches high above the grates. The furnaces have cast-iron furnace mouths, with doors 5 feet wide hinged at the top to open outwards with balance weights. The furnace bottom has an inclination of 1 in 3, from front to back, the rearmost portion, for a width of 4 feet, forming a firebrick hearth or dead plate, and the lower part, having a width of 5 feet, consisting of fire-bars. A wall at the back end of the cells divides each furnace into halves. On one side is a passage forming an opening into the main flue for the escape of the products of combustion, whilst on the other the upper end of the slope is carried up with a steeper inclination to a "feeding hole" for the admission of refuse from the platform above. A large main flue, which also forms the dust chamber, is placed underneath the furnace hearths. The Fryer furnace ordinarily burns from 4 to 6 tons of refuse per cell per 24 hours. It will be observed that the outlets for the products of combustion are placed at the back near the refuse feed opening, an arrangement which is imperfect in design, inasmuch as while a charge of refuse is burning upon the furnace bars the charge which is to follow lies on the dead hearth near the outlet flue. Here it undergoes drying and partial decomposition, giving off offensive empyreumatic vapours which pass into the flue without being exposed to sufficient heat to render them entirely inoffensive. The serious nuisances thus produced in some instances led to the introduction of a second furnace, or "cremator," patented by Mr C. Jones of Ealing in 1885, which was placed in the main flue leading to the chimney-shaft, for the purpose of resolving the organic matters present in the vapour, but the greatly increased cost of burning due to this device led to its abandonment in many cases. This type of cell was largely used during the early period of the history of destructors, but of recent years has to a considerable extent given place to furnaces of more modern design.

***Whiley's.***

A furnace patented[2] in 1891, by Mr Henry Whiley, superintendent of the scavenging department of the Manchester Corporation, is automatic in its action and has been designed primarily with a view to saving labour—the cells being fed, stoked, and clinkered automatically. There is no drying hearth, and the refuse carts tip direct into a shoot or hopper at the back which conducts the material directly on to movable eccentric grate bars. These automatically traverse the material forward into the furnace, and finally push it against a flap-door which opens and allows it to fall out. This apparatus is adapted for dealing with screened rather than unscreened refuse, since it suffers from the objection that the motion of the bars tends to allow fine particles to drop through unburnt. Some difficulty has been experienced from the refuse sticking in the hopper, and exception may also be taken to the continual flapping of the door when the clinker passes out, as cold air is thereby admitted into the furnace. As in the Fryer cell, the outlet for the products of combustion into the main flue is close to the point where the crude refuse is fed into the furnace, and the escape of unburnt vapours is thus facilitated. Forced draught is applied by means of a Root's blower. The Manchester Corporation has 28 cells of this type in use, and the approximate amount of refuse burnt per cell per 24 hours is from 6 to 8 tons at a cost per ton for labour of 3·47 pence.

***Horsfall's.***

Horsfall's destructor[3] (Fig. 2) is a high-temperature furnace of modern type which has been adopted largely in Great Britain and on the continent of Europe. In it some of the general features of the Fryer cell are retained, but the details differ considerably from those of the furnaces already described. Important points in the design are the arrangement

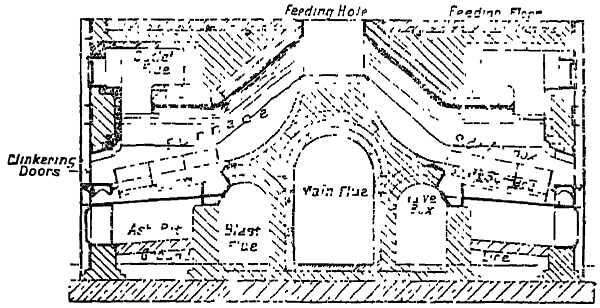


Fig. 2 Horsfall's Improved Destructor.

of the flues and flue outlets for the products of combustion, and the introduction of a blast duct through which air is forced into a closed ash-pit. The feeding-hole is situated at the back of and above the furnace, while the flue opening for the emission of the gaseous products is placed at the front of the furnace over the dead plate; thus the gases distilled from the raw refuse are caused to pass on their way to the main flue over the hottest part of the furnace and through the flue opening in the red-hot reverberatory arch. The steam jet, which plays an important part in the Horsfall furnace, forces air into the closed ash-pit at a pressure of about $\frac{3}{4}$ to 1 inch of water, and in this way a temperature varying from 1500° to 1900° F., as tested by a thermo-electric pyrometer, is maintained in the main flue. In a battery of cells the gases from each are delivered into one main flue, so that a uniform temperature is maintained therein sufficiently high to prevent noxious vapours from reaching the chimney. The cells being charged and clinkered in rotation, when the fire in one is green, in the others it is at its hottest, and the products of combustion do not reach the boiler surfaces until after they have been mixed in the main flue. The cast-iron boxes which are provided at the sides of the furnaces, and through which the blast air is conveyed on its way to the grate, prevent the adhesion of clinker to the side walls of the cells, and very materially preserve the brickwork, which otherwise becomes damaged by the tools used to remove the clinker. The wide clinkering doors are suspended by counterbalance weights and open vertically. The rate of working of these cells varies from 8 tons per cell per 24 hours at Oldham to 10 tons per cell at Bradford, where the furnaces are of the latest type. The cost of labour in stoking and clinkering is about 6d. per ton of the refuse treated at Bradford, and 9d. per ton at Oldham, where the rate of wages is higher. Well-constructed and properly-worked plants of this type should give rise to no nuisance, and may be located in populous neighbourhoods without danger to the public health or comfort.

***Warner's.***

Warner's destructor,[4] known as the "Perfectus," is, in general arrangement, similar to Fryer's, but differs in being provided with special charging hoppers, dampers in flues, dust-catching arrangements, rocking grate bars and other improvements. The refuse is tipped into feeding-hoppers, consisting of rectangular cast-iron boxes over which plates are placed to prevent the escape of smoke and fumes. At the lower portion of the feeding-hopper is a flap-door working on an axis and controlled by an iron lever from the tipping platform. When refuse is to be fed into the furnace the lever is thrown over, the contents of the hopper drop on to the sloping firebrick hearth beneath, and the door is at once closed again. The door should

[1] Patent No. 3125 (1876).
[2] Patent No. 8271 (1891).
[3] Patent No. 8999 (1887); No. 14,709 (1888); No. 22,531 (1891).
[4] Patent No. 18,719 (1888).

be kept open as short a time as possible in order to prevent the admission of cold air into the furnace at the back end, since this leads to the lowering of the temperature of the cells and main flue, and also to paper and other light refuse being carried into the flues and chimney. The flues of each furnace are provided with dampers, which are closed during the process of clinkering in order to keep up the heat. The cells are each 5 feet wide and 11 feet deep, the rearmost portion consisting of a firebrick drying hearth, and the front of rocking grate bars upon which the combustion takes place. The crown of each cell is formed of a reverberatory firebrick arch having openings for the emission of the products of combustion. The flap dampers which are fitted to these openings are operated by horizontal spindles passing through the brickwork to the front of the cell, where they are provided with levers or handles; thus each cell can be worked independently of the others. With the view of increasing the steam-raising capabilities of the furnace, forced draught is sometimes applied and a tubular boiler is placed close to the cells. The amount of refuse consumed varies from 5 tons to 8 tons per cell per 24 hours. At Hornsey, where 12 cells of this type are in use, the cost of labour for burning the refuse is 9½d. per ton.

**Meldrum's.**

The Meldrum "Simplex" destructor (Fig. 3), a modern type of furnace which yields good steam-raising results, is in successful operation at Rochdale, Hereford, and Darwen, at each of which towns the production of steam is an important consideration. Cells have also been laid down at Burton, Hunstanton, Blackburn, and Shipley. In general arrangement the destructor differs considerably from those previously described. The grates are placed side by side without separation except by dead plates, but, in order to localize the forced draught, the ash-pit is divided into parts corresponding with the different grate areas. Each ash-pit is closed air-tight by a cast-iron plate, and is provided with an air-tight door for removing the fine ash. Two patent Meldrum steam-jet blowers are provided for each furnace, supplying any required pressure of blast up to 6 inches' water column, though that usually employed does not exceed 1½ inches. The furnaces are designed for hand-feeding from the front, but hopper-feeding can be applied if desirable. The products of combustion either pass away from the back of each fire-grate into a common flue leading to boilers and the chimney-shaft, or are conveyed sideways over the various grates and a common fire-bridge to the boilers or chimney. The heat in the gases, after passing the boilers, is still further utilized to heat the air supplied to the furnaces, the gases being passed through an air heater or continuous regenerator consisting of a number of cast-iron pipes from which the air is delivered through the Meldrum "blowers" at a temperature of about 300° F. That a high percentage (15 to 18 per cent.) of $CO_2$ is obtained in the furnaces proves a small excess of free oxygen, and no doubt explains the high fuel efficiency obtained by this type of destructor. High-pressure boilers of ample capacity are provided for the accumulation during periods of light load of a reserve of steam, the storage being obtained by utilizing the difference between the highest and

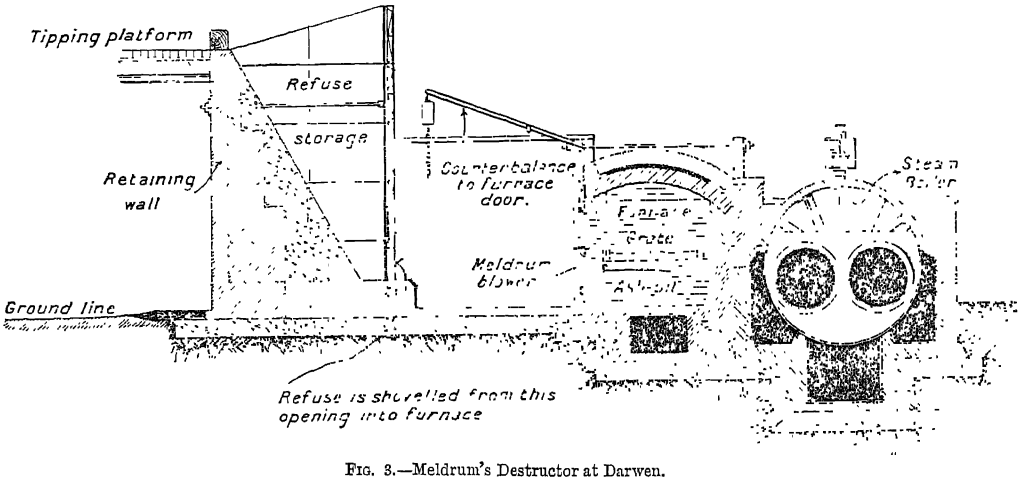


Fig. 3.—Meldrum's Destructor at Darwen.

lowest water-levels and the difference between the maximum and working steam-pressure. Patent locking fire-bars, to prevent lifting when clinkering, are used in the furnace and have a good life. At Rochdale the Meldrum furnaces consume from 53 to 66 lbs. of refuse per square foot of grate area per hour, as compared with 22·4 ℔ per square foot in a low-temperature destructor burning 6 tons per cell per 24 hours with a grate area of 25 square feet. The evaporative efficiency of the Rochdale furnaces varies from 1·39 ℔ to 1·87 ℔ of water (actual) per 1 ℔ of refuse burned, and an average steam-pressure of about 114 ℔ per square inch is maintained. The cost of labour and supervision amounts to 10d. per ton of refuse dealt with. A Lancashire boiler (22 feet by 6 feet 6 inches) at the Sewage Outfall Works, Hereford, evaporates with refuse fuel 2980 ℔ of water per hour, equal to 149 indicated horse-power. About 54 ℔ of refuse are burnt per square foot of grate area per hour with an evaporation of 1·82 ℔ of water per pound of refuse. At Darwen a Meldrum furnace of 104·5 square feet grate area runs the present electric plant consisting of two 150 kilowatt steam dynamos (225 horse-power each), one only being in use at a time. As the dynamos run only 9½ hours per day, while the refuse is burned throughout the 24 hours, there is a large surplus of heat running to waste. This it is proposed to employ for electric tramways and then the available power will be utilized to its full extent.

**Beaman and Deas.**

The Beaman and Deas destructor[1] (Fig. 4) has attracted much attention from public authorities, and successful installations are in operation at Warrington, Dewsbury, Leyton, Canterbury, Llandudno, Colne, Streatham, Rotherhithe, and Wimbledon. Its essential features include a level fire-grate with ordinary type bars, a high-temperature combustion chamber at the back of the cells, a closed ash-pit with forced draught, provision for the admission of a secondary air-supply at the fire-bridge, and a firebrick hearth sloping at an angle of about 52°. From the refuse storage platform the material is fed into a hopper mouth about 18 inches square, and slides down the firebrick hearth, supported by T-irons, to the grate bars, over which it is raked and spread with

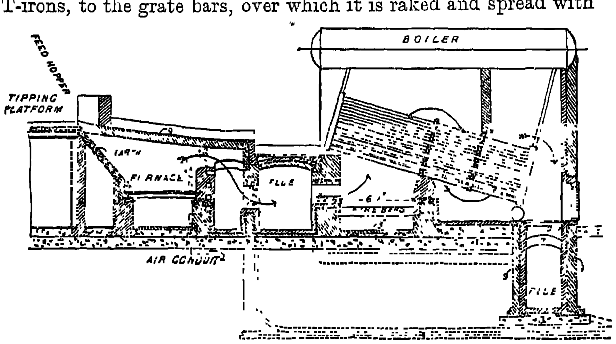


Fig. 4.—Beaman and Deas Destructor at Leyton.

the assistance of long rods manipulated through clinkering doors placed at the sides of the cells. A secondary door in the rear of the cell facilitates the operation. The fire-bars, spaced only $\frac{3}{32}$ inch apart, are of the ordinary stationary type. Vertically, under the fire-bridge, is an air-conduit, from the top of which lead air blast pipes 12 inches in diameter discharging into a hermetically closed ash-pit under the grate area. The air is supplied from fans (Schiele's patent) at a pressure of from 1½ to 2 inches of water, and is controlled by means of baffle valves worked by handles on either side of the furnace, conveniently placed for the attendant. The forced draught tends to keep the bars cool and lessen wear and tear. The fumes from the charge

[1] Patents No. 15,598 (1893) and 23,712 (1893); also Beaman and Deas Sludge Furnace, patent No. 13,029 (1894).

drying on the hearth pass through the fire and over the red-hot fire-bridge, which is perforated longitudinally with air-passages connected with a small flue leading from a grated opening on the face of the brickwork outside; in this way an auxiliary supply of heated oxygen is fed into the combustion chamber. This chamber, in which a temperature approaching 2000° F. is attained, is fitted with large iron doors, sliding with balance weights, which allow the introduction of infected articles, bad meat, etc., and also give access for the periodical removal of fine ash from the flues. The high temperatures attained are utilized by installing one boiler, preferably of the Babcock and Wilcox water-tube type, for each pair of cells, so that the gases, on their way from the combustion chamber to the main flue, pass three times between the boiler tubes. A secondary furnace is provided under the boiler for raising steam by coal, if required, when the cells are out of use. The grate area of each cell is 25 square feet, and the consumption varies from 16 up to 20 tons of refuse per cell per 24 hours. In a 24-hours' test made by the superintendent of the cleansing department, Leeds, at the Warrington installation, the quantity of water evaporated per pound of refuse was 1·14 ℔, the average temperature in the combustion chamber 2000° F. by copper-wire test, and the average air pressure with forced draught, 2½ inches (water gauge). At Leyton, which has a population of over 100,000, an eight-cell plant of this type is successfully dealing with house refuse and filter press cakes of sewage sludge from the Sewage Disposal Works adjoining, and even with material of this low calorific value the total steam-power produced is considerable. Each cell burns about 16 tons of the mixture in 24 hours and develops about 35 indicated horse-power continuously, at an average steam-pressure in the boilers of 105 ℔. The cost of labour at Leyton for burning the mixed refuse is about 1s. 7d. per ton; at Llandudno, where four cells were laid down in connexion with the electric-light station in 1898, it is 1s. 3¼d., and at Warrington, 9½d. per ton of refuse consumed. Combustion is complete, and the destructor may be safely installed in populous districts without nuisance to the inhabitants. Further patents (Wilkie's improvements) have been obtained by Meldrum Brothers (Manchester) in connexion with this destructor.

In addition to the above-described destructors, other modern

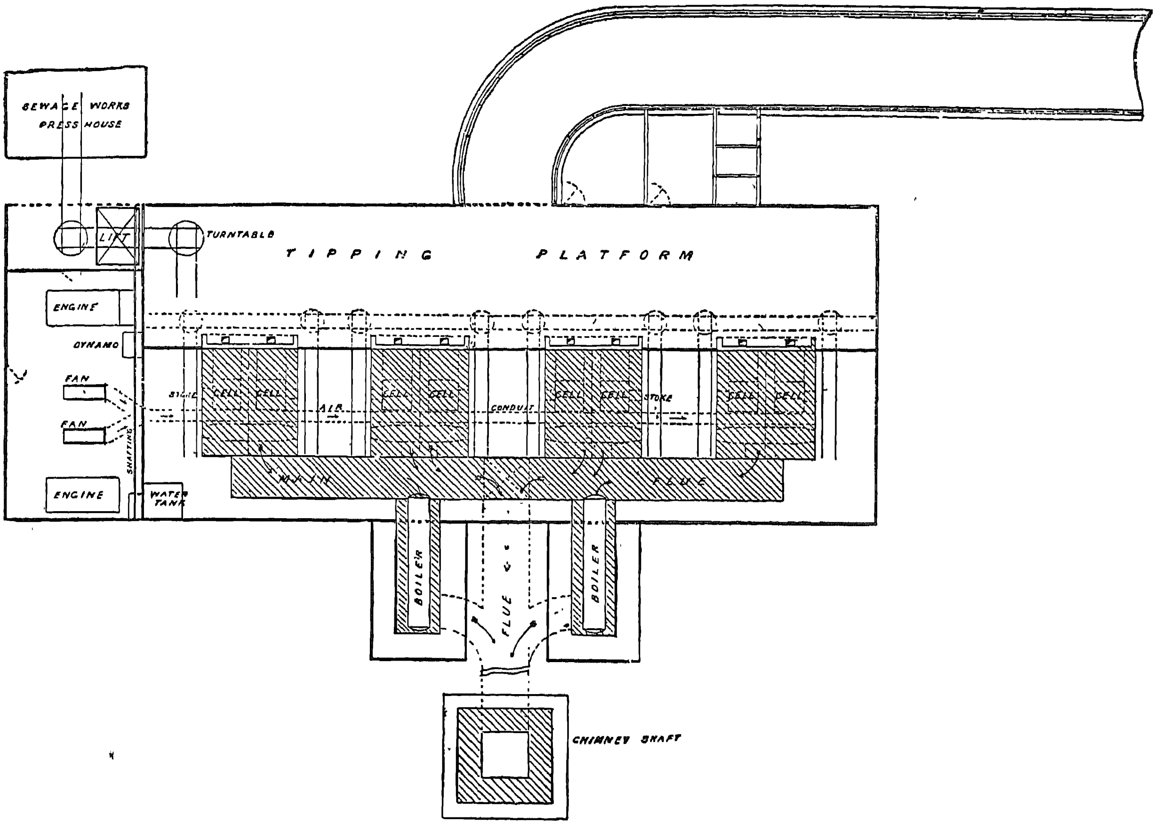


Fig. 5.—Leyton Destructor—Block Plan, showing general arrangement of the works

forms have been introduced from time to time, but adopted to a less degree; amongst these may be mentioned Hanson's Utilizer, Mason's Gasifier, the "Bennett-Phythian," Cracknell's (Melbourne, Victoria), Coltman's (Loughborough), Willoughby's, and Healey's improved destructors. On the continent of Europe, systems for the treatment of refuse have also been devised. Among these may be mentioned those of M. Defosse and M. Helouis. The former has endeavoured to burn the refuse in large quantities by using a forced draught and only washing the smoke.[1] Helouis has extended the operation by using the heat from the combustion of the refuse for drying and distilling the material which is brought gradually on to the grate.

**Destructor accessories.**

Boulnois and Brodie's improved charging tank is a labour-saving apparatus consisting of a wrought-iron truck, 5 ft. wide by 3 ft. deep, and of sufficient length to hold not less than 12 hours' supply for the two cells which it serves. The truck, which moves along a pair of rails laid across the top of the destructor, may be worked by one man. It is divided into compartments holding a charge of refuse in each, and is provided with a pair of doors in the bottom, opening downwards, which are supported by a series of small wheels running on a central rail. A special feeding opening in the reverberatory arch of the cell of the width of the truck, situated over the drying hearth, is formed by a firebrick arch fitted into a frame capable of being moved backwards and forwards by means of a lever. The charging truck, when empty, is brought under the tipping platform, and the carts tip directly into it. When one of the cells has to be fed, the truck is moved along, so that one of the divisions is immediately over the feeding opening, and the wheel holding up the bottom doors rests upon the central rail, which is continued over the movable covering arch. Then the movable arch is rolled back, the doors are released, and the contents are discharged into the cell, so that no handling of the refuse is required from tipping to feeding. This apparatus is in operation at Liverpool, Shoreditch, Cambridge, and elsewhere.

Various forms of patent movable fire-bars have been employed in destructor furnaces. Among these may be mentioned Settle's,[2] Vicar's,[3] Riddle's rocking bars,[4] Horsfall's self-feeding apparatus,[5] and Healey's movable bars;[6] but complicated movable arrangements are not to be recommended, and experience greatly favours the use of a simple stationary type of fire-bar.

[1] *Compte Rendu des Travaux de la Société des Ingénieurs Civils de France*, folio 775 (June 1897).

[2] Patent No. 15,482 (1885).

[3] Patents No. 1955 (1867) and No. 378 (1879).

[4] Patent No. 4896 (1891).

[5] Patent No. 20,207 (1892).

[6] Patents No. 18,398 (1892) and No. 12,990 (1892).

A dust-catching apparatus has been designed and erected at Edinburgh, by the Horsfall Furnace Syndicate, in order to overcome difficulties in regard to the escape of flue dust, &c., from the destructor chimney. Externally, it appears a large circular block of brickwork, 18 ft. in diameter and 13 ft. 7 in. high, connected with the main flue, and situated between the destructor cells and the boiler. Internally it consists of a spiral flue traversing the entire circumference and winding upwards to the top of the chamber. There is an interior well or chamber 6 ft. diameter by 12 ft. high, having a domed top, and communicating with the outer spiral flue by four ports at the top of the chamber. Dust traps, baffle walls, and cleaning doors are also provided for the retention and subsequent weekly removal of the flue dust. The apparatus forms a large reservoir of heat maintained at a steady temperature of from 1500° to 1800° F., and is useful in keeping up steam in the boiler at an equable pressure for a long period. It requires no attention, and has proved successful for its purpose.

Travelling cranes for transporting refuse and feeding cells are sometimes employed at destructor stations, as, for example, at Hamburg. Here the transportation of the refuse is effected by means of specially constructed water-tight iron waggons, containing detachable boxes provided with two double-flap doors at the top for loading, and one flap-door at the back for unloading. There are thirty-six furnaces of the Horsfall type placed in two ranks, each arranged in three blocks of six in the large furnace hall. An electric crane running above each rank lifts the boxes off the waggons and carries them to the feeding-hole of each cell. Here the box is tipped up by an electric pulley and emptied on to the furnace platform. Where the travelling crane is used, the carts (four-wheeled) bringing the refuse may be constructed so that the body of the carriage can be taken off the wheels, lifted up and tipped direct over the furnace as required, and returned again to its frame. The adoption of the travelling crane admits of the reduction in size of the main building, as less platform space for unloading refuse carts is required; the inclined roadway may also be dispensed with. Where a destructor site will not admit of an inclined roadway and platform, the refuse may be discharged from the collecting carts into a lift, and thence elevated into the feeding-bins.

*Working of destructors.*

The general arrangement of a battery of refuse cells at a destructor station is illustrated by Fig. 5. The cells are arranged either side by side, with a common main flue in the rear, or back to back with the main flue placed in the centre and leading to a tall chimney-shaft. The heated gases on leaving the cells pass through the combustion chamber into the main flue, and thence go forward to the boilers, where their heat is absorbed and utilized. Forced draught is supplied from fans through a conduit commanding the whole of the cells. An inclined roadway of as easy gradient as circumstances will admit, is provided for the conveyance of the refuse to the tipping platform, from which it is fed through feed-holes into the furnaces. In the installation of a destructor, the choice of suitable plant and the general design of the works must be largely dependent upon local requirements, and should be entrusted to an engineer experienced in these matters. The following primary considerations, however, may be enumerated as materially affecting the design of such works:—

(*a*) The plant must be simple, easily worked without stoppages, and without mechanical complications upon which stokers may lay the blame for bad results. (*b*) It must be strong, must withstand variations of temperature, must not be liable to get out of order, and should admit of being readily repaired. (*c*) It must be such as can be easily understood by stokers or firemen of average intelligence, so that the continuous working of the plant may not be disorganized by change of workmen. (*d*) A sufficiently high temperature must be attained in the cells to reduce the refuse to an entirely innocuous clinker, and all fumes or gases should pass either through an adjoining red-hot cell or through a chamber whose temperature is maintained by the ordinary working of the destructor itself at a degree sufficient to exclude the possibility of the escape of any unconsumed gases, vapours, or particles. The temperature may vary between 1500° and 2000°. (*e*) The plant must be so worked that while some of the cells are being recharged, others are at a glowing red heat, in order that a high temperature may be uniformly maintained. (*f*) The design of the furnaces must admit of clinkering and recharging being easily and quickly performed, the furnace doors being open for a minimum of time so as to obviate the inrush of cold air to lower the temperature in main flues, &c. (*g*) The chimney draught must be assisted with forced draught from fans or steam jet to a pressure of $1\frac{1}{2}$ inches to 2 inches under grates by water-gauge. (*h*) Where a destructor is required to work without risk of nuisance to the neighbouring inhabitants, its efficiency as a refuse destructor plant must be primarily kept in view in designing the works, steam-raising being regarded as a secondary consideration. Boilers should not be placed immediately over a furnace so as to present a large cooling surface, whereby the temperature of the gases is reduced before the organic matter has been thoroughly burned. (*i*) Where steam-power and a high fuel efficiency are desired a large percentage of $CO_2$ should be sought in the furnaces with as little excess of air as possible, and the flue gases should be utilized in heating the air-supply to the grates, and the feed-water to the boilers. (*j*) Ample boiler capacity and hot-water storage feed-tanks should be included in the design where steam-power is required.

*Cost.*

As to the initial cost of the erection of refuse destructors, few trustworthy data can be given. The outlay necessarily depends, amongst other things, upon the difficulty of preparing the site, upon the nature of the foundations required, the height of the chimney-shaft, the length of the inclined or approach roadway, and the varying prices of labour and materials in different localities. As an example may be mentioned the case of Bristol, where, in 1892, the total cost of constructing a 16-cell Fryer destructor was £11,418, of which £2909 was expended on foundations, and £1689 on the chimney-shaft; the cost of the destructor proper, buildings, and approach road was therefore £6820, or about £426 per cell. The cost per ton of burning refuse in destructors depends mainly upon—(*a*) The price of labour in the locality, and the number of "shifts" or changes of workmen per day; (*b*) the type of furnace adopted; (*c*) the nature of the material to be consumed; (*d*) the interest on and repayment of capital outlay. The cost of burning, ton for ton consumed, in high-temperature furnaces, including labour and repairs, is not greater than in slow-combustion destructors. The average cost of burning refuse at twenty-four different towns throughout England, exclusive of interest on the cost of the works, is 1s. $1\frac{1}{2}$d. per ton burned; the minimum cost is 6d. per ton at Bradford, and the maximum cost 2s. 10d. per ton at Battersea. At Shoreditch the cost per ton for the year ending 25th March 1899, including labour, supervision, stores, repairs, &c. (but exclusive of interest on cost of works), was 2s. 6·9d. The quantity of refuse burned per cell per day of 24 hours varies from about 4 tons up to 20 tons. The ordinary low-temperature destructor, with 25 square feet grate area, burns about 20 ℔ of refuse per square foot of grate area per hour, or between 5 and 6 tons per cell per 24 hours. The Meldrum destructor furnaces at Rochdale burn as much as 66 ℔ per square foot of grate area per hour, and the Beaman and Deas destructor at Llandudno 71·7 ℔ per square foot per hour. The amount, however, always depends materially on the care observed in stoking, the nature of the material, the frequency of removal of clinker, and on the question whether the whole of the refuse passed into the furnace is thoroughly cremated.

*Residues.*

The amount of residue in the shape of clinker and fine ash varies from 22 to 37 per cent. of the bulk dealt with. From 25 to 30 per cent. is a very usual amount. At Shoreditch, where the refuse consists of about 8 per cent. of straw, paper, shavings, &c., the residue contains about 29 per cent. clinker, 2·7 per cent. fine ash, ·5 per cent. flue dust, and ·6 per cent. old tins, making a total residue of 32·8 per cent. As the residuum amounts to from $\frac{1}{4}$th to $\frac{1}{3}$rd of the total bulk of the refuse dealt with, it is a question of the utmost importance that some profitable, or at least inexpensive, means should be devised for its regular disposal. Among other purposes, it has been used for bottoming for macadamized roads, for the manufacture of concrete, for making paving slabs, for forming suburban footpaths or cinder footwalks, and for the manufacture of mortar. The last is a very general, and in many places profitable, mode of disposal.

Through defects in the design and management of many of the early destructors complaints of nuisance frequently arose, and these have, to some extent, brought destructor installations into disrepute. Although some of the older furnaces were decided offenders in this respect, that is by no means the case with the modern improved type of high-temperature furnace; and often, were it not for the great prominence in the landscape of a tall chimney-shaft, the existence of a refuse destructor in a neighbourhood would not be generally known to the inhabitants. A modern furnace, properly designed and worked, will give rise to no nuisance, and may be safely erected in the midst of a populous neighbourhood. To ensure the perfect cremation of the refuse and of the gases given off, forced draught is essential.

*Forced draught.*

This is supplied either as air draught delivered from a rapidly revolving fan, or as steam blast, as in the Horsfall steam jet or the Meldrum blower. With a forced blast less air is required to obtain complete combustion than by chimney draught. The forced draught grate requires

little more than the quantity theoretically necessary, while with chimney draught more than double the theoretical amount of air must be supplied. With forced draught, too, a much higher temperature is attained, and if it is properly worked, little or no cold air will enter the furnaces during stoking operations. As far as possible a balance of pressure in the cells during clinkering should be maintained just sufficient to prevent an inrush of cold air through the flues. The forced draught pressure should not exceed 2 inches' water-gauge. The efficiency of the combustion in the furnaces is conveniently measured by the "Econometer," which registers continuously and automatically the proportion of $CO_2$ passing away in the waste gases; the higher the percentage of $CO_2$ the more efficient the furnace, provided there is no formation of CO, the presence of which would indicate incomplete combustion. The theoretical maximum of $CO_2$ for refuse burning is about 20 per cent.; and, by maintaining an even clean fire, by admitting secondary air over the fire, and by regulating the dampers or the air-pressure in the ash-pit, an amount approximating to this percentage may be attained in a well-designed furnace if properly worked. If the proportion of free oxygen (*i.e.*, excess of air) is large, more air is passed through the furnace than is required for complete combustion, and the heating of this excess is clearly a waste of heat. The position of the econometer in testing should be as near the furnace as possible, as there may be considerable air leakage through the brickwork of the flues.

***Calorific value.***

The modern high-temperature destructor, to render the refuse and gases perfectly innocuous and harmless, is worked at a temperature varying from 1250° to 2000° F., and the maintenance of such temperatures has very naturally suggested the possibility of utilizing this heat-energy for the production of steam-power. Successful steam-raising destructor stations have been in operation during recent years in England, and experience shows that a considerable amount of energy may be derived therefrom, amply justifying a reasonable increase of expenditure on plant and labour. The actual calorific value of the refuse material necessarily varies, but, as a general average, experience shows that, with suitably-designed and properly-managed plant, an evaporation of 1 ℔ of water per pound of refuse burned is a result which may be readily attained, and affords a basis of calculation which engineers may safely adopt in practice. Many destructor steam-raising plants, however, give considerably higher results, as will be seen from the following table:—

| Town. | Type of Furnaces. | Water evaporated per ℔ of Refuse Actual. | Water evaporated per ℔ of Refuse, from and at 212° Fahr. | Average Steam-pressure per square inch. | Total Indicated Horse-power developed per hour (based on 20 ℔ of steam per I.H.P. per hour). |
|---|---|---|---|---|---|
| Rochdale. | Meldrum Bros. (4 cells) | 1·64 ℔ | 1·97 ℔ | 113 ℔ | 350 |
| Hereford. | Meldrum Bros. (4 cells) | 1·51 ,, | 1·82 ,, | 70·92 ,, | 236 |
| Darwen. | Meldrum Bros. (4 cells) | 1·48 ,, | 1·55 ,, | 183 ,, | 275 |
| Oldham. | Horsfall (10 cells) | 1·11 ,, | 1·33 ,, | 128 ,, | 200 |
| Canterbury | Beaman & Deas (2 cells) | 1·41 ,, | 1·59 ,, | 132 ,, | 236 |

From actual experience it may be accepted, therefore, that the calorific value of unscreened house refuse varies from 1 to 2 ℔ of water evaporated per pound of refuse burned, the exact proportion depending upon the quality and condition of the material dealt with. Taking the evaporative power of coal at 10 ℔ of water per pound of coal, this gives for domestic house refuse a value of from $\frac{1}{10}$ to $\frac{1}{5}$ that of coal; or, with coal at 20s. per ton, refuse has a commercial value of from 2s. to 4s. per ton. In London the quantity of house refuse amounts to about $1\frac{1}{4}$ million tons per annum, which is equivalent to from 4 cwt. to 5 cwt. per head per annum. If it be burned in furnaces giving an evaporation of 1 ℔ of water per pound of refuse, it would yield a total power annually of about 138 million brake horse-power hours, and equivalent cost of coal at 20s. per ton for this amount of power, even when calculated upon the very low estimate of 2 ℔[1] of coal per brake horse-power hour, works out at over £123,000. On the same basis, the refuse of a medium-sized town, with, say, a population of 70,000 yielding refuse at the rate of 5 cwt. per head per annum, would afford 112 indicated horse-power per ton burned, and the total indicated horse-power hours per annum would be

$$\frac{70{,}000 \times 5 \text{ cwt.}}{20} \times 112 = 1{,}960{,}000 \text{ I.H.P. hours annually.}$$

If this were applied to the production of electric energy, the electrical horse-power hours would be (with a dynamo efficiency of 90 per cent.)

$$\frac{1{,}960{,}000 \times 90}{100} = 1{,}764{,}000 \text{ E.H.P. hours per annum;}$$

and the watt-hours per annum at the central station would be

$$1{,}764{,}000 \times 746 = 1{,}315{,}944{,}000.$$

Allowing for a loss of 10 per cent. in distribution, this would give 1,184,349,600 watt-hours available in lamps, or with 8 candle-power lamps taking 30 watts of current per lamp, we should have

$$\frac{1{,}184{,}349{,}600 \text{ watt-hours}}{30 \text{ watts}} = 39{,}478{,}320 \text{ 8-c.p. lamp-hours per annum;}$$

that is, $\frac{39{,}478{,}320}{70{,}000 \text{ population}} = 563$ 8-c.p. lamp-hours per annum per head of population.

Taking the loss due to the storage which would be necessary at 20 per cent. on three-quarters of the total or 15 per cent. upon the whole, there would be 478 8-c.p. lamp-hours per annum per head of the population; *i.e.*, if the power developed from the refuse were fully utilized, it would supply electric light at the rate of one 8-c.p. lamp per head of the population for about $1\frac{1}{3}$ hours for every night of the year.

***Difficulties.***

In actual practice, when the electric energy is for the purposes of lighting only, difficulty has been experienced in fully utilizing the thermal energy from a destructor plant owing to the want of adequate means of storage either of the thermal or of the electric energy. A destructor station usually yields a fairly definite amount of thermal energy uniformly throughout the twenty-four hours, while the consumption of electric-lighting current is extremely irregular, the maximum demand being about four times the mean demand. The period during which the demand exceeds the mean is comparatively short, and does not exceed about six hours out of the twenty-four, while for a portion of the time the demand may not exceed $\frac{1}{20}$th of the maximum. This difficulty, at first regarded as somewhat grave, is now substantially minimized by the provision of ample boiler capacity, or by the introduction of feed thermal storage vessels in which hot feed-water may be stored during the hours of light load (say eighteen out of the twenty-four), so that at the time of maximum load the boilers may be filled directly from these vessels, which work at the same pressure and temperature as the boiler. Further, the difficulty above mentioned will disappear entirely at stations where there is a fair day load which practically ceases at about the hour when the illuminating load comes on, thus equalizing the demand upon both destructor and electric plant throughout the twenty-four hours. This arises in cases where current is consumed during the day for motors, fans, lifts, electric tramways, and other like purposes, and, as the employment of electric energy for these services is rapidly becoming general, no difficulty need be anticipated in the successful working of combined destructor and electric plants where these conditions prevail. The more uniform the electrical demand becomes, the more fully may the power from a destructor station be utilized. In the case above cited of a town of 70,000 population, the horse-power to be derived from the refuse, calculated upon the basis of 2 ℔ of coal per brake horse-power hour, which is the utmost efficiency practicable even for very good steam-engines, will cost £1750 per annum for fuel with coal at 20s. per ton, and, in practice, the actual cost would doubtless be nearly double. At Shoreditch during the year ending March 1899, a total of 1,031,348 Board of Trade units of electric energy was supplied to consumers; of this about seven-tenths were generated from the refuse of the district, and on many occasions a load of 400 kilowatts (*i.e.*, $\frac{400 \text{ kilo.} \times 1000}{746} \times \frac{100}{90} = 596$ horse-power) has been carried by refuse fuel only. Some 200 municipalities in England have laid down destructor plants, but although the great majority are utilizing some of the surplus heat generated by the furnaces, at comparatively few stations is the full thermal energy of the refuse turned to commercial utility owing to the fact that the plants were installed before the value of refuse for steam-raising was properly understood. During recent years, however, new and improved plant has been introduced, and in the laying down of all new installations this phase of the question has been kept most prominently in view.

For further information on the subject, reference should be made to William H. Maxwell, Assoc.M.Inst.C.E., on the *Removal and Disposal of Town Refuse, with an exhaustive treat-*

[1] With medium-sized steam plant, a consumption of 4 ℔ of coal per brake horse-power per hour is a very usual performance.

the centre of the town; whilst at the entrance to the large park on the south is the New Palace (1708–18), enlarged in 1850, used as the dower-house. Detmold possesses a natural history museum, theatre, high school, library, the house in which the poet Freiligrath (1810–76) was born, and that in which the dramatist Grabbe (1801–36), also a native, died. Population (1885), 8916; (1900), 11,971.

**Detroit,** a city of the United States, the county seat of Wayne county, and metropolis of the state of Michigan, is situated on the Detroit river in lat. 42° 20′ N. and long. 83° 3′ W. It is generally level, and has an extent along the river of 7 miles and a depth of 3 miles, except that at the centre of the city it extends towards the north more than 5 miles. Its area is 29½ square miles. The streets are very wide, and are kept scrupulously clean. There are three lines of electric street railways, aggregating 160 miles of track, and ten lines of suburban electric cars, carrying both passengers and freight. Sixteen lines of railways connect the city with all parts of the United States and Canada. Ferries connect the city with Windsor and Walkerville in Canada, directly opposite, and with the island park and the various summer resorts along the river front. The foot of each street reaching to the river is converted into a public wharf. There are 28 parks and parkways, aggregating 912 acres, besides the Grand Boulevard, which is a drive 11 miles long, around the city. The largest park is Belle Isle, an island within the city limits, at its eastern extremity, and connected with the mainland by a bridge over the American channel of the Detroit river.

The population in 1890 was 205,876, and in 1900 it had increased to 285,704, of whom 96,503 were foreign-born and 4111 negroes. Out of 78,855 males 21 years of age and over, 3587 (of whom 3262 were foreign-born) were illiterate (unable to write). The birth-rate per thousand averages 14. The death-rate in 1900 was 17·1; in 1890 it was 18·7. There are 69 public schools (3 of which are high schools) and 59 private and parochial schools, employing 1187 teachers. In 1900 there were 91,777 persons of school age (5 to 20 years inclusive). There is one literary college (Jesuit), three colleges of medicine, one of dentistry, and one of law. The State University at Ann Arbor is within easy reach (37 miles). There are four public libraries, the largest of which contains 157,934 volumes. Branches of this library are established in the public schools. The Museum of Art is supported in part by taxation. The building cost $127,000, and the contents, paintings, and articles of vertu are valued at $150,000. There are 80 newspapers and periodicals published in the city, of which 7 are dailies. There are 30 asylums, hospitals, and charitable homes. There are 183 churches, of which 30 are Roman Catholic, 28 Methodist, 25 Lutheran, 24 Episcopal, 17 Baptist.

The basis of the government is the city charter, granted by the State Legislature. The mayor is elected every two years by popular vote; and the council is composed of two members from each of the 17 wards of the city, one from each being elected every year. The waterworks are owned by the city, and are maintained by water rates and an annual tax of $75,000. The supply is taken from Lake St Clair, immediately above the city. The public lighting is entirely electric, and the plant is owned by the city. Much of the lighting is by arc lights on towers 100 to 150 feet high.

Detroit river is so deep at the foot of the streets that any vessel can approach the wharf. It is never so affected by storms that vessels are in danger, and the most severe rains never perceptibly raise its waters. The main commerce of the Great Lakes passes through it. How much this amounts to it is impossible to ascertain, but certainly twice as much as passes the famous Sault Ste Marie Canal, 25,255,810 tons. The shipments of grain from Detroit for 1899 were as follow:—Wheat 1,567,132 bushels, corn 2,304,105 bushels, oats 266,133 bushels, rye 261,869 bushels, and flour 137,000 barrels. There are 23 banks, with an aggregate capital of $7,850,000, deposits amounting to $67,744,955, and total resources of $91,020,715. The bank clearances for the year 1899 were $415,073,499. The assessed valuation of the city, on a basis estimated at 70 per cent. of full value, is $237,799,250, and the entire tax-levy for general purposes about 2 per cent. The total public debt, exclusive of water bonds, is $3,617,165. There is also a debt of the county, for the new county building, of about $1,500,000. The property belonging to the city is valued at $20,430,985. (C. M. B.)

**Deus, João de** (1830–1896), the greatest Portuguese poet of his generation, and perhaps of the 19th century, was born at San Bartholomeu de Messines in the province of Algarbe on 8th March 1830. Matriculating in the faculty of law at the university of Coimbra, he did not proceed to his degree but settled in the city, dedicating himself wholly to the composition of verses, which circulated among professors and undergraduates in manuscript copies. In the volume of his art, as in the conduct of life, he practised a rigorous self-control. Though it is by no means uncommon for Portuguese poets to publish books of verse before they are of age, and though João de Deus was the idol of an academic circle from a very early date, he printed nothing previous to 1855, and the first of his poems to appear in a separate form was *La Lata*, which was issued in 1860. In 1862 he left Coimbra for Beja, where he was appointed editor of *O Bejense*, the chief newspaper in the province of Alemtejo, and four years later he edited the *Folha do Sul*. As the pungent satirical verses entitled *Eleições* prove, he was not an ardent politician, and, though he was returned as Liberal deputy for the constituency of Silves in 1869, he acted independently of all political parties and promptly resigned his mandate. The renunciation implied in the act, which cut him off from all advancement, is in accord with nearly all that is known of his lofty character. In the year of his election as deputy, his friend, José Antonio Garcia Blanco, collected from local journals the series of poems, *Flores do Campo*, which is supplemented by the *Ramo de Flores* (1869). This is João de Deus's masterpiece. *Pires de Marmalada* (1869) is an improvisation of no great merit. The four theatrical pieces—*Amemos o nosso proximo*, *Ser apresentado*, *Ensaio de Casamento*, and *A Viúva inconsolavel*—are prose translations from Méry, cleverly done but not worth the doing. *Horacio e Lydia* (1872), a translation from Ponsard, is a good example of artifice in manipulating that dangerously monotonous measure, the Portuguese couplet. As an indication of a strong spiritual reaction three prose fragments (1873)—*Anna*, *Mãe de Maria*, *A Virgem Maria* and *A Mulher do Levita de Ephrain*—translated from Darboy's *Femmes de la Bible*, are full of significance. The *Folhas soltas* (1876) is a collection of verse in the manner of *Flores do Campo*, brilliantly effective and exquisitely refined. Within the next few years the writer turned his attention to educational problems, and in his *Cartilha maternal* (1876) first expressed the conclusions to which his study of Pestalozzi and Fröbel had led him. This patriotic, pedagogical apostolate was a misfortune for Portuguese literature; his educational mission absorbed João de Deus completely, and is responsible for numerous controversial letters, for a translation

of Théodore-Henri Barrau's treatise, *Des devoirs des enfants envers leurs parents*, for a prosodic dictionary, and for many other publications of no literary value. A copy of verses in Antonio Vieira's *Grinalda de Maria* (1877), the *Loas á Virgem* (1878), and the *Proverbios de Salomão*, are evidence of a complete return to orthodoxy during the poet's last years. By a lamentable error of judgment some worthless pornographic verses entitled *Cryptinas* have been inserted in the completest edition of João de Deus's poems—*Campo de Flores* (Lisbon, 1893). He died at Lisbon on 11th January 1896, was accorded a public funeral, and was buried next to the traditional grave of Camoens in the Jeromite church. His scattered minor prose writings and correspondence have been posthumously published by Dr Theophilo Braga (Lisbon, 1898). His last resting-place corresponds to his position in the history of Portuguese literature. Next to Camoens, no Portuguese poet has been more widely read, more profoundly admired than João de Deus; yet no poet in any country has been more indifferent to public opinion and more deliberately careless of personal fame. He is not responsible for any single edition of his poems, which were put together by pious but ill-informed enthusiasts, who ascribed to him verses that he had not written; he kept no copies of his compositions, seldom troubled to write them himself, and was content for the most part to dictate them to others. He has no great intellectual force, no philosophic doctrine, is limited in theme as in outlook, is curiously uncertain in his touch, often marring a fine poem with a slovenly rhyme or with a misplaced accent; and, on the only occasion when he was induced to revise a set of proofs, his alterations were nearly all for the worse. And yet, though he never appealed to the patriotic spirit, though he wrote nothing at all comparable in force or majesty to the restrained splendour of *Os Lusiadas*, the popular instinct which links his name with that of his great predecessor is eminently just. For Camoens was his model; not the Camoens of the epic, but the Camoens of the lyrics and the sonnets, where the passion of tenderness finds its supreme utterance. Braga has noted five stages of development in João de Deus's artistic life—the imitative, the idyllic, the lyric, the pessimistic, and the devout phases. Under each of these divisions is included much that is of extreme interest, especially to contemporaries who have passed through the same succession of emotional experience, and it is highly probable that *Catúrras* and *Gaspar*, pieces as witty as anything in Bocage but free from Bocage's coarse impiety, will always interest literary students. But it is as the singer of love that João de Deus will delight posterity as he delighted his own generation. The elegiac music of *Rachel* and of *Marina*, the melancholy of *Adeus* and of *Remoinho*, the tenderness and sincerity of *Meu casto lirio*, of *Lagrima celeste*, of *Descalça*, and a score more songs are distinguished by the large, vital simplicity which withstands time. It is precisely in the quality of unstudied simplicity that João de Deus is incomparably strong. The temptations to a display of virtuosity are almost irresistible for a Portuguese poet; he has the tradition of virtuosity in his blood, he has before him the example of all contemporaries, and he has at hand an instrument of wonderful sonority and compass. Yet not once is João de Deus clamorous or rhetorical, not once does he indulge in idle ornament. His prevailing note is that of exquisite sweetness and of reverent purity; yet with all his caressing softness he is never sentimental, and, though he has not the strength for a long flight, emotion has seldom been set to more delicate music. Had he included among his other gifts the gift of selection, had he continued the poetic discipline of his youth instead of dedicating his powers to a task which, well as he performed it, might have been done no less well by a much lesser man, there is scarcely any height to which he might not have risen. (J. F. – K.)

**Deutsch-Brod** (Czech, *Německý Brod*), the chief town of a government district of the same name in Eastern Bohemia, on the Sazawa river, north-west of the Iglau German enclave. It was the scene of a victory by Ziska in 1422 over the Emperor Sigismund, when it was destroyed by the Hussites, and in the preceding century had been a flourishing mining town. It was found impossible, however, to restore the old mines. Deutsch-Brod is now a manufacturing town, producing starch, cloth, glass, spodium, flour, beer, and it has a number of saw-mills. Population, almost exclusively Czech (1890), 5735; (1900), 6526.

**Deutz,** a town of Prussia, incorporated with COLOGNE (*q.v.*) in 1888.

**Déva,** a corporate town of South-East Hungary, near the river Maros, 82 miles east by north of Temesvár; capital of the county of Hunyad. It existed in the time of the Romans, but its oldest edifice is the Calvinist church, dating from the epoch of the Hunyadis (15th century). The neighbourhood was the scene of important events in the War of Independence, 1848–49, and the ruins of the fortress, which was then destroyed, are still very imposing. Population (1891), 4657; (1900), 7089.

**Deventer,** an old Hanse town in the province of Overyssel, Netherlands, on the river Yssel, 25 miles north of Arnheim. The rise of Amsterdam and the shallowing of the Yssel contributed to its decline, but it remains a commercial centre of some importance, trading with the eastern parts of Guelderland and Overyssel. Connexion with Borculo by steam tram has been established; also an institution to carry out agricultural experiments. A new theatre was built in 1875. Population (1900), 26,212.

**De Vere, Aubrey Thomas** (1814–1902), Irish poet and critic, was born at Curragh Chase, county Limerick, on 10th January 1814, being the third son of Sir Aubrey de Vere Hunt. In 1832 his father dropped the final name by royal license. Aubrey de Vere was educated at Trinity College, Dublin, and in his twenty-eighth year began his literary career with *The Waldenses*, which he followed up in the next year by *The Search after Proserpine*. Thenceforward he was continually engaged, till his death on 20th January 1902, in the production of poetry and criticism, devoting a long and industrious life to his enthusiasm for literature. His best known works are: in verse, *The Sisters*, 1861; *The Infant Bridal*, 1864; *Irish Odes*, 1869; *Legends of St Patrick*, 1872; and *Legends of the Saxon Saints*, 1879; and in prose, *Essays chiefly on Poetry*, 1887; and *Essays chiefly Literary and Ethical*, 1889. He also wrote a picturesque volume of travel-sketches, and two dramas in verse, *Alexander the Great*, 1874; and *St Thomas of Canterbury*, 1876; both of which, though they contain fine passages, suffer from diffuseness and a lack of dramatic spirit. The characteristics of Aubrey de Vere's poetry are "high seriousness" and a fine religious enthusiasm. His research in questions of faith led him to the Roman Church; and in many of his poems, notably in the volume of sonnets called *St Peter's Chains*, 1888, he made rich additions to devotional verse. He was a disciple of Wordsworth, whose calm meditative serenity he often echoed with great felicity; and his affection for Greek poetry, truly felt and understood, gave dignity and weight to his own versions of mythological idylls. But perhaps he will be chiefly remembered for the impulse which he gave to the study of Celtic legend and literature. In this direction he has had many followers, who have sometimes assumed the appearance of pioneers; but after Matthew

Arnold's fine lecture on "Celtic Literature," nothing perhaps has had more influence upon the return to Celtic interests than Aubrey de Vere's tender insight into the Irish character, and his stirring reproductions of the early Irish epic poetry. (A. WA.)

**Devizes,** a municipal borough and market town in the Devizes parliamentary division (since 1885) of Wiltshire, England, 23 miles north-north-west of Salisbury by rail. A cottage hospital has been erected. The scanty remains of the ancient castle are mostly incorporated in a modern residence. There are large engineering works and manufactures of agricultural implements; also a large tobacco and snuff factory. Area, 907 acres; population (1881), 6649; (1901), 6532. The Devizes Union District, excluding the borough of Devizes, had a population of (1891) 13,318; (1901), 13,070.

**Devonport,** a municipal (extended 1898), county (1888), and parliamentary borough, naval arsenal, royal dockyard, and garrison town of England, on the Hamoaze or estuary of the Tamar, 1 mile west-north-west of Plymouth, 248 miles by rail west-south-west of London. The borough is divided into 15 wards under a council of 60 members. Among recent institutions are a free library (1882); the Naval Engineering College (1880), enlarged in 1896 by the addition of a new wing costing £30,000, the only establishment of the kind in the United Kingdom (Portsmouth College having been abolished), with 200 students resident in the college; the municipal technical schools, opened in 1899, 80 per cent. of the students being connected with the dockyard; and the new naval barracks (1885). There is a public park (35 acres). No. 3 dock of Devonport dockyard (72 acres) has been recently enlarged to accommodate the biggest ships, and the adjoining dock southwards now admits all but the largest cruisers. One of the building slips, still roofed, measures over 6000 square yards. In a "shed," converted into an open slip, was built the "Ocean," launched in 1898—Devonport's first battle-ship. A new slip suitable for battle-ships or cruisers of the largest type was begun in 1900. Over 7000 workmen are employed in the dockyard. A ropery, producing half the hempen ropes used in the navy, employs 100 women. Keyham steamyard (72 acres), to the north of Devonport, opened in 1853, comprises 3 large docks and 2 basins, the Queen's Dock being 418 feet long. To the north of the docks, the factory, quadrangular in shape, includes an engineer students' shop, a torpedo shop, machinery shops, engine smithery, erecting shop and turnery, iron and brass foundries, pattern and millwrights' shops, flanging works, &c. The Keyham extension works, begun in 1896, includes the reclamation of nearly 100 acres of land to the north of Keyham and of the Naval Engineering College. The scheme provides a closed basin 1550 feet long, 1000 feet wide, and 55 feet deep, communicating with the Hamoaze by a spacious lock as well as a caisson entrance; another tidal basin (10 acres); and 3 graving docks. On the completion, some six or seven years hence, of the extension, the port will command 5 basins and 10 docks, and rank as by far the most capacious arsenal of the world, disposing of a continuous sea frontage, extending nearly three miles, of docks and arsenal. Area of municipal and county borough before extension, 1760 acres; population (1881), 48,939; (1891), 54,803. The extended area is 3160 acres; population (1891), 55,981; (1901), 69,674.

**Devonshire,** a south-western maritime county of England, bounded N.W. by the Bristol Channel, N.E. and E. by Somerset and Dorset, S. by the English Channel, and W. by Cornwall.

*Area and Population.*—The area of the ancient county, as given in the census returns, is 1,667,097 acres, or 2605 square miles. The population in 1881 was 603,654, and in 1891 was 631,808, of whom 297,898 were males and 333,910 females, the number of persons per square mile being 243, and of acres to a person 2·64. In 1901 the population was 660,444. The area of the administrative county, exclusive of the county boroughs, was 1,661,914 acres, with a population of 455,353, and including the county boroughs its area was identical with that of the ancient county, but since 1891 certain changes have been made. In 1896 the parishes of Chardstock and Hawkchurch were transferred from Dorset to Devon; in the same year the boundaries of the county borough of Plymouth were extended; and in 1898 the county borough of Plymouth was again extended. The area of the registration county is 1,650,705 acres, with a population in 1891 of 636,225, of which 336,936 were urban and 299,289 rural. Within this area the increase of population between 1881 and 1891 was 4·60 per cent. The excess of births over deaths between 1881 and 1891 was 63,001, and the increase of resident population was 27,969.

The following table gives the number of marriages, births, and deaths, with the number of illegitimate births, for 1880, 1890, and 1898:—

| Year. | Marriages. | Births. | Deaths. | Illegitimate Births. | |
|---|---|---|---|---|---|
| | | | | Males. | Females. |
| 1880 | 4521 | 18,218 | 12,167 | 436 | 380 |
| 1890 | 4851 | 16,893 | 11,903 | 351 | 388 |
| 1898 | 5038 | 16,222 | 10,844 | 350 | 305 |

The number of marriages in 1899 was 5245, of births 16,294, and of deaths 11,562.

The following table shows the marriage, birth, and death rates per 1000 of the population, with the percentage of illegitimate births, for a series of years:—

| | 1870–79. | 1880. | 1880–89. | 1890. | 1888–97. | 1898. |
|---|---|---|---|---|---|---|
| Marriage-rate . | 15·3 | 14·8 | 14·9 | 15·3 | 15·1 | 15·4 |
| Birth-rate . | 29·9 | 29·8 | 28·8 | 26·6 | 26·4 | 24·8 |
| Death-rate . | 19·8 | 19·9 | 18·4 | 18·8 | 17·5 | 15·7 |
| Percentage of illegitimate births | 5·2 | 4·5 | 4·6 | 4·4 | 4·2 | 4·0 |

The number of Scots in the county in 1891 was 3316, of Irish 6537, and of foreigners 1789.

*Constitution and Government.*—The ancient county is divided into eight parliamentary divisions, and it also includes the parliamentary boroughs of Devonport and Plymouth returning two members, and the borough of Exeter returning one. The administrative county includes thirteen municipal boroughs: Barnstaple (14,137), Bideford (8754), Dartmouth (6579), Devonport (69,674), Exeter (46,940), Honiton (3271), Okehampton (2568), Plymouth (107,509), South Molton (2848), Tiverton (10,382), Torquay (33,625), Great Torrington (3241), and Totnes (4034). Of these, Devonport, Exeter, and Plymouth are county boroughs. The following are urban districts: Ashburton (2628), Bampton (1657), Brixham (8090), Buckfastleigh (2520), Budleigh Salterton (1883), Crediton (3974), Dawlish (4003), East Stonehouse (15,111), Exmouth (10,487), Heavitree (7529), Ilfracombe (8557), Ivybridge (1575), Kingsbridge (3025), Lynton (1641), Newton Abbot (12,518), Northam (5357), Ottery St Mary (3495), Paignton (8385), St Mary Church (6849), St Thomas the Apostle (8245), Salcombe (1710), Seaton (1325), Sidmouth (4201), Tavistock (4728), and Teignmouth (8636). Devonshire is in the western circuit, and assizes are held at Exeter. The boroughs of Barnstaple, Bideford, Dartmouth, Devonport, Exeter, Plymouth, South Molton, and Tiverton have separate courts of quarter sessions. The ancient county, which is almost entirely in the diocese of Exeter, contains 506 entire ecclesiastical parishes, and parts of five others.

*Education.*—There is a residential training college (diocesan) for schoolmasters at Exeter. At Exeter are also the West of England Institution for the deaf and the West of England Institution for the blind, while at Plymouth are the South Devon and Cornwall Institution for the blind and a school board deaf school. The number of elementary schools on 31st August 1899 was 643, of which 239 were board and 404 voluntary schools, the latter including 349 National Church of England schools, 6 Wesleyan, 13 Roman Catholic, and 36 "British and other." The average attendance at board schools was 43,261, and at voluntary schools 50,162. The total school board receipts for the year ended 29th September 1898 were over £144,335. The income under the Technical Instruction Act was over £602, and that under the Agricultural Rates Act over £6114.

*Agriculture.*—About three-fourths of the total area of the county is under cultivation, and of this more than a half is in permanent pasture, a large number of cattle and sheep being raised. The Devon breed of cattle are well adapted both for fattening and dairy purposes. For sheep there are, in addition to the permanent

pasture of the cultivated area, about 158,000 acres in hill pasturage. Over 86,000 acres are under woods and about 27,000 acres under orchards, chiefly of apple trees, nearly every farm having a large orchard for the manufacture of cider. Of the acreage under corn crops, more than one-half is under oats, and less than a third under wheat, the acreage of which has diminished since 1880 about a third. The bulk of the acreage under green crops is occupied by turnips, mangold, and cabbage, potatoes occupying only about a tenth of the whole acreage. The following table gives the larger main divisions of the cultivated area at intervals of five years from 1880 :—

| Year. | Total Area under Cultivation. | Corn Crops. | Green Crops. | Clover. | Permanent Pasture. | Fallow. |
|---|---|---|---|---|---|---|
| 1880 | 1,150,888 | 278,413 | 138,735 | 190,197 | 509,694 | 33,833 |
| 1885 | 1,193,108 | 252,244 | 140,822 | 196,743 | 582,203 | 21,063 |
| 1890 | 1,208,467 | 242,864 | 132,485 | 201,326 | 615,230 | 15,532 |
| 1895 | 1,213,913 | 222,896 | 127,905 | 218,965 | 633,055 | 9,596 |
| 1900 | 1,210,034 | 225,203 | 122,769 | 219,091 | 634,427 | 7,179 |

The following table gives particulars regarding the principal live-stock for the same years :—

| Year. | Total Horses. | Total Cattle. | Cows or Heifers in Milk or in Calf. | Sheep. | Pigs. |
|---|---|---|---|---|---|
| 1880 | 53,944 | 229,471 | 80,280 | 773,916 | 84,815 |
| 1885 | 54,579 | 253,421 | 90,937 | 874,606 | 99,513 |
| 1890 | 55,280 | 259,876 | 95,960 | 913,562 | 123,227 |
| 1895 | 59,916 | 263,506 | 94,685 | 874,408 | 123,937 |
| 1900 | 54,526 | 279,728 | 91,872 | 846,324 | 95,944 |

*Industries and Trade.*—According to the annual report for 1898 of the chief inspector of factories (issued 1900), the total number of persons employed in factories and workshops in 1897 was 36,887, as compared with 34,608 in 1896. Textile factories employed only 2356, of whom 1197 were employed in the manufacture of woollen goods, lace employing 879. Honiton lace is made in other parts of the county as well as in Honiton. In non-textile factories 24,002 persons were employed, there being an increase between 1895 and 1896 of 10·4 per cent., and between 1896 and 1897 of 7·6 per cent. In the manufacture of machines, appliances, conveyances, and tools, 8534 persons were employed, chiefly in the Government establishments at Devonport and Keyham; in the clothing industry 2800, there being a considerable trade in costumes and outfitting; in the manufacture of paper 2755; in the clay and stone industry (including articles in pottery and terra-cotta at Bovey Tracy, Watcombe, &c.), 1047. Of the 10,529 persons employed in workshops as many as 6342 were employed in the clothing industry, and 1576 in the manufacture of machines, appliances, conveyances, and tools. For mineral purposes Devon is included in the duchy of Cornwall. The total number of persons employed in mining in 1899 was 3085. Increasing quantities of marble, granite, and other building stones, as well as limestone and roofing slates, are being dug. In 1899 as many as 527,026 tons of limestone were raised, 290,991 tons of clay (value £82,244), 48,651 tons of granite, 71,487 tons of sandstone, and 13,901 tons of slate. Manganese and tin are mined in only very small quantities. The following table gives particulars regarding the production of arsenic, china clay, and copper in 1890 and 1898 :—

| Year. | Arsenic. | | China Clay. | | Copper. | |
|---|---|---|---|---|---|---|
| | Tons. | Value. | Tons. | Value. | Tons. | Value. |
| 1890 | 4133 | £34,224 | 60,346 | £30,173 | 6038 | £9197 |
| 1899 | 2468 | £40,941 | 52,198 | £30,187 | 990 | £2292 |

Much of the fishing is carried on within the 3 mile limit. Pilchard, cod, sprats, brill, plaice, soles, turbot, shrimps, lobster, oyster, and mussels, are met with, besides herrings and mackerel, which are rather plentiful. The principal fishing stations are Brixham and Plymouth, but there are small ones in all the bays and river outlets. The total amount of fish landed at Brixham in 1899 was 62,337 cwt., valued at £70,685; and at Plymouth 138,972 cwt., valued at £89,003. The annual average for all stations is about 280,000 cwt., valued at £180,000. Much of the fish landed at Plymouth is from Cornwall.

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**Devonshire, Spencer Compton Cavendish,** 8th Duke of (1833– —), was born on 23rd July 1833. He was the son of the seventh duke of Devonshire (who died in 1891 at the age of 83), a man who, without playing a prominent part in public affairs, exercised great influence not only by his position but also by his abilities. In 1854 the marquis of Hartington, as he then was, took his degree at Trinity College, Cambridge, and in 1857 was returned to Parliament for North Lancashire. At the opening of the new Parliament of 1859 he moved the amendment to the address which overthrew the Government of Lord Derby. In 1863 he was Under Secretary for War, and on the formation of the Russell–Gladstone administration at the death of Lord Palmerston he entered it as War Secretary. He retired with his colleagues in July 1866; but upon Mr Gladstone's return to power in 1868 he became Postmaster-General, which office he exchanged in 1871 for that of Secretary for Ireland. When Mr Gladstone, after his electoral defeat and consequent resignation in 1874, temporarily withdrew from the leadership of his party in January 1875, Lord Hartington was chosen his successor. Mr W. E. Forster, who had taken a much more prominent part in public life, was the only other possible nominee, but he declined to stand. Lord Hartington's rank no doubt told in his favour, and Mr Forster's Education Bill had offended the Nonconformist members, who would probably have withheld their support. Lord Hartington's prudent management in difficult circumstances laid his followers under great obligations, since not only was the opposite party in the ascendant, but his own former chief was indulging in the freedom of independence. After the complete defeat of the Conservatives in the general election of 1880, a large proportion of the party would have rejoiced if Lord Hartington could have taken the Premiership instead of Mr Gladstone, and the Queen, in strict conformity with constitutional usage, sent for him as leader of the Opposition. Mr Gladstone, however, was clearly master of the situation: no Cabinet could be formed without him, nor could he reasonably be expected to accept a subordinate post. Lord Hartington, therefore, gracefully abdicated the leadership which he had temporarily assumed, and became Secretary of State for India, from which office, in December 1882, he passed to the War Office. His administration was memorable for the expeditions of General Gordon and Lord Wolseley to Khartum. In June 1885 he resigned along with his colleagues, and in December was elected for the Rossendale Division of Lancashire, created by the new Reform Bill. Immediately afterwards the great political opportunity of Lord Hartington's life came to him in Mr Gladstone's conversion to Home Rule. Lord Hartington's refusal to follow his leader in this course inevitably made him the chief of the new Liberal Unionist party, composed of a large and influential section of the old Liberals. In this capacity he moved the first resolution at the famous public meeting at the Opera House, and also, in the House of Commons, moved the rejection of Mr Gladstone's Bill on the second reading. During the memorable electoral contest which followed, no election excited more interest than Lord Hartington's for the Rossendale Division, where he was returned by a majority of nearly 1500 votes. In the new Parliament he held a position much resembling that which Sir Robert Peel had occupied after his fall from power, the leader of a small, compact party, the standing and ability of whose members were out of all proportion to their numbers, generally esteemed and trusted beyond any other man in the country, yet in his own opinion forbidden to think of office. Lord Salisbury's overtures, at all events, were declined, and Lord Hartington con-

tinued to discharge the delicate duties of the leader of a middle party with no less judgment than he had shown when leading the Liberals during the interregnum of 1875–80. It was not until 1895, when the differences between Conservatives and Liberal Unionists had become almost obliterated by changed circumstances and the habit of acting together, that the duke of Devonshire, as he had become by the death of his father in 1891, consented to enter Lord Salisbury's third Ministry as President of the Council. The duke thus was the nominal representative of education in the Cabinet at a time when educational questions were rapidly becoming of great importance; and the duke's own technical knowledge of this difficult and intricate question being admittedly superficial, a good deal of criticism from time to time resulted. His great contribution to public life, however, has been the weight of character which procured for him universal respect and confidence, and exempted him from bitter attack, even from his most determined political opponents. No man ever doubted the duke of Devonshire's patriotism, or felt entirely secure in differing from his judgment. Wealth and rank combined with character to place him in a measure above party: and he remained a luminous example of the benefit which a democratic community may derive from the existence within it of an aristocratic class and the participation of its members in public affairs. The duke succeeded his father as Chancellor of the University of Cambridge in 1892, and is a Knight of the Garter.

**Dewar, James** (1842– ——), British chemist and physicist, was born at Kincardine-on-Forth, Scotland, on 20th September 1842. He was educated at Dollar Academy and Edinburgh University, being at the latter first a pupil, and afterwards the assistant, of the late Lord Playfair, then professor of chemistry; he also studied under Kekulé at Ghent. In 1875 he was elected Jacksonian professor of natural experimental philosophy at Cambridge, becoming a fellow of Peterhouse, and in 1877 he succeeded Dr J. H. Gladstone as Fullerian professor of chemistry in the Royal Institution, London. He has been president of the Chemical Society and of the Society of Chemical Industry, served on the Balfour Commission on London Water Supply (1893–94), and as a member of the Committee on Explosives (1888–91) invented cordite jointly with Sir Frederick Abel. His scientific work covers a wide field. Of his earlier papers, some deal with questions of organic chemistry, others with Graham's hydrogenium and its physical constants, others with high temperatures, *e.g.*, the temperature of the sun and of the electric spark, others again with electro-photometry and the chemistry of the electric arc. With Professor M'Kendrick, of Glasgow, he investigated the physiological action of light, and examined the changes which take place in the electrical condition of the retina under its influence. With Professor G. D. Liveing, one of his colleagues at Cambridge, he began in 1878 a long series of spectroscopic observations, the most recent of which have been devoted to the spectroscopic examination of various gaseous constituents separated from atmospheric air by the aid of low temperatures. Since the time that liquid air and liquid oxygen have been available in considerable quantities, he has been joined by Professor J. A. Fleming, of University College, London, in the investigation of the electrical behaviour of substances cooled to very low temperatures. His name is most widely known in connexion with his work on the liquefaction of the so-called permanent gases and his researches at temperatures approaching the zero of absolute temperature. His interest in this branch of inquiry dates back at least as far as 1874, when he discussed the "Latent Heat of Liquid Gases" before the British Association. In 1878 he devoted a Friday evening lecture at the Royal Institution to the then recent work of Cailletet and Pictet, and exhibited for the first time in Great Britain the working of the Cailletet apparatus. Six years later, in the same place, he described the researches of Wroblewski and Olszewski, and illustrated for the first time in public the liquefaction of oxygen and air, by means of apparatus specially designed for optical projection so that the actions taking place might be visible to the audience. Soon afterwards he constructed a machine from which the liquefied gas could be drawn off through a valve for use as a cooling agent, and he showed its employment for this purpose in connexion with some researches on meteorites; about the same time he also obtained oxygen in the solid state. By 1891 he had designed and erected at the Royal Institution an apparatus which yielded liquid oxygen by the pint, and towards the end of that year he showed that both liquid oxygen and liquid ozone are strongly attracted by a magnet. About 1892 the idea occurred to him of using vacuum-jacketed vessels for the storage of liquid gases, and so efficient did this device prove in preventing the influx of external heat that it is found possible not only to preserve the liquids for comparatively long periods, but also to keep them so free from ebullition that examination of their optical properties becomes possible. He next experimented with a high-pressure hydrogen jet by which low temperatures were realized through the Thomson-Joule effect, and the successful results thus obtained led him to build the large refrigerating machine by which in 1898 hydrogen was for the first time collected in the liquid state, its solidification following in 1899 (see LIQUID GASES). The Royal Society in 1894 bestowed the Rumford Medal upon Professor Dewar for his work in the production of low temperatures, and in 1899 he became the first recipient of the Hodgkins Gold Medal of the Smithsonian Institution, Washington, for his contributions to our knowledge of the nature and properties of atmospheric air.

**Dewas,** a native state of India, in the Indore agency. For more than a century the state has been divided, almost equally, between the descendants of a former chief, known as the senior and junior branches, or as Baba and Dada Saheb. Both live in the town of Dewas, but exercise exclusive jurisdiction over their several shares. Total area, 289 square miles. Population (1881), 142,162; (1891), 152,073, showing an increase of 7 per cent., which has been almost confined to the share of the senior branch; average density, 526 persons per square mile. The chiefs are Rajputs of the Puar clan, of the same family as the Raja of Dhar. The two chiefs ruling in 1901 were named Krishnaji Rao and Mulhar Rao, these names showing Maratha influence.

The town of DEWAS is situated in 22° 58′ N. lat. and 76° 6′ E. long., about 20 miles north-east of Indore. Population, 11,921. It has a high school and a hospital.

**Dewey, George** (1837– ——), American naval commander, was born in Montpelier, Vt., on 26th December 1837, and graduated at the U.S. Naval Academy in 1858. In the Civil War he served as lieutenant on the steam sloop *Mississippi*, during Farragut's passage of the forts below New Orleans in April 1862, and at Port Hudson in March 1863. After the war he performed various routine duties, rising in grade to commodore (February 1896). On 30th November 1897 he was assigned, at his own request, to sea service, and sent to Asiatic waters. Being notified by telegraph in April 1898, while with his fleet at Hong Kong, that war had been declared with

Spain, and ordered to "capture or destroy the Spanish fleet" at the Philippines, he departed for Manila with his squadron, after procuring coal and provisions for the expedition. Steaming into Manila harbour, his fleet advanced on 1st May at early dawn against the Spanish vessels sighted at the other end of the bay. His flagship, the *Olympia*, led in a fight at close range which lasted, with slight intermission, until the afternoon, when the last Spanish flag was hauled down. The surrender of the city of Manila followed later. After remaining in the Philippines under orders from his Government to main tain control, Dewey returned home, October 1899, receiving great ovations. He was advanced to rear-admiral, with the thanks of Congress, soon after his victory, and was promoted to admiral on 2nd March 1899.

**Dewsbury,** a municipal and parliamentary borough and market-town of Yorkshire, England, on the Calder, 7 miles east-north-east of Huddersfield by rail. The old church of All Saints has been enlarged; besides, there are five Established, a Roman Catholic, and several Nonconformist churches, grammar and technical schools, an infirmary, and, of recent erection, a town-hall, a free library, and public baths. The hall and library in the buildings of an industrial co-operative society also deserve mention. A public park was opened in 1893. There are iron foundries and works for machinery. Area of municipal borough, 1468 acres. Population (1881), 29,637; (1901), 28,050.

**Dhar,** a native state of India, in the Bhopawar agency, Central India, includes many Rajput and Bhil feudatories, and has an area of 1740 square miles. In 1881 it had a population of 151,877, and in 1891 of 169,474, showing an average density of 98 persons per square mile. The revenue in 1897–98 was Rs.8,57,909; the police force numbered 1015 men. The state includes the ruins of Mandu, or Mandogarh, the Mahommedan capital of Malwa.

The town of DHAR is 33 miles west of Mhow, 908 feet above the sea. Population, about 15,000. It is a centre of the opium trade, and has a high school and hospital.

**Dharampur,** a native state of India, in the Gujarat division of Bombay, with an area of 794 square miles. The population in 1881 was 101,289; in 1891 it was 120,498; the estimated gross revenue was Rs.4,12,712, of which Rs.88,000 was expended in public works in 1897–98; the tribute is Rs.9000. The state has been surveyed for land revenue on the Bombay system. The number of police was 170; the number of schools was 20, with 940 pupils in 1897–98. The population of Dharampur town in 1891 was 4775.

**Dharwar,** a town and district of British India, in the Carnatic or Canarese-speaking division of Bombay, with a railway station. The population in 1881 was 27,191; in 1891 it was 32,841. It has two ginning factories and a cotton-mill with 10,000 spindles, employing 200 hands; two high schools, one maintained by the Government and the other by the Basel German Mission, with 466 pupils in 1896–97; training schools for masters and for mistresses; fourteen printing-presses, eleven of which issue periodicals in Canarese and Mahratti.

The DISTRICT OF DHARWAR has an area of 4603 square miles. In 1881 it had a population of 893,587, and in 1891 of 1,051,314, giving an average density of 228 persons per square mile. In 1901 the population was 1,113,426, showing an increase of 6 per cent. The land revenue and rates were Rs.33,01,157, the incidence of assessment being R.1–3–5 per acre; the cultivated area in 1897–98 was 2,076,808 acres, of which 94,323 were irrigated from tanks, &c., including 4381 acres from Government canals; the number of police was 945; the children at school in 1897–98 numbered 34,298, being 3·4 per cent. of the total population; the death-rate in 1897 was 37·57 per thousand. The principal crops are millets, pulse, and cotton. The centres of the cotton trade are Hubli and Gadak, junctions on the Southern Mahratta Railway, which now traverses the district in several directions.

**Dholpur,** a native state of India, in the Rajputana agency, with an area of 1156 square miles. The population in 1881 was 249,657; in 1891 it was 279,980, giving an average density of 242 persons per square mile. In 1901 the population was 271,496, showing a decrease of 3 per cent. The estimated revenue is Rs.12,50,000. There were six schools, with 366 pupils, in 1897–98; and four dispensaries, attended by 25,843 patients. The state is crossed by the Indian Midland Railway from Jhansi to Agra. In recent years it has suffered severely from drought. In 1896–97 the expenditure on famine relief amounted to Rs.1,22,859.

The town of DHOLPUR is 34 miles south of Agra by rail. Population, about 16,000.

**Dhrangadra,** a native state of India, in the Gujarat division of Bombay, situated in the north of the peninsula of Kathiawar. Its area is 1156 square miles. The population in 1881 was 99,686, and in 1891 was 103,754; the estimated gross revenue is Rs.5,75,110, of which Rs.25,790 was expended on public works in 1897–98; the tribute is Rs.44,677. A railway on the metre gauge from Wadhwan to the town of Dhrangadra (21 miles) was opened for traffic in 1898.

The town of DHRANGADRA is situated in 22° 59′ N. lat. and 71° 31′ E. long. There is a printing-press, issuing an official gazette. Population (1891), 15,209.

**Dhuleep Singh** (1837–1893), Maharajah of Lahore, was born in February 1837, and was proclaimed Maharajah on 18th September 1843, under the regency of his mother the Ranee Jinda, a woman of great capacity and strong will, but extremely inimical to the British. He was acknowledged by Runjeet Singh and recognized by the British Government. After six years of peace the Sikhs invaded British territory in 1845, but were defeated in four battles, and terms were imposed upon them at Lahore, the capital of the Punjab. Dhuleep Singh retained his territory, but it was administered to a great extent by the British Government in his name. This arrangement increased the Regent's dislike of the British, and a fresh outbreak occurred in 1848–49. In spite of the valour of the Sikhs, they were utterly routed at Gujarat, and in March 1849 Dhuleep Singh was deposed, a pension of £40,000 a year being granted to him and his dependants. He became a Christian and elected to live in England. On coming of age he made an arrangement with the Government by which his income was reduced to £25,000 in consideration of advances for the purchase of an estate, and he finally settled at Elvedon in Suffolk. While passing through Alexandria in 1864 he met Miss Bamba Muller, the daughter of a German merchant who married an Abyssinian. The Maharajah had been interested in mission work by Sir John Login, and he met Miss Muller at one of the missionary schools where she was teaching. She became his wife on 7th June 1864, and six children were the issue of the marriage. In the year after her death in 1890 the Maharajah married at Paris, as his second wife, an English lady, Miss Ada Douglas Wetherill, who survived him. The Maharajah was passionately fond of sport, and his shooting parties were celebrated, while he himself became a *persona grata* in English society. The result, however, was financial difficulty, and in 1882 he appealed to the Government for

assistance, making various claims based upon the alleged possession of private estates in the Punjab, and upon the surrender of the Kohinoor diamond to the English Crown. His demand was rejected, whereupon he started for India, after drawing up a proclamation to his former subjects. But as it was deemed inadvisable to allow him to visit the Punjab, he remained for some time as a guest at the residency at Aden, and was allowed to receive some of his relatives to witness his abjuration of Christianity, which actually took place within the residency itself. As the climate began to affect his health, the Maharajah at length left Aden and returned to Europe. He stayed for some time in Russia, hoping that his claim against England would be taken up by the Russians; but when that expectation proved futile he proceeded to Paris, where he lived for the rest of his life on the pension allowed him by the Indian Government. His death from an attack of apoplexy took place at Paris, 22nd October 1893. (G. F. B.)

**Dhulia,** a town of British India, administrative headquarters of Khandesh district in Bombay, on the right bank of the Panjhra river. The population in 1881 was 18,449; in 1891 it was 21,880. It has cantonments for the Bhil Corps and a detachment of the Poona Horse. Considerable trade is done in cotton and oil-seeds, and weaving of cotton. It contains the Garud High School, with 348 pupils in 1896–97, and five printing-presses, each issuing a vernacular newspaper. A railway to connect Dhulia with Chalisgaon, on the main line of the Great Indian Peninsula (37 miles), was commenced in 1900.

**Diabetes.** See PATHOLOGY (*Metabolic Diseases*).

**Diamantina,** a town of Brazil, in the state of Minas Geraes, with a population of 13,000, is the centre of the diamond mine district, and yields the larger part of the production of diamonds in Brazil, which is estimated at 40,000 carats a year.

**Diarbekr.**—I. A viláyet of Asiatic Turkey through which the western arm of the Tigris flows. It extends southwards from Palu, on the Euphrates, to Mardin and Nisibin, and is divided into three sanjaks—Arghana, Diarbekr, and Mardin. Cereals, cotton, tobacco, rice, and silk are produced; but most of the fertile lands have been abandoned to the nomads and semi-nomads, who raise large quantities of live-stock. Copper, galena, mineral oil, and silicious sand are found. The population is about 480,000 (Moslems, including nomad and semi-nomad Kúrds, 336,000; Yezidis and Gypsies, 4000; Christians, chiefly Armenians and Syrians, 139,000; Jews, 1000). II. The chief town of the viláyet and of a sanjak of the same name (the ancient Amida), seat of a Governor-General, headquarters of a military district, situated at an altitude of 1950 feet, on a high mass of basalt rock on the right bank of the Tigris, which is here crossed by a stone bridge and is fordable in several places in winter. Its position at the head of raft navigation on the Tigris, and with easy roads to Alexandretta on the Mediterranean, Samsún on the Black Sea, Erzerúm, Bitlis, and Mosul, has always been one of commercial and strategic importance. Old walls, pierced by four gates, and standing above cliffs from 20 to 40 feet high, surround the town, and beneath them, on the river side, are irrigated gardens. At the north-east angle, on the highest ground, are the ruins of a citadel, in which is the Serai or Government House. The streets are narrow, badly paved, and filthy. The houses are low, and built partly of black basalt—whence the ancient name of the town, Kara (black) Amid—and partly of dark coloured sun-dried bricks. In the great mosque, Ulu Jami' and its court are the façades of two Sassanian palaces, apparently built with materials from an older palace, perhaps that of Tigranes II. The churches of SS. Cosmas and Damian (Jacobite) and St James (Greek) are also of interest. The climate in winter is good; snow often lies, and there is sufficient ice for storage for summer use. In summer it is very hot and unhealthy. Epidemics of typhus are frequent, and ophthalmia and the "Aleppo button" are common. Scorpions, noted for the virulence of their poison, abound. There are a few small industries, silver filigree work, morocco leather, cotton, and silk. Fruit is grown near the town, but little of the adjoining land is cultivated. The principal exports are wool, mohair, copper ore, &c.; and the imports, cotton and woollen goods, indigo, coffee, sugar, petroleum, &c. The population is 25,000 (Turks, Kúrds, and Arabs, 13,000; Armenians, Jacobites, Greeks, Protestants, and Jews, 12,000). During the massacres of 1895 the Christians successfully defended themselves against the Moslems. (C. W. W.)

**Diaz, Narcisse Virgilio** (1808–1876), French painter, was born in Bordeaux of Spanish parents, 25th August 1808. At first a figure-painter who indulged in strong colour, in his later life Diaz became a painter of the forest and a "tone artist" of the first order. He spent much time at Barbizon; and although he is the least exalted of the half-dozen great artists who are usually grouped round that name, he sometimes produced works of the highest quality. At the age of ten Diaz became an orphan, and misfortune dogged his earlier years. His foot was bitten by a reptile in Meudon wood, near Sèvres, where he had been taken to live with some friends of his mother. The bite was badly dressed, and ultimately it cost him his leg. Afterwards his wooden stump became famous. At fifteen he entered the studios at Sèvres, where the decoration of porcelain occupied him; but tiring of the restraint of fixed hours, he took to painting Eastern figures dressed in richly coloured garments. Turks and Oriental scenes attracted him, and many brilliant gems remain of this period. About 1831 Diaz encountered Théodore Rousseau, for whom he entertained a great veneration, although Rousseau was four years his junior; but it was not until ten years later that the remarkable incident took place of Rousseau teaching Diaz to paint trees. At Fontainebleau Diaz found Rousseau painting his wonderful forest pictures, and determined to paint in the same way if possible. Rousseau, then in poor health, worried at home, and embittered against the world, was difficult to approach. Diaz followed him surreptitiously to the forest,—wooden leg not hindering,—and he dodged round after the painter, trying to observe his method of work. After a time Diaz found a way to become friendly with Rousseau, and revealed his anxiety to understand his painting. Rousseau was touched with the passionate words of admiration, and finally taught Diaz all he knew. Diaz exhibited many pictures at the Paris Salon, and was decorated in 1851. During the war, twenty years later, he went to Brussels. After 1871 he became fashionable, his works gradually rose in the estimation of collectors, and he worked constantly and successfully. In 1876 he caught cold at his son's grave, and on 18th November of that year he died at Mentone, whither he had gone to recruit his health. Diaz's finest pictures are his forest scenes and storms, and it is on these, and not on his pretty figures, that his fame is likely to rest. There are several fairly good examples of the master in the Louvre, and three small figure pictures in the Wallace Collection, Hertford House. Perhaps the most notable of Diaz's works are "La Fée aux Perles" (1857), in the Louvre; "Sunset in the Forest" (1868);

"The Storm," and "The Forest of Fontainebleau" (1870) at Leeds. Diaz had no well-known pupils, but Léon Richet followed markedly his methods of tree-painting, and J. F. Millet (*q.v.*) at one period painted small figures in avowed imitation of Diaz's then popular subjects.

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**Diaz, Porfirio** (1830-——), President of the Republic of Mexico, was born at Oaxaca 15th September 1830. He was educated for the Church, but upon becoming his own master decided to follow the profession of the law; and, about 1855, the disturbed condition of the country, in revolt against Santa Anna, made him a soldier. He took a prominent part in the resistance to the French invasion in 1863, and so greatly distinguished himself as to have become by 1867 commander of the army of the east, to which the capital surrendered after the execution of the Emperor Maximilian. He then retired into private life, but in 1870–72 was in arms against President Juarez, and in 1875 placed himself at the head of an insurrection against the Government of President Lerdo de Tejada. After many desperate struggles and hairbreadth escapes he entered the city of Mexico in November 1876, and was elected President in 1877. His repudiation of all the promises he had made in the programme he had put forward at the beginning of the civil war caused his term of office to be exceedingly stormy, but he suppressed all opposition, and in 1880 peacefully transmitted his power to General Gonzalez, his Secretary of War. In 1884 he was elected for a second term, and, the provision of the Constitution which forbade the re-election of a President having been repealed, he continued to be regularly re-elected; and no disquieting event has since occurred, except an abortive attempt to assassinate him in 1897. Under his vigorous rule the most anarchical of Spanish American states has become the most orderly; military revolts have disappeared; the laws are executed without opposition; industry has been stimulated, to the great increase of national wealth; roads and railways have been multiplied; foreign capital has been invested and rendered secure; and the financial credit of the country, which had sunk to the lowest ebb, has been entirely re-established. All these benefits are owing to General Diaz's force of character and administrative ability, and he has incontestably earned the title of the regenerator of Mexico.

**Dibrugarh,** a town of British India, in the Lakhimpur district of Assam, of which it is the headquarters, situated on the Dibru river about 4 miles above its confluence with the Brahamaputra. In 1881 it had a population of 7153, and in 1891 of 9876. It is the terminus of steamer navigation on the Brahmaputra, and also of a railway running to important coal-mines and petroleum wells, which will ultimately be connected with the Assam-Bengal system. Large quantities of coal and tea are exported. There are a military cantonment, with 280 men in 1898; the headquarters of the volunteer corps known as the Assam Valley Light Horse; a Government high school, with 292 pupils in 1896–97; a training school for masters; and an aided school for girls. In 1900 a medical school for the province was established, out of a bequest of Rs.50,000 left by the late Brigade-Surgeon J. Berry-White, which will be maintained by the Government, to train hospital assistants for the tea gardens. The Williamson Artisan School is entirely supported by an endowment. There are three printing-presses.

**Dictionary.**—A dictionary is a book in which the words of a language, or words of a special class, are arranged, generally in alphabetical order, and their meaning and idiomatic use are explained in the same or in a different language. Most modern dictionaries give also the pronunciation of the words defined and an account of their derivation or etymology, and some add information of various kinds about the things or processes which certain words designate. If the latter variety are general (not limited to a special class of words) they are commonly called *encyclopædic.* A general dictionary in which the information given relates only to the meaning, idiomatic use, pronunciation, orthography, derivation, and history of words (or to some of these things) is literary, pedagogical, or philological. Special dictionaries are classed as *technical* when they include only the terms of one or more of the sciences, arts, or trades. The name is also given to certain works, such as a "rhyming dictionary," a "dictionary of biography," a "dictionary of quotations," and the like, which are not of a strictly lexicographic character, and to encyclopædias. For a detailed description of dictionaries of various kinds, and for a list of the more important of them, the reader is referred to the article in the ninth edition of this work, vol. vii. (pp. 179–193). Here only the more noteworthy recent work in general lexicography will be considered.

At no time has progress in the making of general dictionaries been so rapid as during the second half of the 19th century. It is to be seen in three things: in the perfecting of the theory of what a general dictionary should be; in the elaboration of methods of collecting and editing lexicographic materials; and in the magnitude and improved quality of the work which has been accomplished or planned. Each of these can best be illustrated from English lexicography, in which the process of development has in all directions been carried farthest. The advance that has been made in theory began with a radical change of opinion with regard to the chief end of the general dictionary of a language. The older view of the matter was that the lexicographer should furnish a standard of usage—should register only those words which are, or at some period of the language have been, "good" from a literary point of view, with their "proper" senses and uses, or should at least furnish the means of determining what these are. In other words, his chief duty was conceived to be to sift and refine, to decide authoritatively questions with regard to good usage, and thus to fix the language as completely as might be possible within the limits determined by the literary taste of his time. Thus the Accademia della Crusca, founded near the close of the 16th century, was established for the purpose of purifying in this way the Italian tongue, and in 1612 the *Vocabolario degli Accademici della Crusca,* long the standard of that language, was published. The Académie Française, the first edition of whose dictionary appeared in 1694, had a similar origin. In England the idea of constructing a dictionary upon this principle arose during the second quarter of the 18th century. It was imagined by men of letters—among them Alexander Pope—that the English language had then attained such perfection that further improvement was hardly possible, and it was feared that if it were not fixed by lexicographic authority deterioration would soon begin. Since there was no English "Academy," it was necessary that the task should fall to some one whose judgment would command respect, and the man who undertook it was Samuel Johnson. His dictionary, the first edition of which, in two

folio volumes, appeared in 1755, was in many respects admirable, but it was inadequate even as a standard of the then existing literary usage. Johnson himself did not long entertain the belief that the natural development of a language can be arrested in that or in any other way. His work was, however, generally accepted as a final authority, and the ideas upon which it was founded dominated English lexicography for more than a century. The first effective protest, in England, against the supremacy of this literary view was made by Dean (later Archbishop) Trench, in a paper on "Some Deficiencies in Existing English Dictionaries" read before the Philological Society in 1857. "A dictionary," he said, "according to that idea of it which seems to me alone capable of being logically maintained, is an *inventory of the language;* much more, but this primarily. . . . It is no task of the maker of it to select the *good* words of the language. . . . The business which he has undertaken is to collect and arrange *all* words, whether good or bad, whether they commend themselves to his judgment or otherwise. . . . *He is an historian of* [the language], *not a critic.*" That is, for the literary view of the chief end of the general dictionary should be substituted the philological or scientific. In Germany this substitution had already been effected by Jacob and Wilhelm Grimm in their dictionary of the German language, the first volume of which appeared in 1854. In brief, then, the modern view is that the general dictionary of a language should be a record of all the words—current or obsolete—of that language, with all their meanings and uses, but should not attempt to be, except secondarily, or indirectly, a guide to "good" usage. A "standard" dictionary has, in fact, been recognized to be an impossibility, if not an absurdity.

This theoretical requirement must, of course, be modified considerably in practice. The date at which a modern language is to be regarded by the lexicographer as "beginning" must, as a rule, be somewhat arbitrarily chosen; while considerable portions of its earlier vocabulary cannot be recovered because of the incompleteness of the literary record. Moreover, not even the most complete dictionary can include all the words which the records—earlier and later—actually contain. Many words, that is to say, which are found in the literature of a language cannot be regarded as, for lexicographic purposes, belonging to that language; while many more may or may not be held to belong to it, according to the judgment—almost the whim—of the individual lexicographer. This is especially true of the English tongue. "That vast aggregate of words and phrases which constitutes the vocabulary of English-speaking men presents, to the mind that endeavours to grasp it as a definite whole, the aspect of one of those nebulous masses familiar to the astronomer, in which a clear and unmistakable nucleus shades off on all sides, through zones of decreasing brightness, to a dim marginal film that seems to end nowhere, but to lose itself imperceptibly in the surrounding darkness" (Dr J. A. H. Murray, *Oxford Dict.*, General Explanations, p. xvii). This "marginal film" of words with more or less doubtful claims to recognition includes thousands of the terms of the natural sciences (the New-Latin classificatory names of zoology and botany, names of chemical compounds and of minerals, and the like); half-naturalized foreign words; dialectal words; slang terms; trade names (many of which have passed or are passing into common use); proper names and many more. Many of these even the most complete dictionary should exclude; others it should include; but where the line shall be drawn will always remain a vexed question.

Another important principle upon which Trench insisted, and which also expresses a requirement of modern scientific philology, is that the dictionary shall be not merely a record, but also an *historical* record of words and their uses. From the literary point of view the most important thing is present usage. To that alone the idea of a "standard" has any application. Dictionaries of the older type, therefore, usually make the common, or "proper," or "root" meaning of a word the starting-point of its definition, and arrange its other senses in a logical or accidental order, commonly ignoring the historical order in which the various meanings arose. Still less do they attempt to give data from which the vocabulary of the language at any previous period may be determined. The philologist, however, for whom the growth, or progressive alteration, of a language is a fact of central importance, regards no record of a language as complete which does not exhibit this growth in its successive stages. He desires to know when and where each word, and each form and sense of it, are first found in the language; if the word or sense is obsolete, when it died; and any other fact that throws light upon its history. He requires, accordingly, of the lexicographer that, having ascertained these data, he shall make them the foundation of his exposition—in particular, of the division and arrangement of his definitions, that sense being placed first which appeared first in order of time. In other words, each article in the dictionary should furnish an orderly biography of the word of which it treats, each word and sense being so dated that the exact time of its appearance and the duration of its use may as nearly as possible be determined. This, in principle, is the method of the new lexicography. In practice it is subject to limitations similar to those of the vocabulary mentioned above. Incompleteness of the early record is here an even greater obstacle; and there are many words whose history is, for one reason or another, so unimportant that to treat it elaborately would be a waste of labour and space.

The adoption of the historical principle involves a further noteworthy modification of older methods, namely, an important extension of the use of quotations. To Dr Johnson belongs the credit of showing how useful, when properly chosen, they may be, not only in corroborating the lexicographer's statements, but also in revealing special shades of meaning or variations of use which his definitions cannot well express. No part of Johnson's work is more valuable than this. This idea was more fully developed and applied by Dr Charles Richardson, whose *New Dictionary of the English Language . . . Illustrated by Quotations from the Best Authors* (1835–36), still remains a most valuable collection of literary illustrations. Lexicographers, however, have, with few exceptions, until a recent date, employed quotations chiefly for the ends just mentioned—as instances of use or as illustrations of correct usage—with scarcely any recognition of their value as historical evidence; and they have taken them almost exclusively from the works of the "best" authors. But since all the data upon which conclusions with regard to the history of a word can be based must be collected from the literature of the language, it is evident that, in so far as the lexicographer is required to furnish evidence for an historical inference, a quotation is the best form in which he can give it. In fact, extracts, properly selected and grouped, are generally sufficient to show the entire meaning and biography of a word without the aid of elaborate definitions. The latter simply save the reader the trouble of drawing the proper conclusions for himself. A further rule of the new lexicography, accordingly, is that quotations should be used, primarily, as historical evidence, and that the history of words and meanings should be exhibited by means of them. The earliest instance of use that can be found, and (if the word or sense is obsolete) the latest, are as a rule to be given; while in the case of an important

word or sense, instances taken from successive periods of its currency also should be cited. Moreover, a quotation which contains an important bit of historical evidence must be used, whether its source is "good," from the literary point of view, or not—whether it is a classic of the language or from a daily newspaper; though where choice is possible, preference should, of course, be given to quotations extracted from the works of the best writers. This rule does not do away with the illustrative use of quotations, which is still recognized as highly important, but it subordinates it to their historical use. It is necessary to add that it implies that the extracts must be given exactly and in the original spelling and capitalization, accurately dated, and furnished with a precise reference to author, book, volume, page, and edition; for insistence upon these requirements—which are obviously important, whatever the use of the quotation may be—is one of the most noteworthy of modern innovations. Johnson usually gave simply the author's name, and often quoted from memory and inaccurately; and many of his successors to this day have followed—altogether or to some extent—his example.

The chief difficulty in the way of this use of quotations —after the difficulty of collection—is that of finding space for them in a dictionary of reasonable size. Preference must be given to those which are essential, the number of those which are cited merely on methodical grounds being made as small as possible. It is hardly necessary to add that the negative evidence furnished by quotations is generally of little value; one can seldom, that is, be certain that the lexicographer has actually found the earliest or the latest use, or that the word or sense has not been current during some intermediate period from which he has no quotations.

Lastly, a much more important place in the scheme of the ideal dictionary is now assigned to the *etymology* of words. This may be attributed, in part, to the recent rapid development of etymology as a science, and to the greater abundance of trustworthy data; but it is chiefly due to the fact that from the historical point of view the connexion between that section of the biography of a word which lies within the language—subsequent, that is, to the time when the language may, for lexicographical purposes, be assumed to have begun, or to the time when the word was adopted or invented—and its antecedent history has become more vital and interesting. Etymology, in other words, is essentially the history of the *form* of a word up to the time when it became a part of the language, and is, in a measure, an extension of the history of the development of the word in the language. Moreover, it is the only means by which the exact relations of allied words can be ascertained, and the separation of words of the same form but of diverse origin (homonyms) can be effected, and is thus, for the dictionary, the foundation of all *family history* and correct *genealogy*. In fact, the attention that has been paid to these two points in the best recent lexicography is one of its distinguishing and most important characteristics. Related to the etymology of words are the changes in their form which may have occurred while they have been in use as parts of the language—modifications of their pronunciation, corruptions by popular etymology or false associations, and the like. The facts with regard to these things which the wide research necessitated by the historical method furnishes abundantly to the modern lexicographer are often among the most novel and interesting of his acquisitions.

It should be added that even approximate conformity to the theoretical requirements of modern lexicography as above outlined is possible only under conditions similar to those under which the *Oxford English Dictionary* was undertaken (see below). The labour demanded is too vast, and the necessary bulk of the dictionary too great. When, however, a language is recorded in one such dictionary, those of smaller size and more modest pretensions can rest upon it as an authority and conform to it as a model so far as their special limitations permit.

The ideal thus developed is primarily that of the general dictionary of the purely philological type, but it applies also to the encyclopædic dictionary. In so far as the latter is strictly lexicographic—deals with words as words, and not with the things they denote—it should be made after the model of the former, and is defective to the extent in which it deviates from it. The addition of encyclopædic matter to the philological in no way affects the general principles involved. It may, however, for practical reasons, modify their application in various ways. For example, the number of obsolete and dialectal words included may be much diminished and the number of scientific terms (for instance, New-Latin botanical and zoological names) be increased; and the relative amount of space devoted to etymologies and quotations may be lessened. In general, since books of this kind are designed to serve more or less as works of general reference, the making of them must be governed by considerations of practical utility which the compilers of a purely philological dictionary are not obliged to regard. The encyclopædic type itself, although it has often been criticized as hybrid—as a mixture of two things which should be kept distinct—is entirely defensible. Between the dictionary and the encyclopædia the dividing-line cannot sharply be drawn. There are words the meaning of which cannot be explained fully without some description of things, and, on the other hand, the description of things and processes often involves the definition of names. To the combination of the two objection cannot justly be made, so long as it is effected in a way—with a selection of material—that leaves the dictionary essentially a dictionary and not an encyclopædia. Moreover, the large vocabulary of the general dictionary makes it possible to present certain kinds of encyclopædic matter with a degree of fulness and a convenience of arrangement which are possible in no single work of any other class. In fact, it may be said that if the encyclopædic dictionary did not exist it would have to be invented; that its justification is its indispensableness. Not the least of its advantages is that it makes legitimate the use of diagrams and pictorial illustrations, which, if properly selected and executed, are often valuable aids to definition.

**Practical methods of modern lexicography.**

On its practical side the advance in lexicography has consisted in the elaboration of methods long in use rather than in the invention of new ones. The only way to collect the data upon which the vocabulary, the definitions, and the history are to be based is, of course, to search for them in the written monuments of the language, as all lexicographers who have not merely borrowed from their predecessors have done. But the wider scope and special aims of the new lexicography demand that the investigation shall be vastly more comprehensive, systematic, and precise. It is necessary, in brief, that, as far as may be possible, the literature (of all kinds) of every period of the language shall be examined systematically, in order that all the words, and senses and forms of words, which have existed during any period may be found, and that enough excerpts (carefully verified, credited, and dated) to cover all the essential facts shall be made. The books, pamphlets, journals, newspapers, and so on which must thus be searched will be numbered by thousands, and the quotations selected may (as in the case of the *Oxford Dictionary*) be counted by millions. This task is beyond the powers of any one man, even though he be a Johnson, or a Littré,

or a Grimm, and it is now assigned to a corps of readers whose number is limited only by the ability of the editor to obtain such assistance. The modern method of editing the material thus accumulated—the actual work of compilation — also is characterized by the application of the principle of the division of labour. Johnson boasted that his dictionary was written with but little assistance from the learned, and the same was in large measure true of that of Littré. Such attempts on the part of one man to write practically the whole of a general dictionary are no longer possible, not merely because of the vast labour and philological research necessitated by modern aims, but more especially because the immense development of the vocabulary of the special sciences renders indispensable the assistance, in the work of definition, of persons who are expert in those sciences. The tendency, accordingly, has been to enlarge greatly the editorial staff of the dictionary, scores of sub-editors and contributors being now employed where a dozen or fewer were formerly deemed sufficient. In other words, the making of a "complete" dictionary has become a co-operative enterprise, to the success of which workers in all the fields of literature and science contribute.

The most complete exemplification of these principles and methods is the *Oxford English Dictionary*. It originated in the suggestion of Trench that an attempt should be made, under the direction of the Philological Society, to complete the vocabulary of existing dictionaries and to supply the historical information which they lacked. The suggestion was adopted, considerable material was collected, and Mr Herbert Coleridge was appointed general editor. He died in 1861, and was succeeded by Mr F. J. Furnivall. Little, however, was done, beyond the collection of quotations—about two millions of which were gathered—until in 1878 the expense of printing and publishing the proposed dictionary was assumed by the Delegates of the Clarendon Press, and the editorship was entrusted to Dr J. A. H. Murray. From that time the work has been carried on with vigour and increasing rapidity, and it will probably be completed about 1912. As the historical point of beginning, the middle of the 12th century was selected, all words that were obsolete at that date being excluded, though the history of words that were current both before and after that date is given in its entirety; and it was decided that the search for quotations—which, according to the original design, was to cover the entire literature down to the beginning of the 16th century and as much of the subsequent literature (especially the works of the more important writers and works on special subjects) as might be possible—should be made more thorough. More than 800 readers, in all parts of the world, offered their aid; and when the preface to the first volume appeared in 1888, the editor was able to announce that the readers had increased to 1300, and that three and one-half millions of quotations, taken from the writings of more than five thousand authors, had been amassed: numbers which must now be very greatly enlarged. The first part was issued in 1884, and up to April 1901 somewhat less, probably, than one-half of the work had appeared (to the word *Lap*, with the exception of the letter *K*; in five volumes and the first part of the sixth). The number of "main words," "subordinate words," and "special combinations" (the last term including a very large number of ordinary compounds, loose compounds, and phrases) defined in these published portions is given as 148,413, a figure which indicates a total for the whole dictionary of considerably more than 300,000. When this is compared with the 40,000 words (about) registered by Johnson, the progress made in the direction of completeness will be evident. Completeness, however, is less important than quality of work, and for this the dictionary is equally notable. The historical method of exposition, particularly by quotations, is applied, if not in all cases with entire success, yet, on the whole, with a regularity and a precision which leave little to be desired. A minor fault is that excerpts from second or third rate authors have occasionally been used where better ones from writers of the first class either must have been at hand or could have been found. As was said above, the literary quality of the quotation is highly important even in historical lexicography, and should not be neglected unnecessarily. Other special features of the book are the completeness with which variations of pronunciation and orthography (with dates) are given; the fulness and scientific excellence of the etymologies, which abound in new information and corrections of old errors; the phonetic precision with which the present (British) pronunciation is indicated; and the elaborate subdivision of meanings. The definitions as a whole are marked by a high degree of accuracy. Work of such magnitude and quality is possible, practically, only when the editor of the dictionary can command not merely the aid of a very large number of scholars and men of science, but their gratuitous aid. In this the *Oxford Dictionary* has been singularly fortunate. The conditions under which it originated, and its aim, have interested scholars everywhere, and led them to contribute to the perfecting of it their knowledge and time. The long list of names of such helpers in Dr Murray's preface is in curious contrast with their absence from Dr Johnson's and the few which are given in that of Littré. Of the dictionary as a whole it may be said that it is one of the greatest achievements, whether in literature or science, of the Victorian Age.

The *Oxford Dictionary* furnishes for the first time data from which the extent of the English word-store at any given period, and the direction and rapidity of its growth, can fairly be estimated. For this purpose the materials furnished by the older dictionaries are quite insufficient, on account of their incompleteness and unhistorical character. For example, one hundred pages of the *Oxford Dictionary* (from the letter H) contain 1002 words, of which, as the dated quotations show, 585 were current in 1750 (though some, of course, were very rare, some dialectal, and so on), 191 were obsolete at that date, and 226 have since come into use. But of the more than 700 words — current or obsolete — which Johnson might thus have recorded, he actually did record only about 300. Later dictionaries give more of them, but they in no way show their status at the date in question. It is worth noting that the figures given seem to indicate that not very many more words have been added to the vocabulary of the language during the past one hundred and fifty years than had been lost by 1750. The pages selected, however, contain comparatively few recent scientific terms. A broader comparison would probably show that the gain has been more than twice as great as the loss.

In the *Deutsches Wörterbuch* of Jacob and Wilhelm Grimm the scientific spirit, as was said above, first found expression in general lexicography. The desirability of a complete inventory and investigation of German words was recognized by Leibnitz and by various 18th-century scholars, but the plan and methods of the Grimms were the direct product of the then new scientific philology. Their design, in brief, was to give an exhaustive account of the words of the literary language (New High German) from about the end of the 15th century, including their earlier etymological and later history, with references to important dialectal words and forms; and to illustrate their use and history abundantly by quotations. The first volume appeared in 1854. At the present time seven others have been completed, and one has nearly been finished, while parts of the remaining three (there are to be twelve in all) have been issued. Jacob Grimm (died 1863) edited the first, second (with his brother, who died in 1859), third, and a part of the fourth volumes; the others have been edited by various distinguished scholars. The scope and methods of this dictionary have been

broadened somewhat as the work has advanced. In general it may be said that it differs from the *Oxford Dictionary* chiefly in its omission of pronunciations and other pedagogic matter; its irregular treatment of dates; its much less systematic and less lucid statement of etymologies; its less systematic and less fruitful use of quotations; and its less convenient and less intelligible arrangement of material and typography.

These general principles lie also at the foundation of the scholarly *Dictionnaire de la langue française* of E. Littré, though they are there carried out less systematically and less completely. In the arrangement of the definitions the first place is given to the most primitive meaning of the word instead of to the most common one, as in the dictionary of the Academy; but the other meanings follow in an order that is often logical rather than historical. Quotations also are frequently used merely as literary illustrations, or are entirely omitted; in the special paragraphs on the history of words before the 16th century, however, they are put to a strictly historical use. This dictionary—perhaps the greatest ever compiled by one man—was published 1863–72. (Supplement, 1878.)

The *Thesaurus Linguae Latinae*, prepared under the auspices of the German Academies of Berlin, Göttingen, Leipzig, Munich, and Vienna, is a notable application of the principles and practical co-operative method of modern lexicography to the classical tongues. The plan of the work is to collect quotations which shall register, with its full context, every word (except the most familiar particles) in the text of each Latin author down to the middle of the 2nd century A.D., and to extract all important passages from all writers of the following centuries down to the 7th; and upon these materials to found a complete historical dictionary of the Latin language. The work of collecting quotations was begun in 1894, and the first part of the first volume has been published.

In the making of all of these great dictionaries (except, of course, the last) the needs of the general public as well as those of scholars have been kept in view. But the type to which the general dictionary designed for popular use has tended more and more to conform is the *encyclopædic*. This combination of lexicon and encyclopædia is exhibited in an extreme—and theoretically objectionable—form in the *Grand dictionnaire universel du XIX^e^ siècle* of Pierre Larousse. Besides common words and their definitions, it contains a great many proper names, with a correspondingly large number of biographical, geographical, historical, and other articles, the connexion of which with the strictly lexicographical part is purely mechanical. Its utility, which—notwithstanding its many defects—is very great, makes it, however, a model which will be copied in the future. Fifteen volumes were published 1866–76, and a much improved new edition (*Nouveau Larousse Illustré*) was being published during 1901–2.

The most notable work of this class, in English, is *The Century Dictionary*, edited by Professor W. D. Whitney, and published 1889–91 in six volumes, containing 7046 pages (large quarto). It conforms to the philological model in giving with great fulness the older as well as the present vocabulary of the language, and in the completeness of its etymologies; but it does not attempt to give the full history of every word within the language. Among its other more noteworthy characteristics are the inclusion of a great number of modern scientific and technical words, and the abundance of its quotations. The quotations are for the most part provided with references, but they are not dated. In the application of the encyclopædic method this dictionary is conservative, excluding, with a few exceptions, proper names, and restricting, for the most part, the encyclopædic matter to descriptive and other details which may legitimately be added to the definitions. Its pictorial illustrations are very numerous and well executed. In the manner of its compilation it is a good example of modern co-operative dictionary-making, being the joint product of a large number of specialists. Next to the *Oxford Dictionary* it is the most complete and scholarly of English lexicons.

Among the more important dictionaries of European languages that have appeared since the list given in the 9th ed. of the *Ency. Brit.* vol. vii. (pp. 183–193) was written are the following:—

ANNANDALE. *The Imperial Dictionary of the English Language*, by John Ogilvie, LL.D.; new edition by Charles Annandale, M.A., London, 1882; 4 volumes. An encyclopædic dictionary, which served in a manner as the foundation of the *Century Dictionary*.—STORMONTH and W. BAYNE. *A Dictionary of the English Language.* 1885.—MURRAY and BRADLEY. *The Oxford English Dictionary: A New English Dictionary on Historical Principles*; founded mainly on the materials collected by the Philological Society. Oxford, 1888 [1884].—WHITNEY. *The Century Dictionary: An Encyclopedic Lexicon of the English Language.* New York, 1889–91. See above.—PORTER. *Webster's International Dictionary of the English Language.* Springfield, Mass., 1890.—FUNK. *A Standard Dictionary of the English Language.* New York, 1894.—HUNTER. *The Encyclopedic Dictionary.* London and New York, 1879–88.—FENNELL. *The Stanford Dictionary of Anglicized Words and Phrases.* Cambridge, 1892.—TOLLER. *An Anglo-Saxon Dictionary based on Manuscript Collections of the late Joseph Bosworth, D.D.* Oxford, 1882–98.—SKEAT. *An Etymological Dictionary of the English Language.* Oxford, 1881.—WRIGHT. *The English Dialect Dictionary.* London. Vol. 1, A–C, 1898; vol. 2, D–G, 1900.—BRADLEY. *A Middle-English Dictionary by Francis Henry Stratman*; a new edition by Henry Bradley. Oxford, 1891.—MÄTZNER and BIELING. *Altenglische Sprachproben, nebst einem Wörterbuch.* Berlin, 1878—. This dictionary had been advanced as far as *Misteleven* in 1900.—BESCHERELLE. *Nouveau dictionnaire national, ou dictionnaire universel de la langue française.* Paris, 1887.—GODEFROY. *Dictionnaire de l'ancienne langue française, et de tous ses dialectes du IX^e^ au XV^e^ siècle.* Paris, 1881–95; *Complément*, 1895—.—HATZFELD, DARMESTETER, and THOMAS. *Dictionnaire général de la langue française.* Paris, 1890–1900.—LARIVE et FLEURY. *Dictionnaire français illustré des mots et des choses.* Paris, 1884–91.—PETROCCHI. *Novo dizionario universale della lingua italiana.* Milan, 1884–91.—CUERVO. *Diccionario de construccion y regimen de la lengua castellana.* A–B (1886): C–D (1894).—MONLAU. *Diccionario etimológico de la lengua castellana.* Madrid, 1881.—ZEROLA, TORO Y GOMES, and ISAZA. *Diccionario enciclopédico de la lengua castellana.* Paris, 1895.—SERRANO. *Diccionario universal de la lengua castellana, ciencias, y artes: enciclopedia de los conocimientos humanos.* Madrid, 1876–81.—BARCIA. *Primer diccionario general etimológico de la lengua española.* Madrid, 1881–83.—SANDERS. *Ergänzungs-Wörterbuch der deutschen Sprache.* Berlin, 1885.—KLUGE. *Etymologisches Wörterbuch der deutschen Sprache.* Strassburg, 1883.—HEYNE. *Deutsches Wörterbuch.* Leipzig, 1890–95.—DIEFENBACH and WÜLCHER. *Hoch-und niederdeutsches Wörterbuch der mittleren und neueren Zeit. In Ergänzung der vorhandenen Wörterbücher, insbesondere das der Brüder Grimm.* Basel, 1885.—WEIGAND. *Deutsches Wörterbuch.* Giessen, 1873.—SCHADE. *Altdeutsches Wörterbuch.* Halle, 1872–82.—KALKAR. *Ordbog til det ældre Danske Sprog.* Copenhagen. (Incomplete.)—DALE. *Groot Woordenboek der Nederlandsche taal.* s'Gravenhage, 1898 (4th ed.).—VRIES and WINKEL. *Woordenboek der Nederlandsche taal.* s'Gravenhage, 1882—.—VERWIJS and VERDAM. *Middelnederlandsch Woordenboek.* s'Gravenhage, 1885–99 (A–N).—FRANCK. *Etymologische Woordenboek der Nederlandsche taal.* 1884–92.—EVANS. *Dictionary of the Welsh Language.* Carmarthen, 1887. (Incomplete.)—CLEASBY-VIGFUSSON. *An Icelandic-English Dictionary based on the MS. Collections of the late Richard Cleasby, enlarged and completed by Gudbrand Vigfusson, M.A.* Oxford, 1874.—MIKLOSICH. *Etymologisches Wörterbuch der Slavischen Sprachen.* Wien, 1886.—BALG. *A Comparative Glossary of the Gothic Language.* Mayville, Wisconsin, 1887–89.—*Thesaurus Linguae Latinae.* Leipzig, 1900. (B. E. S.)

**Didon, Henri** (1840–1900), French Dominican priest, was born at Touvet, Isère, on 17th March 1840. In his early life he was brought into relations with Lacordaire. In consequence, probably, of this he became a Dominican monk in 1862. He completed his theological studies at the Minerva Convent at Rome, and became a great admirer of the theology of Aquinas. The influence of Lacordaire was further shown in the zeal displayed by the young

preacher in favour of a reconciliation between philosophy and science. In 1871 his fame had so much grown that he was chosen to deliver the funeral oration over the murdered archbishop of Paris, Monseigneur Darboy. After this he delivered some discourses at the Church of St Jean de Beauvais in Paris on the relations between science and religion; but his utterances, especially on the question of divorce, were deemed suspicious by those in authority, and his intimacy with Claude Bernard the physiologist was disapproved. He was interdicted from preaching and sent into retirement at the Convent of Corbara in Corsica. After eighteen months he emerged, and travelled in Germany, publishing an interesting work upon that country, entitled *Les Allemands*, on his return to France. In 1890 he produced his best-known work, a Life of Jesus (*Jésus-Christ*), for which he had qualified himself by travel in the Holy Land. In the same year he became director of the College Albert-le-Grand (Albertus Magnus) at Arcueil, and himself founded three auxiliary institutions, École Lacordaire, École Laplace, and École St Dominique. He wrote, in addition, several works on educational questions, and augmented his fame as an eloquent preacher by discourses preached during Lent and Advent. He died in 1900. (J. J. L*.)

**Diedenhofen** (in French, *Thionville*), a fortified town of Germany, in Alsace-Lorraine, dist. Lorraine, on the Moselle, 22 miles north from Metz by rail, a railway junction of some consequence, with cultivation of wine, fruit, and vegetables, brewing, tanning, &c. It is an ancient Frank town (*Theudonevilla*, *Totonisvilla*), in which imperial diets were held in the 8th century; was captured by Condé in 1643 and fortified by Vauban; capitulated to the Prussians in 1870. Population (1885), 8111; (1900), 10,062.

**Dieppe,** chief town of arrondissement, department of Seine Inférieure, France, 35 miles north of Rouen, with terminal station on railway from Paris. The Palais de Justice is a recent erection. Lace, woollen goods, and ceramic wares are now important manufactures. The ivory carving has greatly declined in recent years, and instead of 300 in 1866 only about 40 workmen were employed in it in 1898. Efforts are being made, however, to give a fresh impetus to this industry. In 1900, 1894 vessels of 497,446 tons entered and cleared, of which Great Britain's share was 340,082 tons. Imports were valued (1899) at £5,248,000; exports at £6,732,000. The principal imports were textiles (chiefly silk), forming 50 per cent. The principal exports were textiles (silk, cotton, and woollen), amounting to 40 per cent., and hides and skins. During the summer months large quantities of fruit are sent to England. The total port traffic on the Canal de Bourgoyne amounted to 94,774 tons in 1899. The number of vessels engaged in the fisheries in 1898 was 95, with 471 men. A school of fisheries, similar to that which has already rendered good service at Sables d'Olonne, has been established at Dieppe. A new harbour railway station and a landing stage were opened in 1900, and an esplanade ¾ mile in length is in course of construction. The passenger traffic with England was represented in 1900 by 130,985 arrivals from and 139,143 departures to that country. The harbour, to which an improved approach is projected, comprises an outer and an inner port, with a total length of quayage 3772 feet. Depth at high tide in the outer port (ordinary spring) varies in different parts from 29 to 36 feet. There are four floating docks and a dry dock. The entrance channel, cut in the bed of the Arques, is 1950 feet long and 246 feet wide. Population (1881), 20,408; (1901), 21,798.

**Dietetics.**—The term dietetics is frequently applied to the science of the food and nutrition of man in health and disease. This article deals mainly with that part of the subject which has to do with the composition and nutritive values of foods and their adaptation to the use of people in health. The principal topics are:—1. Food and its functions. 2. Metabolism of matter and energy. 3. Digestibility and availability of food materials. 4. Fuel-value of food. 5. Composition of food materials. 6. Food consumption—studies of dietaries. 7. Hygienic economy of food. 8. Quantities of nutrients needed. 9. Pecuniary economy of food.

1. *Food and its Functions.*—Food is that which, taken into the body, builds tissue or yields energy. More specifically, food supplies the wants of the body in several ways:—(1) it forms the tissues and fluids of the body; (2) it repairs the waste of tissues; (3) it is stored in the body for future consumption; (4) it is consumed as fuel, its potential energy being transformed into heat or muscular energy or other forms of energy required by the body; and (5) in being consumed, it protects tissue or other food from consumption. The most healthful food is that which is best fitted to the needs of the user. To be adapted to his needs, the food must supply the different nutritive ingredients, or nutrients, in the kinds and proportions required by the body for building and repair and for supplying energy. It should also be in forms which the person can easily digest and which will "agree" with him. The cheapest food is that which furnishes the most nutriment at the least cost. The most economical food is that which is most healthful and cheapest. Ordinary food materials, such as meat, fish, eggs, potatoes, wheat, &c., consist of—*refuse*, *e.g.*, the bones of meat and fish, shells of shellfish, skin of potatoes, bran of wheat, &c.; *edible portion*, *e.g.*, the flesh of meat and fish, the white and yolk of eggs, wheat flour, &c. The edible portion consists of water and nutritive ingredients or nutrients.

The principal kinds of nutritive ingredients are *protein*, *fats*, *carbohydrates*, and *mineral matters*. The water, refuse (and salt of salted meat and fish), are here regarded as non-nutrients and, in comparing the values of different food materials for nourishment, are left out of account. The following are familiar examples of compounds of each of the four principal classes of nutrients:—

*Protein.*—The term protein is here used to include the nitrogenous nutrients of foods except the nitrogenous fat, namely, the proteids, *e.g.*, albumen (white of egg), casein (curd) of milk, myosin of muscle (lean meat), gluten of wheat, &c.; and the non-proteids, including the so-called extractives (*e.g.*, creatin) of meats and the amides (*e.g.*, asparagin), and allied compounds of vegetables and fruits.[1]

*Fats.*—Fat of meat; fat (butter) of milk, olive oil, oil of corn, wheat, &c. (Here are included the nitrogenized fats, as lecithin.)

*Carbohydrates.*—Sugars, starches, cellulose (woody fibre), &c.

*Mineral Matters.*—Phosphates, sulphates, and chlorides of potassium, sodium, calcium, &c.

Protein forms tissue (muscle, tendon, &c.) and fat, and serves as fuel. Fats form fatty tissue (not muscle, &c.) and serve as fuel. Carbohydrates are transformed into fat and serve as fuel. All these nutrients yield energy in the form of heat and muscular power. In being themselves burned to yield energy, the nutrients protect each other from being consumed. The protein and fats of body tissue

[1] Unfortunately the terms applied by different writers to these nitrogenous compounds are very conflicting. In accordance with a common usage, preference is here given to the word protein to cover all the nitrogenous compounds except the nitrogenous fats, though the word proteid is sometimes used in this signification.

are used like those of food. An important use of the carbohydrates and fats is to protect body tissue (muscle, &c.) from consumption. What compounds are especially concerned in the production of intellectual or nervous energy is not known. The idea that fish is especially rich in phosphorus and valuable as brain food has no foundation in observed fact.

Heat and muscular work represent forms of energy. The energy is developed as the food is consumed in the body, and is measured in the laboratory by means of an apparatus called the calorimeter. The unit commonly used is the calorie, the amount of heat which would raise the temperature of a kilogram of water 1 degree centigrade, or approximately 1 pound of water 4 degrees Fahrenheit. By heat of combustion is meant the amount of heat which a given substance yields upon combustion with oxygen outside the body. Thus a gram of cane-sugar yields 3·96 calories, and a gram of proteid, in the form of white of egg, 5·69 calories. By fuel-value is here meant the total energy which a given substance can yield the body; in other words, it is the heat of combustion of that part of the food which is capable of oxidation within the body.

2. *Metabolism of Matter and Energy.*—In so far as its material phenomena are concerned, life consists of transformations of matter and energy, to which the term metabolism is applied. The processes of metabolism are thus of two definite and closely allied kinds—the metabolism of matter, in which the changes are chemical, and that of energy, in which the changes are physical. To say that the chemical transformations in the body obey the law of the conservation of matter is simply to say that the body can neither create nor destroy matter—a principle long since demonstrated and universally accepted. It would seem that the metabolism of energy must in like manner obey the law of the conservation of energy, but owing to the great experimental difficulties the actual demonstration of this principle has been long delayed. For this demonstration it is necessary to prove that the income and expenditure of energy are equal. The body receives energy in the compounds of the food and drink. In the processes of nutrition the potential energy of these compounds is metabolized, and appears as kinetic energy in the heat given off from the body, and in the external muscular work performed, although a small amount remains unchanged, mostly in the unoxidized materials excreted by the kidneys, intestines, and otherwise. The minute quantities given off as electricity or light by some animals are here neglected. The apparatus and methods of experimenting lately devised make it possible to measure the energy of income in food and drink on the one hand, and that of expenditure in body heat, external work, and unoxidized excretory products on the other. The potential energy of income and expenditure is measured by the heat of combustion of food and excretory products as determined by burning with oxygen in the bomb calorimeter. The kinetic energy, which is found only in the expenditure, is measured by the respiration calorimeter—an apparatus in which the subject of the experiment (a man, for instance) remains for a number of days and nights under conditions which permit of comparison between the matter and energy taken in and given off. This involves weighings, measurements, and analyses of the food and drink, and of respiratory and other excretory products, and measurements of the heat given off by the body, and of the external mechanical work, allowance being made for the energy of the body material gained or lost during the experiment.

Partial measurements of income and expenditure of energy were published by Rubner[1] in 1894. The experiments were made with dogs without external muscular work. The income of energy was computed from the excretory products, while the outgoings in the form of heat (since no external muscular work was done) were measured directly. In the average of 8 experiments, which continued during 45 days, the two quantities agreed within 0·47 per cent., thus demonstrating, what the author desired to prove, that the heat given off from the body came solely from the oxidation of food within it. Results in accord with these were reported by Studenski[2] and by Laulanie in 1898.[3] Results of experiments with men have been lately published by Atwater, Rosa, and Benedict and associates,[4] who used a respiration calorimeter as above mentioned, and made detailed analyses and determinations of heats of combustion of food, drink, and excretory products, and measurements of heat given off by the body and the heat equivalent of the external muscular work done. In all, 30 experiments had been reported by November 1901, occupying from 2 to 4 days each, or a total of 93 days of experimenting. In some of these experiments the subject was at rest; in others he rode a stationary bicycle belted to a dynamo, so that the external muscular work was used to generate an electric current which was measured and afterwards transformed into heat within the calorimeter by passage through a resistance, the heat being measured with that given off by the body. The diet was generally not far from sufficient to maintain nitrogen and carbon equilibrium. In these experiments the energy actually measured, in the form of heat given off from the body and that from the external muscular work done in work experiments, accord on the average very closely with the estimated potential energy of the material oxidized in the body. It is to be observed, however, that the variations for individual days, and in the averages for the individual experiments as well, were considerable, sometimes amounting to 6 per cent., or even more. This is perhaps not strange in view of the physiological conditions of the experiments. In the average of all the experiments the measured energy of expenditure was 99·8 per cent. of the estimated energy of income; in other words, they agreed within two parts in one thousand. While these results do not absolutely prove the application of the law of the conservation of energy in the human body, they certainly approximate very closely to such demonstration. It is, of course, possible that energy may have been given off from the body in other forms than heat and external muscular work. Thus it is conceivable that intellectual activity may involve a transformation of physical energy, and that this energy may be eliminated in some form now unknown. But if the body did give off energy which was not measured in these experiments, the quantity must have been extremely small. It seems fair to infer from these results that the metabolism of energy in the body occurred in conformity with the law of the conservation of energy.

3. *Digestibility and Availability of Food.*—The value of a food for nutriment depends not only upon the kinds and amounts of nutrients which it contains, but also upon the proportions of these nutrients which the body can digest and make available, and upon the ease and convenience with which the materials are utilized. By digestion in the narrower sense is understood the changes, chiefly chemical, but partly physical, which the food undergoes in the alimentary canal in order to prepare it for absorption. By digestibility of food, as the term is popularly understood, several things are, or may be, meant. Some of these (as the ease with which a given food material is digested, the time required for the process, the influence of different methods of preparation, including cooking, and the influence of condiments) are so difficult of measurement, and others (as bodily conditions, and the question as to whether a given food agrees or disagrees with a given person) are so dependent upon the peculiarities of different individuals, as to make it impossible to lay down hard and fast rules. The term digestibility is also applied to the proportion of the several kinds of nutrients which the body can digest from different kinds of food materials. These proportions are best found by actual experiment in which

[1] *Ztschr. Biol.* 30, 73.

[2] In Russian. Cited in Bulletin No. 45 of the Office of Experiment Stations, U.S. Department of Agriculture: "A Digest of Metabolism Experiments," by W. O. Atwater and C. F. Langworthy.

[3] *Archiv. de biol. norm. et path.*, 1898, 4.

[4] Office of Experiment Stations, U.S. Department of Agriculture, Bulletin No. 63, "Description of a New Respiration Calorimeter," by W. O. Atwater and E. B. Rosa; and Bulletin No. 69, "Experiments on the Metabolism of Matter and Energy in the Human Body," by W. O. Atwater and F. G. Benedict.

people of different classes eat known amounts of different food materials, and the amounts digested are determined by weighings and analyses of the food and excreta. Suppose the diet to consist of bread and milk. The larger part of the nutrients will be digested, absorbed, taken into the circulation, and utilized. A small proportion, however, will pass through the intestines undigested, and along with this undigested residue there will also be excreted a certain amount of residuum, mainly from the digestive juices. That is to say, these two forms of residues, the undigested portions of the food and the metabolic products, are not oxidized, but are excreted together. To find what proportion of the diet is actually available to the body for the two great purposes of building of tissue and yielding of energy, we must take the total quantity of nutrients, and subtract the amounts given off unconsumed. Thus the handling of the bread and milk within the body, and getting it into condition to be metabolized in the system, involves the rejection by the intestines of a certain amount of material unavailable for the general purposes of nutrition. This brings out the difference between digestibility and availability. The former applies to the amounts actually digested in the alimentary canal, the latter to the amounts actually available for use. The difference is practically the amount used to digest the food and make it available.

This subject is comparatively new, and although experimental inquiries have been actively pushed since 1880, and especially since 1890, the results are still insufficient for exact statements regarding the availability of different kinds of food material. The following estimates[1] are based upon the results of nearly 300 experiments, made in Europe and in the United States, with persons, chiefly men, living upon different diets. The figures are subject to revision as data accumulate. While they are not to be taken as exact measures of the availability of every kind of food of each given class, they probably represent fairly well the average availability of these classes of food materials under ordinary circumstances.

*Coefficients of Availability and Fuel-Value of Nutrients.*

| Kind of Food. | Coefficients of Availability. | | | Fuel-Value per gram of Total Nutrients. | | |
|---|---|---|---|---|---|---|
| | Protein. | Fat. | Carbohydrates. | Protein. | Fat. | Carbohydrates. |
| | Per c. | Per c. | Per c. | Cals. | Cals. | Cals. |
| Meats and fish | 97 | 95 | 98 | 4·25 | 9·00 | 3·80 |
| Eggs | 97 | 95 | 98 | 4·35 | 9·00 | 3·80 |
| Dairy products | 97 | 95 | 98 | 4·25 | 8·80 | 3·80 |
| Animal food (of mixed diet) | 97 | 95 | 98 | 4·25 | 8·95 | 3·80 |
| Cereals | 85 | 90 | 98 | 3·70 | 8·35 | 4·10 |
| Legumes (dried) | 78 | 90 | 97 | 3·20 | 8·35 | 4·05 |
| Sugars | — | — | 98 | — | — | 3·85 |
| Starches | — | — | 98 | — | — | 4·10 |
| Vegetables | 83 | 90 | 95 | 2·90 | 8·35 | 4·00 |
| Fruits | 85 | 90 | 90 | 3·15 | 8·35 | 3·60 |
| Vegetable food (of mixed diet) | 85 | 90 | 97 | 3·55 | 8·35 | 4·00 |
| Total food (of mixed diet) | 92 | 95 | 97 | 4·00 | 8·90 | 4·00 |

4. *Fuel-Value of Food.*—The fuel-value of a particular food material depends on the proportions of available nutrients which can be oxidized in the body. It is commonly assumed that the available fats and carbohydrates are completely oxidized. Their fuel-value is the same as the heats of combustion of the available nutrients. The oxidation of the nitrogenous compounds,—proteids and non-proteids,—however, is not complete, considerable portions of the nitrogen being excreted in the kidneys in urea, creatinin, and other organic compounds. In determining the quantities of energy derived from the oxidation of the nitrogenous material in the body, therefore, allowance must be made for the energy lost to the body in these latter compounds. It will be seen that the term fuel-value is here used to represent the potential energy of the material actually oxidized, or capable of being oxidized, in the body. It thus represents the actually available energy, and might be called the physical fuel-value in distinction from the physiological fuel-value, which depends upon the ways the energy, made kinetic, is used by the body. This distinction corresponds to the one above made between the amounts of available nutrients and the extent to which they are actually utilized by the body.

The estimates of Rubner[2] commonly quoted for the fuel-value of the nutrients of mixed diet are as follow:—protein, 4·1; fats, 9·3; and carbohydrates, 4·1 calories per gram. These factors were, however, originally, intended to represent the average heat of combustion of the different nutrients in the ordinary mixed diet, allowance being made for the energy lost in the incomplete oxidation of the nitrogenous compounds of the urine. Later estimates have been made by Atwater and associates,[1] using data much more extensive than were available to Rubner, and including results of a considerable amount of experimenting in the United States. The factors for the different nutrients represent in each case the amount of energy which the body is capable of obtaining from one gram of the particular nutrient as it exists in the food as eaten in ordinary mixed diet.

*Estimates of Heats of Combustion and Fuel-Value of Nutrients in Ordinary Mixed Diet.*

| Nutrients. | Heat of Combustion. | Fuel-Value. |
|---|---|---|
| | Calories. | Calories. |
| One gram of protein | 5·65 | 4·0 |
| One gram of fats | 9·40 | 8·9 |
| One gram of carbohydrates | 4·10 | 4·0 |

Thus, averaging together the fats in ordinary mixed diet, one gram burned in the calorimeter would yield 9·40 calories of energy in the form of heat. Of this gram 95 per cent. is reckoned as available for oxidation in the body, and the part so oxidized would yield energy, in the form of heat, muscular work, &c., equivalent to $(9{\cdot}40 \times {\cdot}95 =)$ 8·9 calories. In like manner the heat of combustion of average protein is estimated at 5·65 calories per gram. Of this, 92 per cent. is estimated as available, and its potential energy would be $(5{\cdot}75 \times {\cdot}92 =)$ 5·2 calories. But part of this escapes oxidation, and is excreted by the kidneys. Allowing 1·2 calories for the potential energy of this portion, that actually oxidized will yield $(5{\cdot}2 - 1{\cdot}2 =)$ 4·0 calories, which is taken as the fuel-value of the protein. Similarly, 97 per cent. of the total energy of carbohydrates is assumed to be available for use in the body. Nutrients of the same class, but from different food materials, vary both in availability and in heat of combustion, and hence in fuel-value. The above estimates seem to represent the best averages available (1900), but are subject to revision.

5. *Composition of Food Materials.*—Different food materials vary widely in their proportions of nutrients, water, and refuse. In general, the animal foods have the most protein and fats, while the vegetable foods are rich in the carbohydrates—starch and sugar. The chief nutrient of lean meats and fish is protein. Cheese has a large quantity of protein because it contains the most of the proteids of the milk. Among the vegetable foods, beans and peas have a high proportion of protein. The proportion in oatmeal is also large. In wheat it is moderate, and in maize meal and rice it is rather small. The materials with the highest fuel-value are those with the most fat, because the fuel-value of the fat is, weight for weight, two and one-fourth times as great as that of either sugar, starch, or protein. Hence fat pork and butter lead the other materials in fuel-value. The fat meats in general

[1] Atwater and Bryant, Connecticut, Agricultural Experiment Station, 1899.

[2] *Ztschr. Biol.*, 21, 1885, p. 377.

stand high in this respect. So also do the grains, flour, and meal, as they have very little water and large quantities of carbohydrates. Potatoes are quite low in the list in respect to fuel-value as well as protein, principally because they are three-fourths water. For the same reason, milk, which is seven-eighths water, ranks low in respect to both protein and fuel-value.

| Kind of Food Material. | Water. | Unavailable Nutrients. | Available Nutrients. | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Protein. | Fat. | Carbohydrates. | Ash. | Fuel-Value. | |
| | | | | | | | Per Pound. | Per Kilo. |
| | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. | Calories. | Calories. |
| Beef[1]— | | | | | | | | |
| Leaner cuts[2] | 64·4 | 1·6 | 18·9 | 14·7 | ... | 0·7 | 1010 | 2220 |
| Medium fat cuts[3] | 61·5 | 1·8 | 17·9 | 18·5 | ... | 0·7 | 1155 | 2545 |
| Fatter cuts[4] | 56·4 | 2·0 | 16·5 | 24·9 | ... | 0·7 | 1400 | 3090 |
| Round | 65·5 | 1·6 | 19·7 | 12·9 | ... | 0·8 | 950 | 2090 |
| Loin | 60·6 | 1·8 | 17·9 | 19·2 | ... | 0·8 | 1185 | 2610 |
| Side | 59·7 | 1·8 | 17·6 | 20·9 | ... | 0·7 | 1250 | 2760 |
| Canned, corned | 51·8 | 2·7 | 25·5 | 17·8 | ... | 3·0 | 1275 | 2805 |
| Dried, smoked | 54·3 | 3·5 | 29·1 | 6·2 | ... | 6·8 | 850 | 1870 |
| Veal— | | | | | | | | |
| Leg | 70·0 | 1·3 | 19·6 | 8·6 | ... | 0·9 | 760 | 1680 |
| Loin | 69·0 | 1·3 | 19·3 | 10·3 | ... | 0·8 | 830 | 1825 |
| Side | 71·3 | 1·2 | 19·6 | 7·7 | ... | 0·8 | 725 | 1595 |
| Mutton— | | | | | | | | |
| Leg | 62·8 | 1·7 | 17·9 | 17·1 | ... | 0·8 | 1095 | 2410 |
| Loin | 50·2 | 2·4 | 15·5 | 31·4 | ... | 0·6 | 1660 | 3665 |
| Side | 53·6 | 2·2 | 15·7 | 28·3 | ... | 0·6 | 1535 | 3380 |
| Pork— | | | | | | | | |
| Loin | 52·0 | 2·2 | 16·1 | 28·6 | ... | 0·8 | 1555 | 3425 |
| Ham, smoked | 40·3 | 3·8 | 15·8 | 36·9 | ... | 3·4 | 1905 | 4200 |
| Fat, salt | 7·9 | 5·4 | 1·8 | 81·9 | ... | 2·9 | 3565 | 7860 |
| Bacon | 18·8 | 4·8 | 9·6 | 64·0 | ... | 3·3 | 2950 | 6500 |
| Lard | 4·8 | 4·8 | 2·1 | 89·3 | ... | 0·1 | 3890 | 8575 |
| Chicken | 63·7 | 1·6 | 18·7 | 15·5 | ... | 0·8 | 1040 | 2295 |
| Turkey | 55·3 | 1·9 | 20·5 | 21·8 | ... | 0·8 | 1350 | 2975 |
| Eggs | 73·7 | 1·1 | 14·4 | 10·0 | ... | 0·8 | 725 | 1600 |
| Cod,[5] fresh | 82·6 | 0·8 | 16·0 | 0·4 | ... | 0·9 | 335 | 740 |
| Cod, salt | 53·5 | 6·8 | 20·9 | 0·3 | ... | 18·5 | 430 | 950 |
| Mackerel,[6] fresh | 73·4 | 1·3 | 18·1 | 6·7 | ... | 0·9 | 650 | 1430 |
| Salmon, tinned | 63·5 | 1·9 | 21·1 | 11·5 | ... | 2·0 | 915 | 2020 |
| Oysters | 88·3 | 0·6 | 5·8 | 1·2 | 3·3 | 0·8 | 225 | 500 |
| Butter | 11·0 | 4·3 | 1·0 | 80·8 | ... | 0·2 | 3410 | 7515 |
| Cheese | 34·2 | 3·4 | 25·1 | 32·0 | 2·4 | 2·9 | 1880 | 4145 |
| Milk (whole) | 87·0 | 0·5 | 3·2 | 3·8 | 5·0 | 0·5 | 310 | 665 |
| Milk (skimmed) | 90·5 | 0·3 | 3·3 | 0·3 | 5·1 | 0·5 | 170 | 370 |
| Maize (Indian corn) meal | 12·5 | 3·2 | 7·5 | 1·7 | 74·3 | 0·8 | 1635 | 3620 |
| Oatmeal | 7·3 | 4·9 | 13·2 | 6·5 | 65·9 | 1·4 | 1800 | 3970 |
| Rice | 12·3 | 2·9 | 6·5 | 0·3 | 77·7 | 0·3 | 1615 | 3560 |
| Rye flour | 12·9 | 3·0 | 5·3 | 0·8 | 77·5 | 0·5 | 1615 | 3570 |
| Buckwheat flour | 13·6 | 2·8 | 5·2 | 1·1 | 76·6 | 0·7 | 1650 | 3640 |
| Graham flour | 11·3 | 3·9 | 10·3 | 2·0 | 71·1 | 1·4 | 1650 | 3640 |
| Entire wheat flour | 11·4 | 3·8 | 10·7 | 1·7 | 71·6 | 0·8 | 1655 | 3650 |
| Fine wheat flour | 12·0 | 3·3 | 8·8 | 0·9 | 74·6 | 0·4 | 1635 | 3605 |
| Wheat breakfast foods | 9·6 | 3·7 | 9·4 | 1·6 | 74·8 | 1·0 | 1680 | 3705 |
| Wheat bread, white | 35·3 | 2·8 | 7·1 | 1·2 | 52·8 | 0·8 | 1200 | 2645 |
| Rye bread | 35·7 | 2·8 | 7·0 | 0·5 | 52·9 | 1·1 | 1170 | 2585 |
| Biscuit (crackers) | 6·8 | 4·3 | 8·3 | 7·9 | 71·3 | 1·4 | 1765 | 3890 |
| Sugar | ... | ... | ... | ... | 98·0 | ... | 1760 | 3870 |
| Starch | ... | ... | ... | ... | 98·0 | ... | 1860 | 4125 |
| Beans, dried | 12·6 | 7·9 | 17·5 | 1·6 | 57·8 | 2·6 | 1495 | 3290 |
| Beets[7] | 87·5 | 1·1 | 1·2 | 0·1 | 9·3 | 0·8 | 200 | 445 |
| Cabbage[8] | 91·5 | 1·0 | 1·3 | 0·3 | 5·1 | 0·8 | 130 | 290 |
| Squash | 88·3 | 1·3 | 1·1 | 0·5 | 8·2 | 0·6 | 195 | 430 |
| Potatoes | 78·3 | 1·5 | 1·6 | 0·1 | 17·7 | 0·8 | 370 | 815 |
| Sweet potatoes | 69·0 | 2·2 | 1·3 | 0·6 | 26·1 | 0·8 | 545 | 1200 |
| Tomatoes | 94·3 | 0·6 | 0·7 | 0·4 | 3·6 | 0·4 | 100 | 215 |
| Apples[9] | 84·6 | 1·6 | 0·3 | 0·5 | 12·8 | 0·2 | 260 | 570 |
| Bananas | 75·3 | 2·7 | 1·0 | 0·5 | 19·9 | 0·6 | 400 | 885 |
| Grapes | 77·4 | 2·4 | 1·0 | 1·4 | 17·4 | 0·4 | 390 | 865 |
| Oranges | 86·9 | 1·4 | 0·6 | 0·2 | 10·5 | 0·4 | 210 | 465 |
| Strawberries[10] | 90·4 | 1·0 | 0·8 | 0·5 | 6·6 | 0·5 | 155 | 345 |

Like food materials differ considerably in percentage composition. This is especially true of meats. Thus the leaner portions of beef from a fat animal may be nearly as fat as the fatter portions from a lean animal. From the analyses now available it would appear that American meats, especially beef and pork, are generally fatter than those produced upon the continent of Europe. English meat products seem to resemble American rather than continental European products in respect to fatness, although the published analyses are insufficient for definite comparison.

The foregoing table shows the average percentage composition of some of the more common food materials. The analyses are mostly of American products, since there are but few available analyses of English food materials, and these probably differ but little from the average of similar materials produced in the United States. The comparatively few available analyses of meats produced on the continent of Europe imply that they contain, as a rule, considerably less fat and more water, and often more protein, than American meats. The fuel-values per pound would consequently be smaller. The values for the leaner meats in the table would very likely represent more nearly the medium fat meats of the Continent, while values for medium fat meats in the table would probably represent fat meats of continental Europe. The figures for leaner parts of beef in the table are for such cuts or joints as the loin, shoulder, rump, and shank. The medium fat meats would include such portions as the rib, loin, and chuck, while the brisket, plate, and navel represent the fatter portions. The proportion of bone in meat as ordinarily purchased will vary from almost nothing in "shoulder clod" and "round" to as much as 40 or 50 per cent. in the shank. The composition of the materials in the table is shown for the edible portion free from refuse.

6. *Food Consumption—Studies of Dietaries.*—The actual food consumption of persons of different age, sex, and occupation is found by means of dietary studies. The general plan of such a study includes the determination of the amounts and composition of the food consumed by a given number of persons during a certain number of days, and the deduction of the quantities per person or per man per day. In dietary studies of families the number of meals for one man to which the total number of actual meals taken is equivalent is frequently estimated upon the basis of the potential energy of the relative amounts of food assumed to be eaten by men and women with different occupations, and by children of different ages, as compared with an adult man at moderately hard manual labour. These energy equivalents are somewhat arbitrary, and will require revision from time to time as data accumulate. Those used in the American dietary studies referred to below are[11]: A man at moderately active manual labour, 10; a man with sedentary occupation, or a woman with moderate work, or a boy between 14 and 16 years of age, 8; a girl between 14 and 16 years, 7; children between 10 and 13 years, 6; between 6 and 9 years, 5; between 2 and 5 years, 4; and under 2 years, 3. Until the last two decades comparatively few exact studies of actual food consumption of people of different age, sex, and occupation had been reported. More of these were from Germany than from any other country, although valuable work had been done in England, France, and elsewhere. Of late the activity of this kind of experimenting in Europe has increased, especially in Russia, Italy, and Sweden. Outside of Europe there has

[1] Meats, eggs, fish, and some vegetables and fruits contain more or less refuse in the form of bone, shell, skins, &c. Thus, on the average, the food materials enumerated above would contain about the following percentages of refuse: beef round 7, loin 13, side 17; veal leg 14, loin 17, side 23; mutton leg, loin, and side 16 to 19; pork loin 20; ham 14; chicken 26; turkey 23; eggs 11; fresh cod (bone, skin, &c.) 53; salt cod 25; and fresh mackerel 45 per cent. The proportion of refuse in vegetables and fruit may vary from 10 to 50 per cent., according to the way they are prepared for the table.

[2] Such as round, shoulder, rump, and shank.

[3] Such as rib, loin, and chuck.

[4] Such as brisket, plate, and flank.

[5] Typical of lean fish, such as haddock, bluefish, flounder, weakfish, bass, perch.

[6] Typical of fat fish, such as salmon, halibut, shad, &c.

[7] Typical of roots, such as parsnips, carrots, &c.

[8] Typical of leafy vegetables, such as cauliflower, lettuce, spinach, &c.

[9] Typical of such fruits as the pear, peach, apricot, &c.

[10] Typical of berries, such as raspberries, &c.

[11] Later experience has led to slight changes in the estimates for boys and girls, making: boys at 12, 7; 13–14, 8; 15–16, 9; and girls at 13–14, 7; 15–16, 8.

been considerable investigation in some Asiatic countries, notably Japan, but the most active inquiry during the past few years has been in the United States.

Not all the studies of dietaries are made with sufficient completeness to furnish accurate data. Those which are being made at the present time are probably more trustworthy than most of the older ones. The total number of studies of dietaries which have been reported is difficult to determine. The number which are sufficiently accurate to be included in statistical averages may perhaps be roughly estimated at 700 to 800, of which over 300 have been made within the past ten years in the United States, and more are rapidly accumulating. The number of persons in the individual studies has varied from 1 to 100 or more. The data thus accumulated may be regarded as the beginning of the study of the comparative nutrition of mankind, but are not yet sufficient to warrant the definite generalizations which are to be desired. The figures of the following table will serve as illustrations:—

*Quantities of Available Nutrients and Energy in Actual Daily Food Consumption of Persons in Different Circumstances.*

(*Quantities per Man per Day unless otherwise stated.*)

| | Number of Studies. | Number of Persons. | Protein. | Fat. | Carbo-hydrates | Fuel-Value |
|---|---|---|---|---|---|---|
| | | | Grams. | Grams | Grams. | Calories. |
| *Persons with active work.* | | | | | | |
| English Royal Engineers | 1 | 495 | 132 | 79 | 612 | 3835 |
| Prussian machinists, Krupp gun works | 1 | 800 | 129 | 107 | 657 | 4265 |
| American college athletes | 9 | 100 | 157 | 205 | 468 | 4540 |
| Swedish mechanics | 5 | 5 | 174 | 105 | 693 | 4595 |
| American machinist's family, Boston, Mass. | 1 | 2 | 167 | 241 | 598 | 5450 |
| Bavarian lumbermen | 3 | 3 | 120 | 277 | 702 | 6010 |
| *Persons with ordinary work.* | | | | | | |
| Bavarian mechanics | 11 | ... | 112 | 32 | 553 | 3060 |
| Russian peasants | ... | ... | 119 | 31 | 571 | 3155 |
| Bavarian farm labourers | 5 | ... | 126 | 52 | 526 | 3200 |
| Prussian prisoners | 1 | ... | 117 | 28 | 620 | 3320 |
| Swedish mechanics | 6 | 6 | 123 | 75 | 507 | 3325 |
| American mechanics' families | 14 | 74 | 95 | 143 | 390 | 3360 |
| American farmers' families | 10 | 66 | 89 | 124 | 453 | 3415 |
| *Professional men.* | | | | | | |
| Japanese professional man | 1 | 1 | 113 | 20 | 404 | 2340 |
| German physicians | 2 | 2 | 120 | 91 | 317 | 2685 |
| Swedish medical students | 5 | 5 | 117 | 108 | 291 | 2725 |
| Danish physician | 1 | 1 | 124 | 133 | 242 | 2790 |
| American professional men's families | 14 | 68 | 96 | 119 | 410 | 3220 |
| Japanese students | 1 | 130 | 106 | 29 | 616 | 3265 |
| American college students | 15 | 874 | 98 | 141 | 445 | 3580 |
| *Persons with little or no exercise.* | | | | | | |
| Men (German) in respiration apparatus | 5 | 2 | 115 | 78 | 261 | 2310 |
| Old men and women[1] in house of refuge | 1 | 477 | 94 | 48 | 377 | 2410 |
| Men (American) in respiration calorimeter | 11 | 3 | 98 | 75 | 319 | 2445 |
| Prussian prisoners without work | ... | ... | 100 | 32 | 457 | 3025 |
| *Persons in destitute circumstances.* | | | | | | |
| German factory girls[1] | 1 | 2 | 52 | 48 | 222 | 1590 |
| German labourer's family | 1 | 3 | 48 | 30 | 278 | 1635 |
| Italian mechanics | 5 | 5 | 70 | 36 | 384 | 2220 |
| American day-labourers' families, Pittsburg, Pa. | 2 | 17 | 74 | 90 | 299 | 2400 |
| Prussian farm labourers | 1 | 3 | 76 | 16 | 556 | 2765 |
| *Miscellaneous.* | | | | | | |
| Inhabitants of Java village, World's Fair, Chicago | 1 | 5 | 61 | 18 | 246 | 1445 |
| Bohemians in Chicago | 8 | 46 | 106 | 96 | 349 | 2800 |
| Italians in Chicago | 3 | 12 | 95 | 105 | 379 | 2960 |
| Russian Jews in Chicago | 10 | 51 | 128 | 98 | 405 | 3135 |
| American negroes | 39 | 114 | 78 | 138 | 427 | 3390 |
| Mexican families, New Mexico | 4 | 18 | 86 | 67 | 595 | 3460 |
| German army ration, peace footing | ... | ... | 105 | 37 | 466 | 2720 |
| German army ration, war footing | ... | ... | 123 | 55 | 474 | 3000 |
| German army ration, extraordinary war ration | ... | ... | 144 | 271 | 321 | 4495 |
| Italian army ration, peace footing | ... | ... | 105 | 13 | 574 | 2935 |
| United States army ration, peace footing | ... | ... | 110 | 153 | 440 | 3725 |

[1] Quantities per person per day.

7. *Hygienic Economy of Food.*—For people in good health and with good digestion there are two important rules to be observed in the regulation of the diet. The first is to choose the things which "agree" with them, and to avoid those which they cannot digest and assimilate without harm. The second is to use such kinds and amounts of food as will supply the nutrients the body needs, and at the same time to avoid burdening it with superfluous material, to be disposed of at the cost of health and strength. There are people who, because of some peculiarity of the alimentary system, are debarred from using foods which for people in general are most wholesome and nutritious. Some persons cannot endure eggs, others suffer if they take milk, others have to avoid certain kinds of meat, and others experience great discomfort if they eat fruits. But these cases are exceptions. In the processes of cleavage which the compounds of the food undergo in the body, substances are often formed which may be in one way or another injurious. In this sense it is literally true that "what is one man's meat is another man's poison." But for the great majority of people in health proper combinations of the ordinary standard wholesome foods make a healthful diet. On the other hand, some foods have at times a great value over and above their use for nourishment. Fruits and garden vegetables often benefit people greatly, not as nutriment merely, for they may have very little of actual nutrients, but because of the vegetable acids or other substances which they contain, and which sometimes serve a most useful purpose.

8. *Quantities of Nutrients Needed.*—Various standards have been proposed by physiological chemists to represent the amounts of nutrients needed by people of different age, sex, and occupation for daily sustenance. The problem is this. How much protein, fats, and carbohydrates, or, more simply, what amounts of protein and energy, are required, under varying circumstances, to build and repair muscular and other nitrogenous materials, tissues, &c., and to supply the demand for internal and external muscular work, heat, or other forms of kinetic energy? Unfortunately, experimental data are still insufficient for entirely trustworthy averages. Two classes of data are employed for the estimates—dietary studies with considerable numbers of people, and metabolism experiments with individuals in which the income and expenditure of the body are studied by quantitative methods. The standards herewith are not to be considered as exact and final, but merely as tentative estimates of the amounts of nutrients and energy required. As the chief function of the fats and carbohydrates is to serve as fuel, their exact proportion in the diet is of less account than their total fuel-value. In the standards proposed by the present writer, therefore, no proportions of fats and carbohydrates are indicated, the

*Standards for Dietaries. Available Nutrients and Energy.*

| | Protein. | Fat. | Carbo-hydrates. | Fuel-Value, |
|---|---|---|---|---|
| | Grams.[2] | Grams. | Grams. | Calories. |
| Man at hard work (Voit) | 133 | 95 | 437 | 3270 |
| Man at moderate work (Voit) | 109 | 53 | 485 | 2965 |
| Man with very hard muscular work (Atwater) | 161 | [3] | [3] | 5500 |
| Man with hard muscular work (Atwater) | 138 | [3] | [3] | 4150 |
| Man with moderately active muscular work (Atwater) | 115 | [3] | [3] | 3400 |
| Man with light muscular work (Atwater) | 103 | [3] | [3] | 3050 |
| Man at "sedentary" or woman with moderately active work (Atwater) | 92 | [3] | [3] | 2700 |
| Woman with light muscular work, or man without muscular exercise (Atwater) | 83 | [3] | [3] | 2450 |

[2] One ounce equals 28·35 grams.
[3] Fats and carbohydrates sufficient, with the protein, to furnish the required energy.

requirement being that the amounts of the two shall suffice, with the protein, to bring up the fuel-value of the food to the indicated amount. It is specially to be noted that the amounts are in terms of available rather than total nutrients and energy.

9. *Pecuniary Economy of Food.*—Statistics of income and cost of living in Great Britain, Germany, and the United States (Massachusetts)[1] show that from 50 to 60 per cent. or more of the income of wage-workers and other people in moderate circumstances is expended for food. This relatively large cost of food, and the important influence of diet upon health and strength, make a more widespread understanding of the subject very desirable. The maxim that "the best is the cheapest" does not apply to food. The best food, in the sense of that which is the finest in appearance and flavour, and which is sold at the highest price, is not generally the cheapest, nor is it always the most healthful or economical. The price of food is not regulated solely by its value for nutriment. Its agreeableness to the palate or to the buyer's fancy is a large factor in determining the current demand and market price. There is no more nutriment in an ounce of protein or fat from the tenderloin of beef than from the round or shoulder. The protein of animal food has, however, an advantage over that of vegetable foods. Animal foods, such as meats, fish, milk, and the like, gratify the palate as most vegetable foods do not, and, what is perhaps of still greater weight in regulating the demand and market price, they satisfy a real need by supplying protein and fats, which vegetable foods lack. In general, animal proteids are more easily and completely digested than vegetable. There is doubtless good ground for paying somewhat more for the same quantity of nutritive material in the animal food. For persons in good health the foods in which the nutrients are most expensive are like costly articles of adornment—people who can well afford them may be justified in buying them, but they are not economical.

*Amounts of Nutrients and Energy furnished for One Shilling in Food Materials at Ordinary Prices.*

| Food Materials as purchased. | Prices per Pound. | One Shilling will buy | | | | |
|---|---|---|---|---|---|---|
| | | Total Food Materials. | Available Nutrients. | | | Fuel-Value. |
| | | | Protein. | Fat. | Carbohydrates. | |
| | s. d. | Pounds. | Pounds. | Pounds. | Pounds. | Calories. |
| Beef, round | 0 10 | 1·20 | ·22 | ·14 | ... | 1,155 |
| | 0 8½ | 1·41 | ·26 | ·17 | ... | 1,235 |
| | 0 5 | 2·40 | ·44 | ·29 | ... | 2,105 |
| Beef, sirloin | 0 10 | 1·20 | ·19 | ·20 | ... | 1,225 |
| | 0 9 | 1·33 | ·21 | ·22 | ... | 1,360 |
| | 0 8 | 1·50 | | | | |
| | 0 5 | 2·40 | | | | |
| Beef, rib | 0 9 | 1·33 | ·19 | ·19 | ... | 1,200 |
| | 0 7½ | 1·60 | | | | |
| | 0 4½ | 2·67 | | | | |
| Mutton, leg | 0 9 | 1·33 | ·20 | ·20 | ... | 1,245 |
| | 0 5 | 2·40 | ·37 | ·35 | ... | 2,245 |
| Pork, spare-rib | 0 9 | 1·33 | ·17 | ·31 | ... | 1,645 |
| | 0 7 | 1·71 | ·22 | ·39 | ... | 2,110 |
| Pork, salt, fat | 0 7 | 1·71 | ·03 | 1·40 | ... | 6,025 |
| | 0 5 | 2·40 | ·04 | 1·97 | ... | 8,460 |
| Pork, smoked ham | 0 8 | 1·50 | ·20 | ·48 | ... | 2,435 |
| | 0 4½ | 2·67 | ·36 | ·85 | ... | 4,330 |
| Fresh cod | 0 4 | 3·00 | ·34 | ·01 | ... | 710 |
| | 0 3 | 4·00 | ·45 | ·01 | ... | 945 |
| Salt cod | 0 3½ | 3·43 | ·54 | ·07 | ... | 1,370 |
| | 0 10 | 1·20 | ·07 | ·01 | ·04 | 275 |
| Milk, whole, 4d. a qt. | 0 2 | 6·00 | ·19 | ·23 | ·30 | 1,915 |
| " 3d. a qt. | 0 1½ | 8·00 | ·26 | ·30 | ·40 | 2,550 |
| " 2d. a qt. | 0 1 | 12·00 | ·38 | ·46 | ·60 | 3,825 |
| Milk, skimmed, 2d. a qt. | 0 1 | 12·00 | ·40 | ·03 | ·61 | 2,085 |
| Butter | 1 6 | ·67 | ·01 | ·54 | ... | 2,320 |
| | 1 3 | ·80 | ·01 | ·64 | ... | 2,770 |
| | 1 0 | 1·00 | ·01 | ·81 | ... | 3,460 |
| Margarine | 0 4 | 3·00 | ... | 2·37 | ... | 10,080 |
| Eggs, 2s. a dozen | 1 4 | ·75 | ·10 | ·07 | ... | 475 |
| " 1½s. a dozen | 1 0 | 1·00 | ·13 | ·09 | ... | 635 |
| " 1s. a dozen | 0 8 | 1·50 | ·19 | ·13 | ... | 950 |
| Cheese | 0 8 | 1·50 | ·38 | ·48 | ·04 | 2,865 |
| | 0 7 | 1·71 | ·43 | ·55 | ·04 | 3,265 |
| | 0 5 | 2·40 | ·60 | ·77 | ·06 | 4,585 |
| Wheat bread | 0 1⅛ | 10·67 | ·76 | ·13 | 5·57 | 12,421 |
| Wheat flour | 0 1⅗ | 7·64 | ·67 | ·07 | 5·63 | 12,110 |
| | 0 1½ | 8·16 | ·72 | ·07 | 6·01 | 12,935 |
| Oatmeal | 0 1⅖ | 8·39 | 1·11 | ·54 | 5·54 | 14,835 |
| | 0 1½ | 8·16 | 1·08 | ·53 | 5·39 | 14,430 |
| Rice | 0 1¾ | 6·86 | ·45 | ·02 | 5·27 | 10,795 |
| Potatoes | 0 0⅔ | 18·00 | ·25 | ·02 | 2·70 | 5,605 |
| | 0 0½ | 24·00 | ·34 | ·02 | 3·60 | 7,470 |
| Beans | 0 2 | 6·00 | 1·05 | ·10 | 3·47 | 8,960 |
| Sugar | 0 1¾ | 6·86 | ... | ... | 6·86 | 12,760 |

[1] Report of Mass. Bureau of Labour, 1884.

The variations in the cost of the actual nutriment in different food materials may be illustrated by comparison of the amounts of nutrients obtained for a given sum in the materials as bought at ordinary market prices. This is done in the foregoing table, which shows the amounts of available nutrients, which one shilling would pay for, in different food materials at prices common in England.

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(W. O. A.)

**Diez,** a town of Prussia, province of Hesse-Nassau, on the Lahn, 30 miles by rail east from Coblenz. It is overlooked by a former castle of the counts of Nassau-Dillenburg, now a prison. Near by is the cadet school of Castle Oranienstein, formerly a nunnery, with its beautiful gardens. It has saw-mills and tanneries and corn-mills. Population (1900), 4303.

**Differential Equations.**—Differential equations arise in the expression of the relations between quantities by the elimination of details, either unknown or regarded as unessential to the formulation of the relations in question. They give rise, therefore, to the two closely connected problems of determining what arrangement of details is consistent with them, and of developing, apart from these details, the general properties expressed by them. Very roughly, two methods of study can be distinguished, with the names Transformation-theories, Function-theories; the former concerned to reduce the algebraical relations to the fewest and simplest forms, eventually with the hope of obtaining explicit expressions of the dependent variables in terms of the independent variables; the latter concerned to determine what general descriptive relations among the quantities are involved by the differential equations, with as little

use of algebraical calculations as may be possible. Under the former heading we may, with the assumption of a few theorems belonging to the latter, arrange the theory of partial differential equations and Pfaff's problem, with their geometrical interpretations, as at present developed, and the applications of Lie's theory of transformation-groups to partial and to ordinary equations; under the latter, the study of linear differential equations in the manner initiated by Riemann, the applications of discontinuous groups, the theory of the singularities of integrals, and the study of potential equations with existence theorems arising therefrom. In order to be clear we shall enter into some detail in regard to partial differential equations of the first order, both those which are linear in any number of variables and those not linear in two independent variables, and also in regard to the function-theory of linear differential equations of the second order. Space renders impossible anything further than the briefest account of many other matters; in particular, the theories of partial equations of higher than the first order, the function-theory of the singularities of ordinary equations not linear and the applications to differential geometry, are taken account of only in the bibliography. It is believed that on the whole the article will be more useful to the reader than if explanations of method had been further curtailed to include more facts.

When we speak of a function without qualification, it is to be understood that in the immediate neighbourhood of a particular set $x_o, y_o, \cdot\cdot$ of values of the independent variables $x, y, \cdot\cdot\cdot$ of the function, at whatever point of the range of values for $x, y, \cdot\cdot\cdot$ under consideration $x_o, y_o, \cdot\cdot$ may be chosen, the function can be expressed as a series of positive integral powers of the differences $x-x_o$, $y-y_o, \cdot\cdot\cdot$, convergent when these are sufficiently small (see FUNCTION, ANALYTIC). Without this condition, which we express by saying that the function is developable about $x_o, y_o, \cdot\cdot$, many results provisionally stated in the transformation theories would be unmeaning or incorrect. If, then, we have a set of $k$ functions, $f_1 \cdot\cdot f_k$ of $n$ independent variables $x_1 \cdot\cdot x_n$, we say that they are independent when $n \geqq k$ and not every determinant of $k$ rows and columns vanishes of the matrix of $k$ rows and $n$ columns whose $r$-th row has the constituents $df_r/dx_1 \cdot\cdot df_r/dx_n$; the justification being in the theorem, which we assume, that if the determinant involving, for instance, the first $k$ columns be not zero for $x_1=x_1{}^o \cdot\cdot x_n=x_n{}^o$, and the functions be developable about this point, then from the equations $f_1=c_1 \cdot\cdot f_k=c_k$ we can express $x_1 \cdot\cdot x_k$ by convergent power series in the differences $x_{k+1}-x_k{}^o{}_{+1} \cdot\cdot x_n-x_n{}^o$, and so regard $x_1 \cdot\cdot x_k$ as functions of the remaining variables. This we often express by saying that the equations $f_1=c_1 \cdot\cdot f_k=c_k$ can be solved for $x_1 \cdot\cdot x_k$. The explanation is given as a type of explanation often understood in what follows.

***Ordinary equations of the first order.***

We may conveniently begin by stating the theorem: If each of the $n$ functions $\phi_1 \cdot\cdot \phi_n$ of the $(n+1)$ variables $x_1 \cdot\cdot x_n t$ be developable about the values $x_1{}^o \cdot\cdot x_n{}^o t^o$, the $n$ differential equations of the form $dx_i/dt=\phi_i(tx_1 \cdot\cdot x_n)$ are satisfied by convergent power series $x_r=x_r{}^o+(t-t^o)\mathrm{A}_{r1}+(t-t_o)^2 \mathrm{A}_{r2}+\cdot\cdot\cdot$ reducing respectively to $x_1{}^o \cdot\cdot x_n{}^o$ when $t=t^o$; and the only functions satisfying the equations and reducing respectively to $x_1{}^o \cdot\cdot x_n{}^o$ when $t=t^o$, are those determined by continuation of these series. If the result of solving these $n$ equations for $x_1{}^o \cdot\cdot x_n{}^o$ be written in the form $\omega_1(x_1 \cdot\cdot x_n t)=x_1{}^o \cdot\cdot \omega_n(x_1 \cdot\cdot x_n t)=x_n{}^o$, it is at once evident that the differential equation $df/dt+\phi_1 df/dx_1+\cdot\cdot\cdot+\phi_n df/dx_n=0$ possesses $n$ integrals, namely, the functions $\omega_1 \cdot\cdot \omega_n$, which are developable about the values $(x_1{}^o \cdot\cdot x_n{}^o t^o)$ and reduce respectively to $x_1 \cdot\cdot x_n$ when $t=t^o$. And in fact it has no other integrals so reducing. Thus this equation also possesses an unique integral reducing when $t=t^o$ to an arbitrary function $\psi(x_1 \cdot\cdot x_n)$, this integral being $\psi(\omega_1 \cdot\cdot \omega_n)$. Conversely, the existence of these *principal* integrals $\omega_1 \cdot\cdot \omega_n$ of the partial equation establishes the existence of the specified solutions of the ordinary equations $dx_i/dt=\phi_i$.

***Single homogeneous partial equation of the first order.***

The following sketch of the proof of the existence of these principal integrals for the case $n=2$ will show the character of more general investigations. Put $x$ for $x-x^o$, &c., and consider the equation $a(xyt)df/dx+b(xyt)df/dy=df/dt$, wherein the functions $a, b$ are developable about $x=0$, $y=0$, $t=0$; say $a(xyt)=a_o+ta_1+t^2a_2/2!+\cdot\cdot$, $b(xyt)=b_o+tb_1+t^2b_2/2!+\cdot\cdot$, so that $ad/dx+bd/dy=\delta_o+t\delta_1+\frac{1}{2}t^2\delta_2+\cdot\cdot$, where $\delta_r=a_r d/dx+b_r d/dy$. In order that $f=p_o+tp_1+t^2p_2/2!+\cdot\cdot$, wherein $p_o, p_1$ are power series in $x, y$, should satisfy the equation, it is necessary, as we find by equating like terms, that $p_1=\delta_o p_o$, $p_2=\delta_o p_1+\delta_1 p_o$, &c., and in general $p_{s+1}=\delta_o p_s+s_1\delta_1 p_{s-1}+s_2\delta_2 p_{s-2}+\cdot\cdot\cdot+\delta_s p_o$, where $s_r=(s!)/(r!)(s-r!)$. Now compare with the given equation another equation $\mathrm{A}(xyt)d\mathrm{F}/dx+\mathrm{B}(xyt)d\mathrm{F}/dy=d\mathrm{F}/dt$, wherein each coefficient in the expansion of either A or B is real and positive, and not less than the absolute value of the corresponding coefficient in the expansion of $a$ or $b$. In the second equation let us substitute a series $\mathrm{F}=\mathrm{P}_o+t\mathrm{P}_1+t^2\mathrm{P}_2/2!+\cdot\cdot$, wherein the coefficients in $\mathrm{P}_o$ are real and positive, and each not less than the absolute value of the corresponding coefficient in $p_o$; then putting $\Delta_r=\mathrm{A}_r d/dx+\mathrm{B}_r d/dy$, we obtain necessary equations of the same form as before, namely, $\mathrm{P}_1=\Delta_o\mathrm{P}_o$, $\mathrm{P}_2=\Delta_o\mathrm{P}_1+\Delta_1\mathrm{P}_o, \cdot\cdot\cdot$ and in general $\mathrm{P}_{s+1}=\Delta_o\mathrm{P}_s+s_1\Delta_1\mathrm{P}_{s-1}+\cdot\cdot+\Delta_s\mathrm{P}_o$.

***Proof of the existence of integrals.***

These give for every coefficient in $\mathrm{P}_{s+1}$ an integral aggregate with real positive coefficients of the coefficients in $\mathrm{P}_s, \mathrm{P}_{s-1}, \cdot\cdot\cdot, \mathrm{P}_o$ and the coefficients in A and B; and they are the same aggregates as would be given by the previously obtained equations for the corresponding coefficients in $p_{s+1}$ in terms of the coefficients in $p_s p_{s-1} \cdot\cdot p_o$ and the coefficients in $a$ and $b$. Hence as the coefficients in $\mathrm{P}_o$ and also in A, B are real and positive, it follows that the values obtained in succession for the coefficients in $\mathrm{P}_1$, $\mathrm{P}_2, \cdot\cdot$ are real and positive; and further, taking account of the fact that the absolute value of a sum of terms is not greater than the sum of the absolute values of the terms, it follows, for each value of $s$, that every coefficient in $p_{s+1}$ is, in absolute value, not greater than the corresponding coefficient in $\mathrm{P}_{s+1}$. Thus if the series for F be convergent, the series for $f$ will also be; and we are thus reduced to (1), specifying functions A, B with real positive coefficients, each in absolute value not less than the corresponding coefficient in $a, b$; (2) proving that the equation $\mathrm{A}d\mathrm{F}/dx+\mathrm{B}d\mathrm{F}/dy=d\mathrm{F}/dt$ possesses an integral $\mathrm{P}_o+t\mathrm{P}_1+t^2\mathrm{P}_2/2!+\cdot\cdot$ in which the coefficients in $\mathrm{P}_o$ are real and positive, and each not less than the absolute value of the corresponding coefficient in $p_o$. If $a, b$ be developable for $x, y$ both in absolute value less than $r$ and for $t$ less in absolute value than R, and for such values $a, b$ be both less in absolute value than the real positive constant M, it is not difficult to verify that we may take $\mathrm{A}=\mathrm{B}=\mathrm{M}\left(1-\frac{x+y}{r}\right)^{-1}\left(1-\frac{t}{\mathrm{R}}\right)^{-1}$, and obtain

$$\mathrm{F}=r-(r-x-y)\left[1-\frac{4\mathrm{MR}}{r}\left(1-\frac{x+y}{r}\right)^{-2}\log\left(1-\frac{t}{\mathrm{R}}\right)^{-1}\right]^{\frac{1}{2}},$$

and that this solves the problem when $x, y, t$ are sufficiently small for the two cases $p_o=x$, $p_o=y$. One obvious application of the general theorem is to the proof of the existence of an integral of an ordinary linear differential equation given by the $n$ equations $dy/dx=y_1$, $dy_1/dx=y_2, \cdot\cdot$, $dy_{n-1}/dx=p-p_1y_{n-1}-\cdot\cdot\cdot-p_ny$; but in fact any simultaneous system of ordinary equations is reducible to a system of the form $dx_i/dt=\phi_i(tx_1 \cdot\cdot x_n)$.

***Simultaneous linear partial equations.***

Suppose we have $k$ homogeneous linear partial equations of the first order in $n$ independent variables, the general equation being $a_{\sigma 1}df/dx_1+\cdot\cdot+a_{\sigma n}df/dx_n=0$, where $\sigma=1 \cdot\cdot k$, and that we desire to know whether the equations have common solutions, and if so, how many. It is to be understood that the equations are linearly independent, which implies that $k \leqq n$ and not every determinant of $k$ rows and columns is identically zero in the matrix in which the $i$-th element of the $\sigma$-th row is $a_{\sigma i}(i=1 \cdot\cdot n,\ \sigma=1 \cdot\cdot k)$. Denoting the left side of the $\sigma$-th equation by $\mathrm{P}_\sigma f$, it is clear that every common solution of the two equations $\mathrm{P}_\sigma f=0$, $\mathrm{P}_\rho f=0$ is also a solution of the equation $\mathrm{P}_\rho(\mathrm{P}_\sigma f)-\mathrm{P}_\sigma(\mathrm{P}_\rho f)=0$. We immediately find, however, that this is also a linear equation, namely, $\Sigma \mathrm{H}_i df/dx_i=0$ where $\mathrm{H}_i=\mathrm{P}_\rho a_{\sigma i}-\mathrm{P}_\sigma a_{\rho i}$, and if it be not already contained among the given equations, or be linearly deducible from them, it may be added to them, as not introducing any additional limitation of the possibility of their having common solutions. Proceeding thus with every pair of the original equations, and then with every pair of the possibly augmented system so obtained, and so on continually, we shall arrive at a system of equations, linearly independent of each other and therefore not more than $n$ in number, such that the combination, in the way described, of every pair of them, leads to an equation which is linearly deducible from them. If the number of this so-called *complete system* is $n$, the equations give $df/dx_1=0 \cdot\cdot df/dx_n=0$, leading to the nugatory result $f=$ a constant. Suppose, then, the number of this system to be $r < n$; suppose, further, that from the matrix of the coefficients

a determinant of $r$ rows and columns not vanishing identically is that formed by the coefficients of the differential coefficients of $f$ in regard to $x_1 \cdots x_r$; also that the coefficients are all developable about the values $x_1=x_1^o \cdots x_n=x_n^o$, and that for these values the determinant just spoken of is not zero. Then the main theorem is that the complete system of $r$ equations, and therefore the originally given set of $k$ equations, have in common $n-r$ solutions, say $\omega_{r+1} \cdots \omega_n$, which reduce respectively to $x_{r+1} \cdots x_n$ when in them for $x_1 \cdots x_r$ are respectively put $x_1^o \cdots x_r^o$; so that also the equations have in common a solution reducing when $x_1=x_1^o \cdots x_r=x_r^o$ to an arbitrary function $\psi(x_{r+1} \cdots x_n)$ which is developable about $x_r^o{}_{+1} \cdots x_n^o$, namely, this common solution is $\psi(\omega_{r+1} \cdots \omega_n)$. It is seen at once that this result is a generalization of the theorem for $r=1$, and its proof is conveniently given by induction from that case. It can be verified without difficulty (1) that if from the $r$ equations of the complete system we form $r$ independent linear aggregates, with coefficients not necessarily constants, the new system is also a complete system; (2) that if in place of the independent variables $x_1 \cdots x_n$ we introduce any other variables which are independent functions of the former, the new equations also form a complete system. It is convenient, then, from the complete system of $r$ equations to form $r$ new equations by solving separately for $df/dx_1, \cdots, df/dx_r$; suppose the general equation of the new system to be $Q_\sigma f=df/dx_\sigma+c_{\sigma,r+1}df/dx_{r+1}+\cdots+c_{\sigma n}df/dx_n=0(\sigma=1\cdots r)$. Then it is easily obvious that the equation $Q_\rho Q_\sigma f - Q_\sigma Q_\rho f=0$ contains only the differential coefficients of $f$ in regard to $x_{r+1} \cdots x_n$; as it is at most a linear function of $Q_1 f, \cdots, Q_r f$, it must be identically zero. So reduced the system is called a *Jacobian system*. Of this system $Q_1 f=0$ has $n-1$ principal solutions reducing respectively to $x_2 \cdots x_n$ when $x_1=x_1^o$, and its form shows that of these the first $r-1$ are exactly $x_2 \cdots x_r$. Let these $n-1$ functions together with $x_1$ be introduced as $n$ new independent variables in all the $r$ equations. Since the first equation is satisfied by $n-1$ of the new independent variables, it will contain no differential coefficients in regard to them, and will reduce therefore simply to $df/dx_1=0$, expressing that any common solution of the $r$ equations is a function only of the $n-1$ remaining variables. Thereby the investigation of the common solutions is reduced to the same problem for $r-1$ equations in $n-1$ variables. Proceeding thus, we reach at length one equation in $n-r+1$ variables, from which, by retracing the analysis, the proposition stated is seen to follow.

***Complete systems of linear partial equations.***

***Jacobian systems.***

The analogy with the case of one equation is, however, still closer. With the coefficients $c_{\sigma,j}$ of the equations $Q_\sigma f=0$ in transposed array $(\sigma=1\cdots r,\ j=r+1\cdots n)$ we can put down the $(n\text{-}r)$ equations, $dx_j=c_{1j}dx_1+\cdots+c_{rj}dx_r$, equivalent to the $r(n-r)$ equations $dx_j/dx_\sigma=c_{\sigma j}$. That consistent with them we may be able to regard $x_{r+1} \cdots x_n$ as functions of $x_1 \cdots x_r$, these being regarded as independent variables, it is clearly necessary that when we differentiate $c_{\sigma j}$ in regard to $x_\rho$ on this hypothesis the result should be the same as when we differentiate $c_{\rho j}$ in regard to $x_\sigma$ on this hypothesis. The differential coefficient of a function $f$ of $x_1 \cdots x_n$ on this hypothesis, in regard to $x_\rho$, is, however, $df/dx_\rho+c_{\rho,r+1}df/dx_{r+1}+\cdots+c_{\rho n}df/dx_n$, namely, is $Q_\rho f$. Thus the consistence of the $n-r$ total equations requires the conditions $Q_\rho c_{\sigma j}-Q_\sigma c_{\rho j}=0$, which are, however, verified in virtue of $Q_\rho(Q_\sigma f)-Q_\sigma(Q_\rho f)=0$. And it can in fact be easily verified that if $\omega_{r+1} \cdots \omega_n$ be the principal solutions of the Jacobian system, $Q_\sigma f=0$, reducing respectively to $x_{r+1} \cdots x_n$ when $x_1=x_1^o \cdots x_r=x_r^o$, and the equations $\omega_{r+1}=x_r^o{}_{+1} \cdots \omega_n=x_n^o$ be solved for $x_{r+1} \cdots x_n$ to give $x_j=\psi_j(x_1 \cdots x_r,\ x_r^o{}_{+1} \cdots x_n^o)$, these values solve the total equations and reduce respectively to $x_r^o{}_{+1} \cdots x_n^o$ when $x_1=x_1^o \cdots x_r=x_r^o$. And the total equations have no other solutions with these initial values. Conversely, the existence of these solutions of the total equations can be deduced *à priori* and the theory of the Jacobian system based upon them. The theory of such total equations, in general, finds its natural place under the heading *Pfaffian Expressions*, below.

***System of total differential equations.***

A practical method of reducing the solution of the $r$ equations of a Jacobian system to that of a single equation in $n-r+1$ variables may be explained in connexion with a geometrical interpretation which will perhaps be clearer in a particular case, say $n=3$, $r=2$. There is then only one total equation, say $dz=adx+bdy$; if we do not take account of the condition of integrability, which is here $da/dy+bda/dz=db/dx+adb/dz$, this equation may be regarded as defining through an arbitrary point $x_oy_oz_o$ of three-dimensional space (about which $a$, $b$ are developable) a plane, namely, $z-z_o=a_o(x-x_o)+b_o(y-y_o)$, and therefore, through this arbitrary point $\infty^2$ directions, namely, all those in the plane. If now there be a surface $z=\psi(xy)$, satisfying $dz=adx+bdy$ and passing through $x_oy_oz_o$, this plane will touch the surface, and the operations of passing along the surface from $(x_oy_oz_o)$ to $(x_o+dx_o,\ y_o,\ z_o+dz_o)$ and then to $(x_o+dx_o,\ y_o+dy_o,\ z_o+d^1z_o)$, ought to lead to the same value of $d^1z_o$ as do the operations of passing along the surface from $(x_oy_oz_o)$ to $(x_o,\ y_o+dy_o,\ z_o+\delta z_o)$, and then to $(x_o+dx_o,\ y_o+dy_o,\ z_o+\delta^1z_o)$, namely, $\delta^1z_o$ ought to be equal to $d^1z_o$. But we find $d^1z_o=a_odx_o+b(x_o+dx_o,\ y_o,\ z_o+a_odx_o)dy_o=a_odx_o+b_ody_o+dx_ody_o\left(\frac{db}{dx_o}+a_o\frac{db}{dz_o}\right)$, and so at once reach the condition of integrability. If now we put $x=x_o+t$, $y=y_o+mt$, and regard $m$ as constant, we shall in fact be considering the section of the surface by a fixed plane $y-y_o=m(x-x_o)$; along this section $dz=dt(a+bm)$; if we then integrate the equation $dz/dt=a+bm$, where $a$, $b$ are expressed as functions of $m$ and $t$, with $m$ kept constant, finding the solution which reduces to $z_o$ for $t=0$, and in the result again replace $m$ by $(y-y_o)/(x-x_o)$, we shall have the surface in question. In the general case the equations $dx_j=c_{1j}dx_1+\cdots+c_{rj}dx_r$ similarly determine through an arbitrary point $x_1^o \cdots x_n^o$ a planar manifold of $r$ dimensions in space of $n$ dimensions, and when the conditions of integrability are satisfied, every direction in this manifold through this point is tangent to the manifold of $r$ dimensions, expressed by $\omega_{r+1}=x_r^o{}_{+1} \cdots \omega_n=x_n^o$, which satisfies the equations and passes through this point. If we put $x_1-x_1^o=t$, $x_2-x_2^o=m_2t$, $\cdots$, $x_r-x_r^o=m_rt$, and regard $m_2 \cdots m_r$ as fixed, the $(n-r)$ total equations take the form $dx_j/dt=c_{1j}+m_2c_{2j}+\cdots+m_rc_{rj}$, and their integration is equivalent to that of the single partial equation $df/dt+\sum_{j=r+1}^{n}(c_{1j}+m_2c_{2j}+\cdots+m_rc_{rj})df/dx_j=0$ in the $n-r+1$ variables $t$, $x_{r+1} \cdots x_n$. Determining the solutions $\Omega_{r+1} \cdots \Omega_n$ which reduce to respectively $x_{r+1} \cdots x_n$ when $t=0$, and putting therein $t=x_1-x_1^o$, $m_2=(x_2-x_2^o)/(x_1-x_1^o)$, $\cdots$, $m_r=(x_r-x_r^o)/(x_1-x_1^o)$, we obtain the solutions of the original system of partial equations previously denoted by $\omega_{r+1} \cdots \omega_n$. It is to be remarked, however, that the presence of the fixed parameters $m_2 \cdots m_r$ in the single integration may frequently render it more difficult than if they were assigned numerical quantities.

***Geometrical interpretation and solution.***

***Mayer's method of integration.***

We have above considered the integration of an equation $dz=adx+bdy$ on the hypothesis that the condition $da/dy+bda/dz=db/dx+adb/dz$. It is natural to inquire what relations among $x$, $y$, $z$, if any, are implied by, or are consistent with, a differential relation $adx+bdy+cdz=o$, when $a$, $b$, $c$ are unrestricted functions of $x$, $y$, $z$. This problem leads to the consideration of the so-called Pfaffian *Expression* $adx+bdy+cdz$; it can be shown (1) if each of the quantities $db/dz-dc/dy$, $dc/dx-da/dz$, $da/dy-db/dx$, which we shall denote respectively by $u_{23}$, $u_{31}$, $u_{12}$, be identically zero, the expression is the differential of a function of $x$, $y$, $z$, equal to $dt$ say; (2) that if the quantity $au_{23}+bu_{31}+cu_{12}$ is identically zero, the expression is of the form $udt$, that is can be made a perfect differential by multiplication by the factor $\frac{1}{u}$; (3) that in general the expression is of the form $dt+u_1dt_1$. Consider the matrix of four rows and three columns, in which the elements of the first row are $a$, $b$, $c$, and the elements of the $(r+1)$-th row, for $r=1$, 2, 3, are the quantities $u_{r1}$, $u_{r2}$, $u_{r3}$, where $u_{11}=u_{22}=u_{33}=0$. Then it is easily seen that the cases (1), (2), (3) above correspond respectively to the cases when (1) every determinant of this matrix of two rows and columns is zero, (2) every determinant of three rows and columns is zero, (3) when no condition is assumed. This result can be generalized as follows: if $a_1 \cdots a_n$ be any functions of $x_1 \cdots x_n$, the so-called Pfaffian expression $a_1dx_1+\cdots+a_ndx_n$ can be reduced to one or other of the two forms $u_1dt_1+\cdots+u_kdt_k$, $dt+u_1dt_1+\cdots+u_{k-1}dt_{k-1}$, wherein $t$, $u_1, \cdots, t_1, \cdots$ are independent functions of $x_1 \cdots x_n$, and $k$ is such that in these two cases respectively $2k$ or $2k-1$ is the rank of a certain matrix of $n+1$ rows and $n$ columns, that is, the greatest number of rows and columns in a non-vanishing determinant of the matrix; the matrix is that whose first row is constituted by the quantities $a_1 \cdots a_n$, whose $s$-th element in the $(r+1)$-th row is the quantity $da_r/dx_s-da_s/dx_r$. The proof of such a reduced form can be obtained from the two results: (1) If $t$ be any given function of the $2m$ independent variables $u_1 \cdots u_mt_1 \cdots t_m$, the expression $dt+u_1dt_1+\cdots+u_mdt_m$ can be put into the form $u'_1dt'_1+\cdots+u'_mdt'_m$. (2) If the quantities $u_1 \cdots u_mt_1 \cdots t_m$ be connected by a relation, the expression $u_1dt_1+\cdots+u_mdt_m$ can be put into the form $dt'+u'_1dt'_1+\cdots+u'_{m-1}dt'_{m-1}$; and if the relation connecting $u_1 \cdots u_mt_1 \cdots t_m$ be homogeneous in $u_1 \cdots u_m$, then $t'$ can be taken to be zero. These two results are deductions from the theory of *contact transformations* (see below), and their demonstration requires, beside elementary algebraical considerations, only the theory of complete systems of linear homogeneous partial differential equations of the first order. When the existence of the reduced form of the Pfaffian expression containing only independent quantities is thus once assured, the identification of the number $k$ with that defined by the specified matrix may, with some difficulty, be made *à posteriori*.

***Pfaffian Expressions.***

In all cases of a single Pfaffian equation we are thus led to consider what is implied by a relation $dt-u_1dt_1-\cdots-u_mdt_m=0$, in which $t, u_1 \cdots u_mt_1 \cdots t_m$ are, except for this equation, independent variables. This is to be satisfied in virtue of one or several relations connecting the variables; these must involve relations con-

necting $t, t_1 \cdots t_m$ only, and in one of these at least $t$ must actually enter. We can then suppose that in one actual system of relations in virtue of which the Pfaffian equation is satisfied, all the relations connecting $t, t_1 \cdots t_m$ only are given by $t=\psi(t_{s+1} \cdots t_m)$, $t_1=\psi_1(t_{s+1} \cdots t_m) \cdots t_s=\psi_s(t_{s+1} \cdots t_m)$; so that the equation $d\psi - u_1 d\psi_1 - \cdots - u_s d\psi_s - u_{s+1}dt_{s+1} - \cdots - u_m dt_m = 0$ is identically true in regard to $u_1 \cdots u_m$ $t_{s+1} \cdots t_m$; equating to zero the coefficients of the differentials of these variables, we thus obtain $m$-$s$ relations of the form $d\psi/dt_j - u_1 d\psi_1/dt_j - \cdots - u_s d\psi_s/dt_j - u_j = 0$; these $m$-$s$ relations, with the previous $s+1$ relations, constitute a set of $m+1$ relations connecting the $2m+1$ variables in virtue of which the Pfaffian equation is satisfied independently of the form of the functions $\psi, \psi_1 \cdots \psi_s$. There is clearly such a set for each of the values $s=0$, $s=1, \cdots$, $s=m-1$, $m$. And for any value of $s$ there may exist relations additional to the specified $m+1$ relations, provided they do not involve any relation connecting $t, t_1 \cdots t_m$ only, and are consistent with the $m$-$s$ relations connecting $u_1 \cdots u_m$. It is now evident that, essentially, the integration of a Pfaffian equation $a_1 dx_1 + \cdots + a_n dx_n = 0$, wherein $a_1 \cdots a_n$ are functions of $x_1 \cdots x_n$, is effected by the processes necessary to bring it to its reduced form, involving only independent variables. And it is easy to see that if we suppose this reduction to be carried out in all possible ways, there is no need to distinguish the classes of integrals corresponding to the various values of $s$; for it can be verified without difficulty that by putting $t'=t-u_1t_1-\cdots-u_st_s$, $t'_1=u_1, \cdots, t'_s=u_s$, $u'_1=-t_1, \cdots$, $u'_s=-t_s$, $t'_{s+1}=t_{s+1} \cdots t'_m=t_m$, $u'_{s+1}=u_{s+1} \cdots u'_m=u_m$, the reduced equation becomes changed to $dt'-u'_1dt'_1-\cdots-u'_mdt'_m=0$, and the general relations changed to $t'=\psi(t'_{s+1} \cdots t'_m)-t'_1\psi_1(t'_{s+1} \cdots t'_m) - \cdots - t'_s\psi_s(t'_{s+1} \cdots t'_m), =\phi$, say, together with $u'_1=d\phi/dt'_1, \cdots$, $u'_m=d\phi/dt'_m$, which contain only one relation connecting the variables $t'\, t'_1 \cdots t'_m$ only.

***Single linear Pfaffian equation.***

This method for a single Pfaffian equation can, strictly speaking, be generalized to a simultaneous system of ($n$-$r$) Pfaffian equations $dx_j = c_{1j}dx_1 + \cdots + c_{rj}dx_r$ only in the case already treated, when this system is satisfied by regarding $x_{r+1} \cdots x_n$ as suitable functions of the independent variables $x_1 \cdots x_r$; in that case the integral manifolds are of $r$ dimensions. When these are non-existent, there may be integral manifolds of higher dimensions; for if $d\phi=\phi_1dx_1+\cdots+\phi_rdx_r+\phi_{r+1}(c_{1r+1}dx_1+\cdots+c_{rr+1}dx_r)+\phi_{r+2}(\quad)+\cdots$ be identically zero, then $\phi_\sigma+c_{\sigma r+1}\phi_{r+1}+\cdots+c_{\sigma n}\phi_n=0$, or $\phi$ satisfies the $r$ partial differential equations previously associated with the total equations; when these are not a complete system, but included in a complete system of $r+\mu$ equations, having therefore $n-r-\mu$ independent integrals, the total equations are satisfied over a manifold of $r+\mu$ dimensions. See E. v. Weber, *Math. Annal.* lv. (1901), p. 386.

***Simultaneous Pfaffian equations.***

It seems desirable to add here certain results, largely of algebraic character, which naturally arise in connexion with the theory of contact transformations. For any two functions of the $2n$ independent variables $x_1 \cdots x_np_1 \cdots p_n$ we denote by $(\phi\psi)$ the sum of the $n$ terms such as $\dfrac{d\phi}{dp_i}\dfrac{d\psi}{dx_i}-\dfrac{d\psi}{dp_i}\dfrac{d\phi}{dx_i}$. For two functions of the $(2n+1)$ independent variables $zx_1 \cdots x_np_1 \cdots p_n$ we denote by $[\phi\psi]$ the sum of the $n$ terms such as $\dfrac{d\phi}{dp_i}\left(\dfrac{d\psi}{dx_i}+p_i\dfrac{d\psi}{dz}\right)-\dfrac{d\psi}{dp_i}\left(\dfrac{d\phi}{dx_i}+p_i\dfrac{d\phi}{dz}\right)$. It can at once be verified that for any three functions $[f[\phi\psi]]+[\phi[\psi f]]+[\psi[f\phi]]=\dfrac{df}{dz}[\phi\psi]+\dfrac{d\phi}{dz}[\psi f]+\dfrac{d\psi}{dz}[f\phi]$, which when $f, \phi, \psi$ do not contain $z$ becomes the identity $(f(\phi\psi))+(\phi(\psi f))+(\psi(f\phi))=0$. Then if $X_1 \cdots X_nP_1 \cdots P_n$ be such functions of $x_1 \cdots x_np_1 \cdots p_n$ that $P_1dX_1+\cdots+P_ndX_n$ is identically equal to $p_1dx_1+\cdots+p_ndx_n$, it can be shown by elementary algebra, after equating coefficients of independent differentials, (1) that the functions $X_1 \cdots P_n$ are independent functions of the $2n$ variables $x_1 \cdots p_n$, so that the equations $x'_i=X_i$, $p'_i=P_i$ can be solved for $x_1 \cdots x_np_1 \cdots p_n$, and represent therefore a transformation, which we call a homogeneous contact transformation; (2) that the $X_1 \cdots X_n$ are homogeneous functions of $p_1 \cdots p_n$ of zero dimensions, the $P_1 \cdots P_n$ are homogeneous functions of $p_1 \cdots p_n$ of dimension one, and the $\frac{1}{2}n(n-1)$ relations $(X_iX_j)=0$ are verified. So also are the $n^2$ relations $(P_iX_i)=1$, $(P_iX_j)=0$, $(P_iP_j)=0$. Conversely, if $X_1 \cdots X_n$ be independent functions, each homogeneous of zero dimension in $p_1 \cdots p_n$, satisfying the $\frac{1}{2}n(n-1)$ relations $(X_iX_j)=0$, then $P_1 \cdots P_n$ can be uniquely determined, by solving linear algebraic equations, such that $P_1dX_1+\cdots+P_ndX_n=p_1dx_1+\cdots+p_ndx_n$. If now we put $n+1$ for $n$, put $z$ for $x_{n+1}$, Z for $X_{n+1}$, $Q_i$ for $-P_i/P_{n+1}$, for $i=1 \cdots n$, put $q_i$ for $-p_i/p_{n+1}$ and $\sigma$ for $q_{n+1}/Q_{n+1}$, and then finally write $P_1 \cdots P_np_1 \cdots p_n$ for $Q_1 \cdots Q_nq_1 \cdots q_n$, we obtain the following results: If $ZX_1 \cdots X_nP_1 \cdots P_n$ be functions of $zx_1 \cdots x_np_1 \cdots p_n$, such that the expression $dZ-P_1dX_1-\cdots-P_ndX_n$ is identically equal to $\sigma(dz-p_1dx_1-\cdots-p_ndx_n)$, and $\sigma$ not zero, then (1) the functions $ZX_1 \cdots X_nP_1 \cdots P_n$ are independent functions of $zx_1 \cdots x_np_1 \cdots p_n$, so that the equations $z'=Z$, $x'_i=X_i$, $p'_i=P_i$ can be solved for $zx_1 \cdots x_np_1 \cdots p_n$, and determine a transformation which we call a (non-homogeneous) contact transformation; (2) the $ZX_1 \cdots X_n$ verify the $\frac{1}{2}n(n+1)$ identities $[ZX_i]=0$, $[X_iX_j]=0$. And the further identities $[P_iX_i]=\sigma$, $[P_iX_j]=0$, $[P_iZ]=\sigma P_i$, $[P_iP_j]=0$, $[Z\sigma]=\sigma\dfrac{dZ}{dz}-\sigma^2$, $[X_i\sigma]=\sigma\dfrac{dX_i}{dz}$, $[P_i\sigma]=\sigma\dfrac{dP_i}{dz}$ are also verified. Conversely, if $ZX_1 \cdots X_n$ be independent functions satisfying the identities $[ZX_i]=0$, $[X_iX_j]=0$, then $\sigma$, other than zero, and $P_1 \cdots P_n$ can be uniquely determined, by solution of algebraic equations, such that $dZ-P_1dX_1-\cdots-P_ndX_n=\sigma(dz-p_1dx_1-\cdots-p_ndx_n)$. Finally, there is a particular case of great importance arising when $\sigma=1$, which gives the results: (1) If $UX_1 \cdots X_nP_1 \cdots P_n$ be $2n+1$ functions of the $2n$ independent variables $x_1 \cdots x_np_1 \cdots p_n$, satisfying the identity $dU+P_1dX_1+\cdots+P_ndX_n=p_1dx_1+\cdots+p_ndx_n$, then the $2n$ functions $P_1 \cdots P_nX_1 \cdots X_n$ are independent, and we have $(X_iX_j)=0$, $(X_iU)=\delta X_i$, $(P_iX_i)=1$, $(P_iX_j)=0$, $(P_iP_j)=0$, $(P_iU)+P_i=\delta P_i$, where $\delta$ denotes the operator $p_1d/dp_1+\cdots+p_nd/dp_n$; (2) If $X_1 \cdots X_n$ be independent functions of $x_1 \cdots x_np_1 \cdots p_n$, such that $(X_iX_j)=0$, then U can be found by a quadrature, such that $(X_iU)=\delta X_i$; and when $X_i \cdots X_n$, U satisfy these $\frac{1}{2}n(n+1)$ conditions, then $P_1 \cdots P_n$ can be found, by solution of linear algebraic equations, to render true the identity $dU+P_1dX_1+\cdots+P_ndX_n=p_1dx_1+\cdots+p_ndx_n$; (3) Functions $X_1 \cdots X_nP_1 \cdots P_n$ can be found to satisfy this differential identity when U is an arbitrary given function of $x_1 \cdots x_np_1 \cdots p_n$; but this requires integrations. In order to see what integrations, it is only necessary to verify the statement that if U be an arbitrary given function of $x_1 \cdots x_np_1 \cdots p_n$, and, for $r<n$, $X_1 \cdots X_r$ be independent functions of these variables, such that $(X_\sigma U)=\delta X_\sigma$, $(X_\rho X_\sigma)=0$, for $\rho, \sigma=1 \cdots r$, then the $r+1$ homogeneous linear partial differential equations of the first order $(Uf)+\delta f=0$, $(X_\rho f)=0$, form a complete system. It will be seen that the assumptions above made for the reduction of Pfaffian expressions follow from the results here enunciated for contact transformations.

***Contact transformations.***

We pass on now to consider the solution of any partial differential equation of the first order; we attempt to explain certain ideas relatively to a single equation with any number of independent variables (in particular, an ordinary equation of the first order with one independent variable) by speaking of a single equation with two independent variables $x$, $y$, and one dependent variable $z$. It will be seen that we are naturally led to consider systems of such simultaneous equations, of which we give some account below. The central discovery of the transformation theory of the solution of an equation $F(x, y, z, dz/dx, dz/dy)=0$ is that its solution can be reduced to the solution of partial equations which are *linear*. For this, however, we must regard $dz/dx$, $dz/dy$, during the process of integration, not as the differential coefficients of a function $z$ in regard to $x$ and $y$, but as variables independent of $x, y, z$, the too great indefiniteness that might thus appear to be introduced being provided for in another way. We notice, in fact, that if $z=\psi(x,y)$ be a solution of the differential equation, then $dz=dx\,d\psi/dx+dy\,d\psi/dy$; thus if we denote the equation by $F(xyzpq)=0$, and prescribe the condition $dz=pdx+qdy$ for every solution, any solution such as $z=\psi(x, y)$ will necessarily be associated with the equations $p=dz/dx$, $q=dz/dy$, and $z$ will satisfy the equation in its original form. We have previously seen (under *Pfaffian Expressions*) that if five variables $xyzpq$, otherwise independent, be subject to $dz-pdx-qdy=0$, they must in fact be subject to at least three mutual relations. If we associate with a point $xyz$ the plane $Z-z=p(X-x)+q(Y-y)$ passing through it, where X, Y, Z are current co-ordinates, and call this association a surface-element; and if two consecutive elements of which the point $(x+dx, y+dy, z+dz)$ of one lies on the plane of the other, for which, that is, the condition $dz=pdx+qdy$ is satisfied, be said to be *connected*, and an infinity of connected elements following one another continuously be called a *connectivity*, then our statement is that a connectivity consists of not more than $\infty^2$ elements, the whole number of elements $(xyzpq)$ that are possible being called $\infty^5$. The solution of an equation $F(x, y, z, dz/dx, dz/dy)=0$ is then to be understood to mean finding in all possible ways, from the $\infty^4$ elements $(xyzpq)$ which satisfy $F(xyzpq)=0$

***Partial differential equation of the first order.***

a set of $\infty^2$ elements forming a connectivity; or, more analytically, finding in all possible ways two relations $G=0$, $H=0$ connecting $x$, $y$, $z$, $p$, $q$ and independent of $F=0$, so that the three relations together may involve $dz=pdx+qdy$. Such a set of three relations may, for example, be of the form $z=\psi(x, y)$, $p=d\psi/dx$, $q=d\psi/dy$; but it may also, as another case, involve two relations $z=\psi(y)$, $x=\psi_1(y)$ connecting $x$, $y$, $z$, the third relation being $\psi'(y)=p\psi'_1(y)+q$, the connectivity consisting in that case, geometrically, of a curve in space taken with $\infty^1$ of its tangent planes; or, finally, a connectivity is constituted by a fixed point and all the planes passing through that point. This generalized view of the meaning of a solution of $F=0$ is of advantage, moreover, in view of anomalies otherwise arising from special forms of the equation itself. For instance, we may include the case, sometimes arising when the equation to be solved is obtained by transformation from another equation, in which F does not contain either $p$ or $q$. Then the equation has $\infty^2$ solutions, each consisting of an arbitrary point of the surface $F=0$ and all the $\infty^2$ planes passing through this point; it also has $\infty^2$ solutions, each consisting of a curve drawn on the surface $F=0$ and all the tangent planes of this curve, the whole consisting of $\infty^2$ elements; finally, it has also an isolated (or singular) solution consisting of the points of the surface, each associated with the tangent plane of the surface thereat, also $\infty^2$ elements in all. Or again, a linear equation $F=Pp+Qq-R=0$, wherein P, Q, R are functions of $x$, $y$, $z$ only, has $\infty^2$ solutions, each consisting of one of the curves defined by $dx/P=dy/Q=dz/R$ taken with all the tangent planes of this curve; and the same equation has $\infty^2$ solutions, each consisting of the points of a surface containing $\infty^1$ of these curves and the tangent planes of this surface. And for the case of $n$ variables there is similarly the possibility of $n+1$ kinds of solution of an equation $F(x_1 \cdots x_n z p_1 \cdots p_n)=0$; these can, however, by a simple contact transformation be reduced to one kind, in which there is only one relation $z'=\psi(x'_1 \cdots x'_n)$ connecting the new variables $x'_1 \cdots x'_n z'$ (see under *Pfaffian Expressions*); just as in the case of the solution $z=\psi(y)$, $x=\psi_1(y)$, $\psi'(y)=p\psi'_1(y)+q$ of the equation $Pp+Qq=R$ the transformation $z'=z-px$, $x'=p$, $p'=-x$, $y'=y$, $q'=q$ gives the solution $z'=\psi(y')+x'\psi_1(y')$, $p'=dz'/dx'$, $q'=dz'/dy'$ of the transformed equation. These explanations take no account of the possibility of $p$ and $q$ being infinite; this can be dealt with by writing $p=-u/w$, $q=-v/w$, and considering homogeneous equations in $u$, $v$, $w$, with $udx+vdy+wdz=0$ as the differential relation necessary for a connectivity; in practice we use the ideas associated with such a procedure more often without the appropriate notation.

***Meaning of a solution of the equation.***

In utilizing these general notions we shall first consider the theory of characteristic chains, initiated by Cauchy, which shows well the nature of the relations implied by the given differential equation; the alternative ways of carrying out the necessary integrations are suggested by considering the method of Jacobi and Mayer, while a good summary is obtained by the formulation in terms of a Pfaffian expression.

***Order of the ideas.***

Consider a solution of $F=0$ expressed by the three independent equations $F=0$, $G=0$, $H=0$. If it be a solution in which there is more than one relation connecting $x$, $y$, $z$, let new variables $x'y'z'p'q'$ be introduced, as before explained under *Pfaffian Expressions*, in which $z'$ is of the form $z'=z-p_1x_1-\cdots-p\,x_s$ ($s=1$ or 2), so that the solution becomes of a form $z'=\psi(x'y')$, $p'=d\psi/dx'$, $q'=d\psi/dy'$, which then will identically satisfy the transformed equations $F'=0$, $G'=0$, $H'=0$. The equation $F'=0$, if $x'y'z'$ be regarded as fixed, expresses that the plane $Z-z'=p'(X-x')+q'(Y-y')$ is tangent to a certain cone whose vertex is $x'y'z'$, the consecutive point $(x'+dx', y'+dz', z'+dz')$ of the generator of contact being such that $dx'\Big/\dfrac{dF'}{dp'}=dy'\Big/\dfrac{dF'}{dq'}=dz'\Big/\left(p'\dfrac{dF'}{dp'}+q'\dfrac{dF'}{dq'}\right)$. Passing in this direction on the surface $z'=\psi(x'y')$ the tangent plane of the surface at this consecutive point is $(p'+dp', q'+dq')$, where, since $F'(x', y', \psi, d\psi/dx', d\psi/dy')=0$ is identical, we have $dx'(dF'/dx'+p'dF'/dz')+dp'dF'/dp'=0$. Thus the equations, which we shall call the characteristic equations,

$$dx'\Big/\frac{dF'}{dp'}=dy'\Big/\frac{dF'}{dq'}=dz'\Big/\left(p'\frac{dF'}{dp'}+q'\frac{dF'}{dq'}\right)=dp'\Big/\left(-\frac{dF'}{dx'}-p'\frac{dF'}{dz'}\right)=dq'\Big/\left(-\frac{dF'}{dy'}-q'\frac{dF'}{dz'}\right)$$

are satisfied along a connectivity of $\infty^1$ elements consisting of a curve on $z'=\psi(x'y')$ and the tangent planes of the surface along this curve. The equation $F'=0$, when $p'$, $q'$ are fixed, represents a curve in the plane $Z-z'=p'(X-x')+q'(Y-y')$, passing through $x'y'z'$; if $(x'+\delta x', y'+\delta y', z'+\delta z')$ be a consecutive point of this curve, we find at once $\delta x'\left(\dfrac{dF'}{dx'}+p'\dfrac{dF'}{dz'}\right)+\delta y'\left(\dfrac{dF'}{dy'}+q'\dfrac{dF'}{dz'}\right)=0$; thus the equations above give $\delta x'dp'+\delta y'dq'=0$, or the tangent line of the plane curve, is, on the surface $z'=\psi(x'y')$, in a direction conjugate to that of the generator of the cone. Putting each of the fractions in the characteristic equations equal to $dt$, the equations enable us, starting from an arbitrary element $x'_0y'_0z'_0p'_0q'_0$ about which all the quantities $F'$, $dF'/dp'$, etc., occurring in the denominators, are developable, to define, from the differential equation $F'=0$ alone, a connectivity of $\infty^1$ elements, which we call a *characteristic chain*; and it is remarkable that when we transform again to the original variables $(xyzpq)$, the form of the differential equations for the chain is unaltered, so that they can be written down at once from the equation $F=0$. Thus we have proved that the characteristic chain starting from any ordinary element of any integral of this equation $F=0$ consists only of elements belonging to this integral. For instance, if the equation do not contain $p$, $q$, the characteristic chain, starting from an arbitrary plane through an arbitrary point of the surface $F=0$, consists of a pencil of planes whose axis is a tangent line of the surface $F=0$. Or if $F=0$ be of the form $Pp+Qq=R$, the chain consists of a curve satisfying $dx/P=dy/Q=dz/R$ and a single infinity of tangent planes of this curve, determined by the tangent plane chosen at the initial point. In all cases there are $\infty^3$ characteristic chains, whose aggregate may therefore be expected to exhaust the $\infty^4$ elements satisfying $F=0$.

***Characteristic chains.***

Consider, in fact, a single infinity of connected elements each satisfying $F=0$, say a chain connectivity T, consisting of elements specified by $x_0y_0z_0p_0q_0$, which we suppose expressed as functions of a parameter $u$, so that $U_0=dz_0/du-p_0dx_0/du-q_0dy_0/du$ is everywhere zero on this chain; further, suppose that each of $F$, $dF/dp$, $\cdots$, $dF/dx+pdF/dz$ is developable about each element of this chain T, and that T is *not* a characteristic chain. Then consider the aggregate of the characteristic chains issuing from all the elements of T. The $\infty^2$ elements, consisting of the aggregate of these characteristic chains, satisfy $F=0$, provided the chain connectivity T consists of elements satisfying $F=0$; for each characteristic chain satisfies $dF=0$. It can be shown that these chains are connected; in other words, that if $xyzpq$ be any element of one of these characteristic chains, not only is $dz/dt-pdx/dt-qdy/dt=0$, as we know, but also $U=dz/du-pdx/du-qdy/du$ is also zero. For we have

$$\frac{dU}{dt}=\frac{d}{dt}\left(\frac{dz}{du}-p\frac{dx}{du}-q\frac{dy}{du}\right)-\frac{d}{du}\left(\frac{dz}{dt}-p\frac{dx}{dt}-q\frac{dy}{dt}\right)=\frac{dp}{du}\frac{dx}{dt}-\frac{dp}{dt}\frac{dx}{du}+\frac{dq}{du}\frac{dy}{dt}-\frac{dq}{dt}\frac{dy}{du},$$

which is equal to

$$\frac{dp}{du}\frac{dF}{dp}+\frac{dx}{du}\left(\frac{dF}{dx}+p\frac{dF}{dz}\right)+\frac{dq}{du}\frac{dF}{dq}+\frac{dy}{du}\left(\frac{dF}{dy}+q\frac{dF}{dz}\right)=-\frac{dF}{dz}.U.$$

As $\dfrac{dF}{dz}$ is a developable function of $t$, this, giving $U=U_0\, exp\left(-\displaystyle\int_{t_0}^{t}\frac{dF}{dz}dt\right)$, shows that U is everywhere zero. Thus integrals of $F=0$ are obtainable by considering the aggregate of characteristic chains issuing from arbitrary chain connectivities T satisfying $F=0$; and such connectivities T are, it is seen at once, determinable without integration. Conversely, as such a chain connectivity T can be taken out from the elements of any given integral all possible integrals are obtainable in this way. For instance, an arbitrary curve in space, given by $x_0=\theta(u)$, $y_0=\phi(u)$, $z_0=\psi(u)$, determines by the two equations $F(x_0y_0z_0p_0q_0)=0$, $\psi'(u)=p_0\theta'(u)+q_0\phi'(u)$, such a chain connectivity T, through which there passes a perfectly definite integral of the equation $F=0$. By taking $\infty^2$ initial chain connectivities T, as for instance by taking the curves $x_0=\theta$, $y_0=\phi$, $z_0=\psi$ to be the $\infty^2$ curves upon an arbitrary surface, we thus obtain $\infty^2$ integrals, and so $\infty^4$ elements:

***Complete integral constructed with characteristic chains.***

satisfying $F=0$. In general, if functions G, H, independent of F, be obtained, such that the equations $F=0$, $G=b$, $H=c$ represent an integral for all values of the constants $b$, $c$, these equations are said to constitute a *complete integral*. Then $\infty^4$ elements satisfying $F=0$ are known, and in fact every other form of integral can be obtained without further integrations.

In the foregoing discussion of the differential equations of a characteristic chain, the denominators $\frac{dF}{dp}, \cdot\cdot$ may be supposed to be modified in form by means of $F=0$ in any way conducive to a simple integration. In the immediately following explanation of ideas, however, we consider indifferently all equations $F=$ constant; when a function of $xyzpq$ is said to be zero, it is meant that this is so identically, not in virtue of $F=0$; in other words, we consider the integration of $F=a$, where $a$ is an arbitrary constant. In the theory of linear partial equations we have seen that the integration of the equations of the characteristic chains, from which, as has just been seen, that of the equation $F=a$ follows at once, would be involved in completely integrating the single linear homogeneous partial differential equation of the first order $[Ff]=0$, where the notation is that explained above under *Contact Transformations*.

***Operations necessary for integration of F=a.***

One obvious integral is $f=F$. Putting $F=a$, where $a$ is arbitrary, and eliminating one of the independent variables, we can reduce this equation $[Ff]=0$ to one in four variables; and so on. Calling, then, the determination of a single integral of a single homogeneous partial differential equation of the first order in $n$ independent variables, *an operation of order* $n-1$, the characteristic chains, and therefore the most general integral of $F=a$, can be obtained by successive operations of orders 3, 2, 1. If, however, an integral of $F=a$ be represented by $F=a$, $G=b$, $H=c$, where $b$ and $c$ are arbitrary constants, the expression of the fact that a characteristic chain of $F=a$ satisfies $dG=0$, gives $[FG]=0$; similarly, $[FH]=0$ and $[GH]=0$, these three relations being identically true. Conversely, suppose that an integral G, independent of F, has been obtained of the equation $[Ff]=0$, which is an operation of order three. Then it follows from the identity $[f[\phi\psi]]+[\phi[\psi f]]+[\psi[f\phi]]=\frac{df}{dz}[\psi\phi]+\frac{d\phi}{dz}[\psi f]+\frac{d\psi}{dz}[f\phi]$ before remarked, by putting $\phi=F$, $\psi=G$, and then $[Ff]=A(f)$, $[Gf]=B(f)$, that $AB(f)-BA(f)=\frac{dF}{dz}B(f)-\frac{dG}{dz}A(f)$, so that the two linear equations $[Ff]=0$, $[Gf]=0$ form a complete system; as two integrals F, G are known, they have a common integral H, independent of F, G, determinable by an operation of order one only. The three functions F, G, H thus identically satisfy the relations $[FG]=[GH]=[FH]=0$. The $\infty^2$ elements satisfying $F=a$, $G=b$, $H=c$, wherein $a$, $b$, $c$ are assigned constants, can then be seen to constitute an integral of $F=a$. For the conditions that a characteristic chain of $G=b$ issuing from an element satisfying $F=a$, $G=b$, $H=c$ should consist only of elements satisfying these three equations are simply $[FG]=0$ $[GH]=0$. Thus, starting from an arbitrary element of ($F=a$, $G=b$, $H=c$), we can single out a connectivity of elements of ($F=a$, $G=b$, $H=c$) forming a characteristic chain of $G=b$; then the aggregate of the characteristic chains of $F=a$ issuing from the elements of this characteristic chain of $G=b$ will be a connectivity consisting only of elements of ($F=a$, $G=b$, $H=c$), and will therefore constitute an integral of $F=a$; further, it will include all elements of ($F=a$, $G=b$, $H=c$). This result follows also from a theorem given under *Contact Transformations*, which shows, moreover, that though the characteristic chains of $F=a$ are not determined by the three equations $F=a$, $G=b$, $H=c$, no further integration is now necessary to find them. By this theorem, since identically $[FG]=[GH]=[FH]=0$, we can find, by the solution of linear algebraic equations only, a non-vanishing function $\sigma$ and two functions A, C, such that $dG-AdF-CdH=\sigma(dz-pdx-qdy)$; thus all the elements satisfying $F=a$, $G=b$, $H=c$, satisfy $dz=pdx+qdy$ and constitute a connectivity, which is therefore an integral of $F=a$. While, further, from the associated theorems, F, G, H, A, C are independent functions and $[FC]=0$. Thus C may be taken to be the remaining integral independent of G, H, of the equation $[Ff]=0$, whereby the characteristic chains are entirely determined.

When we consider the particular equation $F=0$, neglecting the case when neither $p$ nor $q$ enters, and supposing $p$ to enter, we may express $p$ from $F=0$ in terms of $xyzq$, and then eliminate it from all other equations. Then instead of the equation $[Ff]=0$, we have, if $F=0$ give $p=\psi(xyzq)$, the equation $\Omega f=-\left(\frac{df}{dx}+\psi\frac{df}{dz}\right)+\frac{d\psi}{dq}\left(\frac{df}{dy}+q\frac{df}{dz}\right)-\left(\frac{d\psi}{dy}+q\frac{d\psi}{dz}\right)\frac{df}{dq}=0$, moreover obtainable by omitting the term in $\frac{df}{dp}$ in $[p-\psi, f]=0$. Let $x_o y_o z_o q_o$ be values about which the coefficients in this equation are developable, and let $\zeta$, $\eta$, $\omega$ be the principal solutions reducing respectively to $z$, $y$ and $q$ when $x=x_o$. Then the equations $p=\psi$, $\zeta=z_o$, $\eta=y_o$, $\omega=q_o$ represent a characteristic chain issuing from the element $x_o y_o z_o \psi_o q_o$; we have seen that the aggregate of such chains issuing from the elements of an arbitrary chain satisfying $dz_o-p_o dx_o-q_o dy_o=0$ constitute an integral of the equation $p=\psi$. Let this arbitrary chain be taken so that $x_o$ is constant; then the condition for initial values is only $dz_o-q_o dy_o=0$, and the elements of the integral constituted by the characteristic chains issuing therefrom satisfy $d\zeta-\omega d\eta=0$. Hence this equation involves $dz-\psi dx-qdy=0$, or we have $dz-\psi dx-qdy=\sigma(d\zeta-\omega d\eta)$, where $\sigma$ is not zero. Conversely, the integration of $p=\psi$ is, essentially, the problem of writing the expression $dz-\psi dx-qdy$ in the form $\sigma(d\zeta-\omega d\eta)$, as must be possible (from what was said under *Pfaffian Expressions*).

***The single equation F=0 and Pfaffian formulation.***

To integrate a system of simultaneous equations of the first order $X_1=a_1 \cdot\cdot\cdot X_r=a_r$ in $n$ independent variables $x_1 \cdot\cdot x_n$ and one dependent variable $z$, we write $p_1$ for $dz/dx_1$, &c., and attempt to find $n+1-r$ further functions Z, $X_{r+1} \cdot\cdot X_n$, such that the equations $Z=a$, $X_i=a_i (i=1 \cdot\cdot n)$ involve $dz-p_1dx_1-\cdot\cdot\cdot-p_ndx_n=0$. By an argument already given, the common integral, if existent, must be satisfied by the equations of the characteristic chains of any one equation $X_i=a_i$; thus each of the expressions $[X_iX_j]$ must vanish in virtue of the equations expressing the integral, and we may without loss of generality assume that each of the corresponding $\frac{1}{2}r(r-1)$ expressions formed from the $r$ given differential equations vanishes in virtue of these equations. The determination of the remaining $n+1-r$ functions may, as before, be made to depend on characteristic chains, which in this case, however, are manifolds of $r$ dimensions obtained by integrating the equations $[X_1f]=0 \cdot\cdot\cdot [X_rf]=0$; or having obtained one integral of this system other than $X_1 \cdot\cdot X_r$, say $X_{r+1}$, we may consider the system $[X_1f]=0 \cdot\cdot [X_{r+1}f]=0$, for which, again, we have a choice; and at any stage we may use Mayer's method and reduce the simultaneous linear equations to one equation involving parameters; while if at any stage of the process we find some but not all of the integrals of the simultaneous system, they can be used to simplify the remaining work; this can only be clearly explained in connexion with the theory of so-called function groups for which we have no space. One result arising is that the simultaneous system $p_1=\phi_1, \cdot\cdot, p_r=\phi_r$, wherein $p_1 \cdot\cdot p_r$ are not involved in $\phi_1 \cdot\cdot \phi_r$, if it satisfies the $\frac{1}{2}r(r-1)$ relations $[p_i-\phi_i, p_j-\phi_j]=0$, has a solution $z=\psi(x_1 \cdot\cdot x_n)$, $p_1=d\psi/dx_1 \cdot\cdot$, $p_n=d\psi/dx_n$, reducing to an arbitrary function, of $x_{r+1} \cdot\cdot\cdot x_n$ only, when $x_1=x_1^o \cdot\cdot x_r=x_r^o$ under certain conditions as to developability; a generalization of the theorem for linear equations. The problem of integration of this system is, as before, to put $dz-\phi_1dx_1-\cdot\cdot\cdot-\phi_rdx_r-p_{r+1}dx_{r+1}-\cdot\cdot\cdot-p_n\,dx_n$ into the form $\sigma(d\zeta-\omega_{r+1}d\xi_{r+1}-\cdot\cdot\cdot\omega_nd\xi_n)$; and here $\zeta$, $\xi_{r+1} \cdot\cdot \xi_n$ $\omega_{r+1} \cdot\cdot\cdot \omega_n$ may be taken, as before, to be principal integrals of a certain complete system of linear equations; those, namely, determining the characteristic chains.

***System of equations of the first order.***

If L be a function of $t$ and of the $2n$ quantities $x_1 \cdot\cdot x_n \dot{x}_1 \cdot\cdot \dot{x}_n$, where $\dot{x}_i$ denotes $dx_i/dt$, &c., and if in the $n$ equations $\frac{d}{dt}\left(\frac{dL}{d\dot{x}_i}\right)=\frac{dL}{dx_i}$ we put $p_i=\frac{dL}{d\dot{x}_i}$, and so express $\dot{x}_1 \cdot\cdot \dot{x}_n$ in terms of $t$, $x_1 \cdot\cdot x_n p_1 \cdot\cdot p_n$, assuming that the determinant of the quantities $\frac{d^2L}{d\dot{x}_i\,d\dot{x}_j}$ is not zero; if, further, H denote the function of $t$, $x_1 \cdot\cdot x_n p_1 \cdot\cdot p_n$, numerically equal to $p_1\dot{x}_1+\cdot\cdot+p_n\dot{x}_n-L$, it is easy to prove that $dp_i/dt=-dH/dx_i$, $dx_i/dt=dH/dp_i$. These so-called *canonical* equations form part of those for the characteristic chains of the single partial equation $dz/dt+H(tx_1 \cdot\cdot x_n, dz/dx_1, \cdot\cdot\cdot, dz/dx_n)=0$, to which then the solution of the original equations for $x_1 \cdot\cdot x_n$ can be reduced. It may be shown (1) that if $z=\psi(tx_1 \cdot\cdot x_nc_1 \cdot\cdot c_n)+c$ be a complete integral of this equation, then $p_i=d\psi/dx_i$, $d\psi/dc_i=e_i$ are $2n$ equations giving the solution of the canonical equations referred to, where $c_1 \cdot\cdot c_n$ and $e_1 \cdot\cdot e_n$ are arbitrary constants; (2) that if $x_i=X_i(tx_1^o \cdot\cdot p_n^o)$, $p_i=P_i(tx_1^o \cdot\cdot p_n^o)$ be the principal solutions of the canonical equations for $t=t^o$, and $\omega$ denote the result of substituting these values in $p_1dH/dp_1+\cdot\cdot\cdot+p_ndH/dp_n-H$, and $\Omega=\int_{t_o}^{t}\omega dt$, where, after integration, $\Omega$ is to be expressed as a function of $t$, $x_1 \cdot\cdot x_nx_1^o \cdot\cdot x_n^o$, then $z=\Omega+z^o$ is a complete integral of the partial equation.

***Equations of dynamics.***

A system of differential equations is said to allow a certain continuous group of transformations (see GROUPS) when the introduction for the variables in the differential equations of the new variables arising in the general finite equations of the group leads, for all values of the parameters of the group, to the same differential equations in the new variables. It would be interesting

to verify in examples that this is the case in at least the majority of the differential equations which are known to be integrable in finite terms. As space forbids the attempt, we give a theorem of very general application for the case of a simultaneous complete system of linear partial homogeneous differential equations of the first order, to the solution of which the various differential equations discussed have been reduced. It will be enough to consider whether the given differential equations allow the infinitesimal transformations of the group.

***Application of theory of continuous groups to formal theories.***

It can be shown easily that sufficient conditions in order that a complete system $\Pi_1 f=0 \cdot\cdot \Pi_k f=0$, in $n$ independent variables, should allow the infinitesimal transformation $\mathrm{P}f=0$ are expressed by $k$ equations $\Pi_i \mathrm{P}f - \mathrm{P}\Pi_i f = \lambda_{i1}\Pi_1 f + \cdot\cdot + \lambda_{ik}\Pi_k f$. Suppose now a complete system of $n-r$ equations in $n$ variables to allow a group of $r$ infinitesimal transformations $(\mathrm{P}_1 f, \cdot\cdot, \mathrm{P}_r f)$ which has an invariant subgroup of $r-1$ parameters $(\mathrm{P}_1 f, \cdot\cdot, \mathrm{P}_{r-1} f)$, it being supposed that the $n$ quantities $\Pi_1 f, \cdot\cdot, \Pi_{n-r} f, \mathrm{P}_1 f, \cdot\cdot, \mathrm{P}_r f$ are not connected by an identical linear equation (with coefficients even depending on the independent variables). Then it can be shown that one solution of the complete system is determinable by a quadrature. For each of $\Pi_i \mathrm{P}_\sigma f - \mathrm{P}_\sigma \Pi_i f$ is a linear function of $\Pi_1 f, \cdot\cdot, \Pi_{n-r} f$ and the simultaneous system of independent equations $\Pi_1 f=0 \cdot\cdot \Pi_{n-r} f=0, \mathrm{P}_1 f=0 \cdot\cdot \mathrm{P}_{r-1} f=0$ is therefore a complete system, allowing the infinitesimal transformation $\mathrm{P}_r f$. This complete system of $n-1$ equations has therefore one common solution $\omega$, and $\mathrm{P}_r(\omega)$ is a function of $\omega$. By choosing $\omega$ suitably, we can then make $\mathrm{P}_r(\omega)=1$. From this equation and the $n-1$ equations $\Pi_i\omega=0$, $\mathrm{P}_\sigma\omega=0$, we can determine $\omega$ by a quadrature only. Hence can be deduced a much more general result, *that if the group of* r *parameters be integrable, the complete system can be entirely solved by quadratures*; it is only necessary to introduce the solution found by the first quadrature as an independent variable, whereby we obtain a complete system of $n-r$ equations in $n-1$ variables, subject to an integrable group of $r-1$ parameters, and to continue this process. We give some examples of the application of the theorem. (1) If an equation of the first order $y'=\psi(x, y)$ allow the infinitesimal transformation $\xi df/dx+\eta df/dy$, the integral curves $\omega(x, y)=y^o$, wherein $\omega(x, y)$ is the solution of $\dfrac{df}{dx}+\psi(x, y)\dfrac{df}{dy}=0$ reducing to $y$ for $x=x^o$, are interchanged among themselves by the infinitesimal transformation, or $\omega(x, y)$ can be chosen to make $\xi d\omega/dx+\eta d\omega/dy=1$; this, with $d\omega/dx+\psi d\omega/dy=0$, determines $\omega$ as the integral of the complete differential $(dy-\psi dx)/(\eta-\psi\xi)$. This result itself shows that every ordinary differential equation of the first order is subject to an infinite number of infinitesimal transformations. But every infinitesimal transformation $\xi df/dx+\eta df/dy$ can by change of variables (after integration) be brought to the form $df/dy$, and all differential equations of the first order allowing this group can then be reduced to the form $\mathrm{F}(x, dy/dx)=0$. (2) In the case of an ordinary equation of the second order $y''=\psi(xyy')$, equivalent to $dy/dx=y_1$, $dy_1/dx=\psi(xyy_1)$, if $\mathrm{H}, \mathrm{H}_1$ be the solutions for $y$ and $y_1$ chosen to reduce to $y^o$ and $y_1{}^o$ when $x=x^o$, and the equations $\mathrm{H}=y$, $\mathrm{H}_1=y_1$ be equivalent to $\omega=y^o$, $\omega_1=y_1{}^o$, then $\omega$, $\omega_1$ are the principal solutions of $\Pi f=df/dx+y_1 df/dy+\psi df/dy_1=0$. If the original equation allow an infinitesimal transformation whose first *extended* form (see art. GROUPS) is $\mathrm{P}f=\xi df/dx+\eta df/dy+\eta_1 df/dy_1$, where $\eta_1\delta t$ is the increment of $dy/dx$ when $\xi\delta t$, $\eta\delta t$ are the increments of $x$, $y$, and is to be expressed in terms of $x$, $y$, $y_1$, then each of $\mathrm{P}\omega$ and $\mathrm{P}\omega_1$ must be functions of $\omega$ and $\omega_1$, or the partial differential equation $\Pi f$ must allow the group $\mathrm{P}f$. Thus by our general theorem, if the differential equation allow a group of two parameters (and such a group is always integrable), it can be solved by quadratures, our explanation sufficing, however, only provided the form $\Pi f$ and the two infinitesimal transformations are not linearly connected. It can be shown, from the fact that $\eta_1$ is a quadratic polynomial in $y_1$, that no differential equation of the second order can allow more than 8 really independent infinitesimal transformations, and that every homogeneous linear differential equation of the second order allows just 8, being in fact reducible to $d^2y/dx^2=0$. Since every group of more than two parameters has subgroups of two parameters, a differential equation of the second order allowing a group of more than two parameters can, as a rule, be solved by quadratures. By transforming the group we see that if a differential equation of the second order allows a single infinitesimal transformation, it can be transformed to the form $\mathrm{F}(x, d\gamma/dx, d^2\gamma/dx^2)$; this is not the case for every differential equation of the second order. (3) For an ordinary differential equation of the third order, allowing an integrable group of three parameters whose infinitesimal transformations are not linearly connected with the partial equation to which the solution of the given ordinary equation is reducible, the similar result follows that it can be integrated by quadratures. But if the group of three parameters be simple, this result must be replaced by the statement that the integration is reducible to quadratures and that of a so-called Riccati equation of the first order, of the form $dy/dx=\mathrm{A}+\mathrm{B}y+\mathrm{C}y^2$, where A, B, C are functions of $x$. (4) Similarly for the integration by quadratures of an ordinary equation $y_n=\psi(xyy_1 \cdot\cdot y_{n-1})$ of any order. Moreover, the group allowed by the equation may quite well consist of extended contact transformations. An important application is to the case where the differential equation is the resolvent equation defining the group of transformations or rationality group of another differential equation (see below); in particular, when the rationality group of an ordinary linear differential equation is integrable, the equation can be solved by quadratures.

***Consideration of function theories of differential equations.***

Following the practical and provisional division of theories of differential equations, to which we alluded at starting, into transformation theories and function theories, we pass now to give some account of the latter. These are both a necessary logical complement of the former, and the only remaining resource when the expedients of the former have been exhausted. While in the former investigations we have dealt only with values of the independent variables about which the functions are developable, the leading idea now becomes, as was long ago remarked by G. Green, the consideration of the neighbourhood of the values of the variables for which this developable character ceases. Beginning, as before, with existence theorems applicable for ordinary values of the variables, we are to consider the cases of failure of such theorems.

***A general existence theorem.***

When in a given set of differential equations the number of equations is greater than the number of dependent variables, the equations cannot be expected to have common solutions unless certain conditions of compatibility, obtainable by equating different forms of the same differential coefficients deducible from the equations, are satisfied. We have had examples in systems of linear equations, and in the case of a set of equations $p_1=\phi_1, \cdot\cdot, p_r=\phi_r$. For the case when the number of equations is the same as that of dependent variables, the following is a general theorem which should be referred to: Let there be $r$ equations in $r$ dependent variables $z_1 \cdot\cdot z_r$ and $n$ independent variables $x_1 \cdot\cdot x_n$; let the differential coefficient of $z_\sigma$ of highest order which enters be of order $h_\sigma$, and suppose $d^{h_\sigma}z_\sigma/dx_1{}^{h_\sigma}$ to enter, so that the equations can be written $d^{h_\sigma}z_\sigma/dx_1{}^{h_\sigma}=\Phi_\sigma$, where in the general differential coefficient of $z_\rho$ which enters in $\Phi_\sigma$, say $d^{k_1+\cdot\cdot+k_n}z_\rho/dx_1{}^{k_1}\cdot\cdot dx_n{}^{k_n}$, we have $k_1 < h_\rho$ and $k_1+\cdot\cdot+k_n \leqq h_\rho$. Let $a_1 \cdot\cdot a_n b_1 \cdot\cdot b_r$ and $b^\rho{}_{k_1 \cdot\cdot k_n}$ be a set of values of $x_1 \cdot\cdot x_n z_1 \cdot\cdot z_r$ and of the differential coefficients entering in $\Phi_\sigma$ about which all the functions $\Phi_1 \cdot\cdot \Phi_r$ are developable. Corresponding to each dependent variable $z_\sigma$, we take now a set of $h_\sigma$ functions of $x_2 \cdot\cdot x_n$, say $\phi_\sigma, \phi_\sigma{}^{(1)}, \cdots, \phi_\sigma{}^{(h-1)}$, arbitrary save that they must be developable about $a_2 a_3 \cdot\cdot a_n$, and such that for these values of $x_2 \cdot\cdot x_n$, the function $\phi_\rho$ reduces to $b_\rho$, and the differential coefficient $d^{k_2+\cdot\cdot+k_n}\phi_\rho{}^{(k_1)}/dx_2{}^{k_2}\cdot\cdot dx_n{}^{k_n}$ reduces to $b_{k_1}{}^\rho{}_{\cdot\cdot k_n}$. Then the theorem is that there exists one, and only one, set of functions $z_1 \cdot\cdot z_r$ of $x_1 \cdot\cdot x_n$ developable about $a_1 \cdot\cdot a_n$ satisfying the given differential equations, and such that for $x_1=a_1$ we have $z_\sigma=\phi_\sigma$, $dz_\sigma/dx_1=\phi_\sigma{}^{(1)} \cdots d^{h_\sigma-1}z_\sigma/d^{h_\sigma-1}x_1=\phi_\sigma{}^{(h_\sigma-1)}$. And, moreover, if the arbitrary functions $\phi_\sigma\phi_\sigma{}^{(1)}\cdots$ contain a certain number of arbitrary variables $t_1 \cdot\cdot t_m$, and be developable about the values $t_1{}^o \cdot\cdot t_m{}^o$ of these variables, the solutions $z_1 \cdot\cdot z_r$ will contain $t_1 \cdot\cdot t_m$, and be developable about $t_1{}^o \cdot\cdot t_m{}^o$.

The proof of this theorem may be given by showing that if ordinary power series in $x_1-a_1 \cdot\cdot x_n-a_n\ t_1-t_1{}^o \cdot\cdot t_m-t_m{}^o$ be substituted in the equations wherein in $z_\sigma$ the coefficients of $(x_1-a_1)^o$, $x_1-a_1, \cdots, (x_1-a_1)^{h_\sigma-1}$ are the arbitrary functions $\phi_\sigma\phi_\sigma{}^{(1)}\cdot\cdot\phi_\sigma{}^{(h-1)}$,

divided respectively by 1, 1!, 2!, &c., then the differential equations determine uniquely all the other coefficients, and that the resulting series are convergent. We rely, in fact, upon the theory of monogenic analytical functions (see art. FUNCTIONS, ANALYTIC), a function being determined entirely by its development in the neighbourhood of one set of values of the independent variables, from which all its other values arise by *continuation*; it being of course understood that the coefficients in the differential equations are to be continued at the same time. But it is to be remarked that there is no ground for believing, if this method of continuation be utilized, that the function is single-valued; we may quite well return to the same values of the independent variables with a different value of the function, belonging, as we say, to a different branch of the function; and there is even no reason for assuming that the number of branches is finite, or that different branches have the same singular points and regions of existence. Moreover, and this is the most difficult consideration of all, all these circumstances may be dependent upon the values supposed given to the arbitrary constants of the integral; in other words, the singular points may be either *fixed*, being determined by the differential equations themselves, or they may be *movable* with the variation of the arbitrary constants of integration. Such difficulties arise even in establishing the reversion of an elliptic integral, in solving the equation $\left(\frac{dx}{ds}\right)^2=(x-a_1)(x-a_2)(x-a_3)(x-a_4)$; about an ordinary value the right side is developable; if we put $x-a_1=t_1^2$, the right side becomes developable about $t_1=0$; if we put $x=1/t$, the right side of the changed equation is developable about $t=0$; it is quite easy to show that the integral reducing to a definite value $x_o$ for a value $s_o$ is obtainable by a series in integral powers; this, however, must be supplemented by showing that for no values of $s$ does the value of $x$ become entirely undetermined.

**Singular points of solutions.**

These remarks will show the place of the theory now to be sketched of a particular class of ordinary linear homogeneous differential equations whose importance arises from the completeness and generality with which they can be discussed. We have seen that if in the equations $dy/dx=y_1$, $dy_1/dx=y_2, \cdots, dy_{n-2}/dx=y_{n-1}$, $dy_{n-1}/dx=a_n y+a_{n-1}y_1+\cdots+a_1 y_{n-1}$, wherein $a_1, a_2, \cdots, a_n$ are now to be taken to be rational functions of $x$, the value $x=x^o$ be one for which no one of these rational functions is infinite, and $y^o, y_1^o, \cdots, y^o_{n-1}$ be quite arbitrary finite values, then the equations are satisfied by $y=y^o u+y_1^o u_1+\cdots+y^o_{n-1}u_{n-1}$, wherein $u, u_1, \cdots, u_{n-1}$ are functions of $x$, independent of $y^o\cdots y^o_{n-1}$, developable about $x=x^o$; this value of $y$ is such that for $x=x^o$ the functions $y, y_1\cdots y_{n-1}$ reduce respectively to $y^o y_1^o \cdots y^o_{n-1}$; it can be proved that the region of existence of these series extends within a circle centre $x^o$ and radius equal to the distance from $x^o$ of the nearest point at which one of $a_1\cdots a_n$ becomes infinite. Now consider a region enclosing $x^o$, and only one of the places, say $\Sigma$, at which one of $a_1\cdots a_n$ becomes infinite. When $x$ is made to describe a closed curve in this region, including this point $\Sigma$ in its interior, it may well happen that the continuations of the functions $u, u_1, \cdots, u_{n-1}$ give, when we have returned to the point $x$, values $v, v_1, \cdots, v_{n-1}$, so that the integral under consideration becomes changed to $y^o v+y_1^o v_1+\cdots+y^o_{n-1}v_{n-1}$. At $x^o$ let this branch and the corresponding values of $y_1\cdots y_{n-1}$ be $\eta^o\eta^o_1\cdots\eta^o_{n-1}$; then, as there is only one series satisfying the equation and reducing to $(\eta^o\eta^o_1\cdots\eta^o_{n-1})$ for $x=x^o$, and the coefficients in the differential equation are single-valued functions, we must have $\eta^o u+\eta_1^o u_1+\cdots+\eta^o_{n-1}u_{n-1}=y^o v+y^o_1 v_1+\cdots+y^o_{n-1}v_{n-1}$; as this holds for arbitrary values of $y^o\cdots y^o_{n-1}$, upon which $u\cdots u_{n-1}$ and $v\cdots v_{n-1}$ do not depend, it follows that each of $v\cdots v_{n-1}$ is a linear function of $u\cdots u_{n-1}$ with constant coefficients, say $v_i=A_{i1}u+\cdots+A_{in}u_{n-1}$. Then $y^o v+\cdots+y^o_{n-1}v_{n-1}=(\Sigma_i A_{i1}y^o_i)u+\cdots+(\Sigma_i A_{in}y^o_i)u_{n-1}$; this is equal to $\mu(y^o u+\cdots+y^o_{n-1}u_{n-1})$ if $\Sigma_i A_{ir}y^o_i=\mu y^o_{r-1}$; eliminating $y^o\cdots y^o_{n-1}$ from these linear equations, we have a determinantal equation of order $n$ for $\mu$; let $\mu_1$ be one of its roots; determining the ratios of $y^o y_1^o\cdots y^o_{n-1}$ to satisfy the linear equations, we have thus proved that there exists an integral, H, of the equation, which when continued round the point $\Sigma$ and back to the starting-point, becomes changed to $H_1=\mu_1 H$. Let now $\xi$ be the value of $x$ at $\Sigma$, and $r_1$ one of the values of $\frac{1}{2\pi i}\log\mu_1$; consider the function $(x-\xi)^{-r_1}H$; when $x$ makes a circuit round $x=\xi$, this becomes changed to $exp(-2\pi i r_1)(x-\xi)^{-r_1}\mu_1 H$, that is, is unchanged; thus we may put $H=(x-\xi)^{r_1}\phi_1$, $\phi_1$ being a function single-valued for paths in the region considered described about $\Sigma$, and therefore, by Laurent's Theorem (see art. FUNCTIONS, ANALYTIC), capable of expression in the annular region about this point by a series of positive and negative integral powers of $x-\xi$, which in general may contain an infinite number of negative powers; there is, however, no reason to suppose $r_1$ to be an integer, or even real. Thus, if all the roots of the determinantal equation in $\mu$ are different, we obtain $n$ integrals of the forms $(x-\xi)^{r_1}\phi_1, \cdots, (x-\xi)^{r_n}\phi_n$. In general we obtain as many integrals of this form as there are really different roots; and the problem arises to discover, in case a root be $k$ times repeated, $k-1$ equations of as simple a form as possible to replace the $k-1$ equations of the form $y^o v+\cdots+y^o_{n-1}v_{n-1}=\mu(y^o u+\cdots+y^o_{n-1}u_{n-1})$ which would have existed had the roots been different. The most natural method of obtaining a suggestion lies probably in remarking that if $r_2=r_1+h$, there is an integral $[(x-\xi)^{r_1+h}\phi_2-(x-\xi)^{r_1}\phi_1]/h$, wherein the coefficients in $\phi_2$ are the same functions of $r_1+h$ as are the coefficients in $\phi_1$ of $r_1$; when $h$ vanishes, this integral takes the form $(x-\xi)^{r_1}\left[\frac{d\phi_1}{dr_1}+\phi_1\log(x-\xi)\right]$, or say $(x-\xi)^{r_1}[\psi_1+\phi_1\log(x-\xi)]$; denoting this by $2\pi i\mu_1 K$, and $(x-\xi)^{r_1}\phi_1$ by H, a circuit of the point $\xi$ changes K into $K'=\frac{1}{2\pi i\mu_1}\left[e^{2\pi i r_1}(x-\xi)^{r_1}\psi_1+e^{2\pi i r_1}(x-\xi)^{r_1}\phi_1(2\pi i+\log(x-\xi))\right]=\mu_1 K+H$. A similar artifice suggests itself when three of the roots of the determinantal equation are the same, and so on. We are thus led to the result, which is justified by an examination of the algebraic conditions, that whatever may be the circumstances as to the roots of the determinantal equation, $n$ integrals exist, breaking up into batches, the values of the constituents $H_1, H_2, \cdots$ of a batch after circuit about $x=\xi$ being $H_1'=\mu_1 H_1$, $H_2'=\mu_1 H_2+H_1$, $H_3'=\mu_1 H_3+H_2$, and so on. And this is found to lead to the forms $(x-\xi)^{r_1}\phi_1$, $(x-\xi)^{r_1}[\psi_1+\phi_1\log(x-\xi)]$, $(x-\xi)^{r_1}[\chi_1+\chi_2\log(x-\xi)+\phi_1(\log(x-\xi))^2]$, and so on. Here each of $\phi_1\psi_1\chi_1\chi_2\cdots$ is a series of positive and negative integral powers of $x-\xi$ in which the number of negative powers may be infinite.

**Linear differential equations with rational coefficients.**

It appears natural enough now to inquire whether, under proper conditions for the forms of the rational functions $a_1\cdots a_n$, it may be possible to ensure that in each of the series $\phi_1\psi_1\chi_1\cdots$ the number of negative powers shall be finite. Herein lies, in fact, the limitation which experience has shown to be justified by the completeness of the results obtained. Assuming $n$ integrals in which in each of $\phi_1, \psi_1, \chi_1\cdots$ the number of negative powers is finite, there is a definite homogeneous linear differential equation having these integrals; this is found by forming it to have the form $y'^n=(x-\xi)^{-1}b_1 y'^{(n-1)}+(x-\xi)^{-2}b_2 y'^{(n-2)}+\cdots+(x-\xi)^{-n}b_n y$, where $b_1\cdots b_n$ are finite for $x=\xi$. Conversely, assume the equation to have this form. Then on substituting a series of the form $(x-\xi)^r[1+A_1(x-\xi)+A_2(x-\xi)^2+\cdots]$ and equating the coefficients of like powers of $x-\xi$, it is found that $r$ must be a root of an algebraic equation of order $n$; this equation, which we shall call the index equation, can be obtained at once by substituting for $y$ only $(x-\xi)^r$ and replacing each of $b_1\cdots b_n$ by their values at $x=\xi$; arrange the roots $r_1, r_2, \cdots$ of this equation so that the real part of $r_i$ is equal to, or greater than, the real part of $r_{i+1}$, and take $r$ equal to $r_1$; it is found that the coefficients $A_1, A_2\cdots$ are uniquely determinate, and that the series converges within a circle about $x=\xi$ which includes no other of the points at which the rational functions $a_1\cdots a_n$ become infinite. We have thus a solution $H_1=(x-\xi)^{r_1}\phi_1$ of the differential equation. If we now substitute in the equation $y=H_1\int\eta dx$, it is found to reduce to an equation of order $n-1$ for $\eta$ of the form $\eta'^{(n-1)}=(x-\xi)^{-1}c_1\eta'^{(n-2)}+\cdots+(x-\xi)^{n-1}c_{n-1}\eta$, wherein $c_1\cdots c_{n-1}$ are not infinite at $x=\xi$. To this equation precisely similar reasoning can then be applied; its index equation has in fact the roots $r_2-r_1-1, \cdots, r_n-r_1-1$; if $r_2-r_1$ be zero, the integral $(x-\xi)^{-1}\psi_1$ of the $\eta$ equation will give an integral of the original equation containing $\log(x-\xi)$; if $r_2-r_1$ be an integer, and therefore a negative integer, the same will be true, unless in $\psi_1$ the term in $(x-\xi)^{r_1-r_2}$ be absent; if neither of these arise, the original equation will have an integral $(x-\xi)^{r_2}\phi_2$. The $\eta$ equation can now, by means of the one integral of it belonging to the index $r_2-r_1-1$, be similarly reduced to one of order $n-2$, and so on. The result will be that stated above. We shall say that an equation of the form in question is *regular* about $x=\xi$.

**Regular equations.**

We may examine in this way the behaviour of the integrals at all the points at which any one of the rational functions $a_1\cdots a_n$ becomes infinite; in general we must expect that beside these the value $x=\infty$ will be a singular point for the solutions of the differential equation. To test this we put $x=1/t$ throughout, and examine as before at $t=0$. For instance, the ordinary linear equation with constant coefficients has no singular point for finite values of $x$; at $x=\infty$ it has a singular point and is not regular; or again, Bessel's equation $x^2y''+xy'+(x^2-n^2)y=0$ is regular about $x=0$, but not about $x=\infty$. An equation regular at all the finite singularities and also at $x=\infty$ is called a Fuchsian equation. We proceed to examine particularly the case of an equation of the second order $y''+ay'+by=0$. Putting $x=\frac{1}{t}$, it becomes $d^2y/dt^2+(2t^{-1}-at^{-2})dy/dt+bt^{-4}y=0$, which is not regular about $t=0$ unless $2-at^{-1}$ and $bt^{-2}$,

**Fuchsian equations.**

that is, unless $ax$ and $bx^2$ are finite at $x=\infty$; which we thus assume; putting $y=t^r(1+A_1t+\cdot\cdot)$, we find for the index equation at $x=\infty$ the equation $r(r-1)+r\ (2-ax)_o+(bx^2)_o=0$.

***Equation of the second order.***

If there be finite singular points at $\xi_1\cdot\cdot\xi_m$, where we assume $m>1$, the cases $m=0$, $m=1$ being easily dealt with, and if $\phi(x)=(x-\xi_1)\cdot\cdot\cdot(x-\xi_m)$, we must have $a\cdot\phi(x)$ and $b\cdot[\phi(x)]^2$ finite for all finite values of $x$, equal say to the respective polynomials $\psi(x)$ and $\theta(x)$, of which by the conditions at $x=\infty$, the highest respective orders possible are $m-1$ and $2(m-1)$. The index equation at $x=\xi_1$ is $r(r-1)+r\psi(\xi_1)/\phi'(\xi_1)+\theta(\xi_1)/[\phi'(\xi_1)]^2=0$, and if $\alpha_1$, $\beta_1$ be its roots, we have $\alpha_1+\beta_1=1-\psi(\xi_1)/\phi'(\xi_1)$ and $\alpha_1\beta_1=\theta(\xi_1)/[\phi'(\xi_1)]^2$. Thus by an elementary theorem of algebra, the sum $\Sigma(1-\alpha_i-\beta_i)/(x-\xi_i)$, extended to the $m$ finite singular points, is equal to $\psi(x)/\phi(x)$, and the sum $\Sigma(1-\alpha_i-\beta_i)$ is equal to the ratio of the coefficients of the highest powers of $x$ in $\psi(x)$ and $\phi(x)$, and therefore equal to $1+\alpha+\beta$, where $\alpha$, $\beta$ are the indices at $x=\infty$. Further, if $(x, 1)_{m-2}$ denote the integral part of the quotient $\theta(x)/\phi(x)$, we have $\Sigma\alpha_i\beta_i\phi'(\xi_i)/(x-\xi_i)$ equal to $-(x, 1)_{m-2}+\theta(x)/\phi(x)$, and the coefficient of $x^{m-2}$ in $(x, 1)_{m-2}$ is $\alpha\beta$. Thus the differential equation has the form $y''+y'\Sigma(1-\alpha_i-\beta_i)/(x-\xi_i)+y[(x,1)_{m-2}+\Sigma\alpha_i\beta_i\phi'(\xi_i)/(x-\xi_i)]/\phi(x)=0$. If, however, we make a change in the dependent variable, putting $y=(x-\xi_1)^{\alpha_1}\cdot\cdot(x-\xi_m)^{\alpha_m}\eta$, it is easy to see that the equation changes into one having the same singular points about each of which it is regular, and that the indices at $x=\xi_i$ become 0 and $\beta_i-\alpha_i$, which we shall denote by $\lambda_i$, for $(x-\xi_j)^{\alpha_j}$ can be developed in positive integral powers of $x-\xi_i$ about $x=\xi_i$; by this transformation the indices at $x=\infty$ are changed to $\alpha+\alpha_1+\cdot\cdot+\alpha_m$, $\beta+\beta_1+\cdot\cdot\cdot+\beta_m$ which we shall denote by $\lambda$, $\mu$. If we suppose this change to have been introduced, and still denote the independent variable by $y$, the equation has the form $y''+y'\Sigma(1-\lambda_i)/(x-\xi_i)+y(x,1)_{m-2}/\phi(x)=0$, while $\lambda+\mu+\lambda_1+\cdot\cdot\ \lambda_m=m-1$. Conversely, it is easy to verify that if $\lambda\mu$ be the coefficient of $x^{m-2}$ in $(x, 1)_{m-2}$, this equation has the specified singular points and indices whatever be the other coefficients in $(x, 1)_{m-2}$.

***Hypergeometric equation.***

Thus we see that (beside the cases $m=0$, $m=1$) the "Fuchsian equation" of the second order with *two* finite singular points is distinguished by the fact that it has a definite form when the singular points and the indices are assigned. In that case, putting $(x-\xi_1)/(x-\xi_2)=t/(t-1)$, the singular points are transformed to 0, 1, $\infty$, and, as is clear, without change of indices. Still denoting the independent variable by $x$, the equation then has the form $x(1-x)y''+y'[1-\lambda_1-x(1+\lambda+\mu)]-\lambda\mu y=0$, which is the ordinary hypergeometric equation. Provided none of $\lambda_1$, $\lambda_2$, $\lambda-\mu$ be zero or integral, it has the solutions $F(\lambda, \mu, 1-\lambda_1, x)$, $x^{\lambda_1}F(\lambda+\lambda_1, \mu+\lambda_1, 1+\lambda_1, x)$ about $x=0$; about $x=1$ it has the solutions $F(\lambda, \mu, 1-\lambda_2, 1-x)$, $(1-x)^{\lambda_2}F(\lambda+\lambda_2, \mu+\lambda_2, 1+\lambda_2, 1-x)$, where $\lambda+\mu+\lambda_1+\lambda_2=1$; about $x=\infty$ it has the solutions $x^{-\lambda}F(\lambda, \lambda+\lambda_1, \lambda-\mu+1, x^{-1})$, $x^{-\mu}F(\mu, \mu+\lambda_1, \mu-\lambda+1, x^{-1})$, where $F(\alpha\beta\gamma x)$ is the series $1+\alpha\beta x/\gamma+\dfrac{\alpha(\alpha+1)\beta(\beta+1)x^2}{1.2.\gamma(\gamma+1)}\cdot\cdot\cdot$, which converges when $|x|<1$, whatever $\alpha, \beta, \gamma$ may be, converges for all values of $x$ for which $|x|=1$ provided the real part of $\gamma-\alpha-\beta>0$ algebraically, and converges for all these values except $x=1$ provided the real part of $\gamma-\alpha-\beta>-1$ algebraically. In accordance with our general theory, logarithms are to be expected in the solution when one of $\lambda_1$, $\lambda_2$, $\lambda-\mu$ is zero or integral. Indeed when $\lambda_1$ is a negative integer, not zero, the second solution about $x=0$ would contain vanishing factors in the denominators of its coefficients; in case $\lambda$ or $\mu$ be one of the positive integers $1, 2, \cdot\cdot(-\lambda_1)$, vanishing factors occur also in the numerators; and then, in fact, the second solution about $x=0$ becomes $x^{\lambda_1}$ times an integral polynomial of degree $(-\lambda_1)-\lambda$ or of degree $(-\lambda_1)-\mu$. But when $\lambda_1$ is a negative integer including zero, and neither $\lambda$ nor $\mu$ is one of the positive integers $1, 2\cdot\cdot(-\lambda_1)$, the second solution about $x=0$ involves a term having the factor $\log x$. When $\lambda_1$ is a positive integer, not zero, the second solution about $x=0$ persists as a solution, in accordance with the order of arrangement of the roots of the index equation in our theory; the first solution is then replaced by an integral polynomial of degree $-\lambda$ or $-\mu$, when $\lambda$ or $\mu$ is one of the negative integers $0, -1, -2, \cdot\cdot\cdot, 1-\lambda_1$, but otherwise contains a logarithm. Similarly for the solutions about $x=1$ or $x=\infty$; it will be seen below how the results are deducible from those for $x=0$.

***March of the integral.***

Denote now the solutions about $x=0$ by $u_1, u_2$; those about $x=1$ by $v_1$, $v_2$; and those about $x=\infty$ by $w_1$, $w_2$; in the region $(S_oS_1)$ common to the circles $S_o$, $S_1$ of radius 1 whose centres are the points $x=0$, $x=1$, all the first four are valid, and there exist equations $u_1=Av_1+Bv_2$, $u_2=Cv_1+Dv_2$ where A, B, C, D are constants; in the region $(S_1S)$ lying inside the circle $S_1$ and outside the circle $S_o$, those that are valid are $v_1v_2w_1w_2$, and there exist equations $v_1=Pw_1+Qw_2$, $v_2=Rw_1+Tw_2$, where P, Q, R, T are constants; thus considering any integral whose expression within the circle $S_o$ is $au_1+bu_2$, where $a$, $b$ are constants, the same integral will be represented within the circle $S_1$ by $(aA+bC)v_1+(aB+bD)v_2$, and outside these circles will be represented by $[(aA+bC)P+(aB+bD)R]w_1+[(aA+bC)Q+(aB+bD)T]w_2$. A single-valued branch of such integral can be obtained by making a barrier in the plane joining $\infty$ to 0 and 1 to $\infty$; for instance, by excluding the consideration of real negative values of $x$ and of real positive values greater than 1, and defining the phase of $x$ and $x-1$ for real values between 0 and 1 as respectively 0 and $\pi$.

***Transformation of the equation into itself.***

We can form the Fuchsian equation of the second order with three arbitrary singular points $\xi_1$, $\xi_2$, $\xi_3$, and no singular point at $x=\infty$, and with respective indices $\alpha_1\beta_1\alpha_2\beta_2\alpha_3\beta_3$ such that $\alpha_1+\beta_1+\alpha_2+\beta_2+\alpha_3+\beta_3=1$. This equation can then be transformed into the hypergeometric equation in 24 ways; for out of $\xi_1$, $\xi_2$, $\xi_3$ we can in six ways choose two, say $\xi_1$, $\xi_2$, which are to be transformed respectively into 0 and 1, by $(x-\xi_1)/(x-\xi_2)=t/(t-1)$; and then there are four possible transformations of the dependent variable which will reduce one of the indices at $t=0$ to zero and one of the indices at $t=1$ also to zero, namely, we may reduce either $\alpha_1$ or $\beta_1$ at $t=0$, and simultaneously either $\alpha_2$ or $\beta_2$ at $t=1$. Thus the hypergeometric equation itself can be transformed into itself in 24 ways, and from the expression $F(\lambda, \mu, 1-\lambda_1, x)$ which satisfies it follow 23 other forms of solution; they involve four series in each of the arguments, $x, x-1, \dfrac{1}{x}, \dfrac{1}{1-x}, \dfrac{x-1}{x}, \dfrac{x}{x-1}$. Five of the 23 solutions agree with the fundamental solutions already described about $x=0$, $x=1$, $x=\infty$; and from the principles by which these were obtained it is immediately clear that the 24 forms are, in value, equal in fours.

***Inversion. Modular functions.***

The quarter periods K, K′ of Jacobi's theory of elliptic functions, of which $K=\int_0^{\frac{\pi}{2}}(1-h\ \sin^2\theta)^{-\frac{1}{2}}d\theta$, and K′ is the same function of $1-h$, can easily be proved to be the solutions of a hypergeometric equation of which $h$ is the independent variable. When K, K′ are regarded as defined in terms of $h$ by the differential equation, the ratio K′/K is an infinitely many valued function of $h$. But it is remarkable that Jacobi's own theory of theta functions leads to an expression for $h$ in terms of K′/K [see art. FUNCTIONS, ANALYTIC] in terms of single-valued functions. We may then attempt to investigate, in general, in what cases the independent variable $x$ of a hypergeometric equation is a single-valued function of the ratio $s$ of two independent integrals of the equation. The same inquiry is suggested by the problem of ascertaining in what cases the hypergeometric series $F(\alpha\beta\gamma x)$ is the expansion of an algebraic (irrational) function of $x$. In order to explain the meaning of the question, suppose that the plane of $x$ is divided along the real axis from $-\infty$ to 0 and from 1 to $+\infty$, and, supposing logarithms not to enter about $x=0$, choose two quite definite integrals $y_1, y_2$ of the equation, say $y_1=F(\lambda\mu 1-\lambda_1 x)$, $y_2=x^{\lambda_1}F(\lambda+\lambda_1, \mu+\lambda_1, 1+\lambda_1, x)$, with the condition that the phase of $x$ is zero when $x$ is real and between 0 and 1. Then the value of $s=\dfrac{y_2}{y_1}$ is definite for all values of $x$ in the divided plane, $s$ being a single-valued monogenic branch of an analytical function existing and without singularities all over this region. If, now, the values of $s$ that so arise be plotted on to another plane, a value $p+iq$ of $s$ being represented by a point $(p, q)$ of this $s$-plane, and the value of $x$ from which it arose being mentally associated with this point of the $s$-plane, these points will fill a connected region therein, with a continuous boundary formed of four portions corresponding to the two sides of the two barriers of the $x$-plane. The question is then, firstly, whether the same value of $s$ can arise for two different values of $x$, that is, whether the same point $(p, q)$ of the $s$-plane can arise twice, or in other words, whether the region of the $s$-plane overlaps itself or not. Supposing this is not so, a second part of the question presents itself. If in the $x$-plane the barrier joining $-\infty$ to 0 be momentarily removed, and $x$ describe a small circle with centre at $x=0$ starting from a point $x=-h-ik$, where $h, k$ are small, real, and positive and coming back to this point, the original value $s$ at this point will be changed to a value $\sigma$, which in the original case did not arise for this value of $x$, and possibly not at all. If, now, after restoring the barrier, the values arising by continuation from $\sigma$ be similarly plotted on the $s$-plane, we shall again obtain a region which, while not overlapping itself, may quite possibly overlap the former region. In that case two values of $x$ would arise for the same value or values of the quotient $y_2/y_1$, arising from two different branches of this quotient. We shall understand then, by the condition that $x$ is to be a single-valued function of $x$, that the region in the $s$-plane corresponding to any branch is not to overlap itself, and that no two of the regions corresponding to the different branches are to overlap. Now in describing the circle about $x=0$ from $x=-h-ik$ to $-h+ik$, where $h$ is small and $k$ evanescent, $s=x^{\lambda_1}F(\lambda+\lambda_1, \mu+\lambda_1, 1+\lambda_1, x)/F(\lambda, \mu, 1-\lambda_1, x)$ is changed to $\sigma=se^{2\pi i\lambda_1}$. Thus the two portions of

boundary of the $s$-region corresponding to the two sides of the barrier $(-\infty, 0)$ meet (at $s=0$ if the real part of $\lambda_1$ be positive) at an angle $2\pi L_1$, where $L_1$ is the absolute value of the real part of $\lambda_1$; the same is true for the $\sigma$-region representing the branch $\sigma$. The condition that the $s$-region shall not overlap itself requires, then, $L_1 \overline{\gtrless} 1$. But, further, we may form an infinite number of branches $\sigma = se^{2\pi i\lambda_1}$, $\sigma_1 = \sigma e^{2\pi i\lambda_1}$, $\cdots$ in the same way, and the corresponding regions in the plane upon which $y_2/y_1$ is represented will have a common point and each have an angle $2\pi L_1$; if neither overlaps the preceding, it will happen, if $L_1$ is not zero, that at length one is reached overlapping the first, unless for some positive integer $a$ we have $2\pi a L_1 = 2\pi$, in other words $L_1 = 1/a$. If this be so, the branch $\sigma_{a-1} = se^{2\pi i a\lambda_1}$ will be represented by a region having the angle at the common point common with the region for the branch $s$; but not altogether coinciding with this last region unless $\lambda_1$ be real, and therefore $=\pm 1/a$; then there is only a finite number, $a$, of branches obtainable in this way by crossing the barrier $(-\infty, 0)$. In precisely the same way, if we had begun by taking the quotient $s' = (x-1)^{\lambda_2} F(\lambda+\lambda_2, \mu+\lambda_2, 1+\lambda_2, 1-x)/F(\lambda, \mu, 1-\lambda_2, 1-x)$ of the two solutions about $x=1$, we should have found that $x$ is not a single-valued function of $s'$ unless $\lambda_2$ is the inverse of an integer, or is zero; as $s'$ is of the form $(As+B)/(Cs+D)$, A, B, C, D constants, the same is true in our case; equally, by considering the integrals about $x=\infty$ we find, as a third condition necessary in order that $x$ may be a single-valued function of $s$, that $\lambda-\mu$ must be the inverse of an integer or be zero. These three differences of the indices, namely, $\lambda_1, \lambda_2, \lambda-\mu$, are the quantities which enter in the differential equation satisfied by $x$ as a function of $s$, which is easily found to be $-\dfrac{x_{111}}{x_1^3} + \dfrac{3}{2}\dfrac{x_{11}^2}{x_1^4} = \frac{1}{2}(h-h_1-h_2)x^{-1}(x-1)^{-1} + \frac{1}{2}h_1 x^{-2} + \frac{1}{2}h_2(x-1)^{-2}$, where $x_1 = dx/ds$, etc.; and $h_1 = 1-\lambda_1^2$, $h_2 = 1-\lambda_2^2$, $h_3 = 1-(\lambda-\mu)^2$. Into the converse question whether the three conditions are sufficient to ensure (1) that the $s$ region corresponding to any branch does not overlap itself, (2) that no two such regions overlap, we have no space to enter. The second question clearly requires the inquiry whether the group (that is, the monodromy group) of the differential equation is properly discontinuous. (See art. GROUPS.)

The foregoing brief account will give an idea of the nature of the function theories of differential equations; it appears essential not to exclude some explanation of a theory intimately related both to such theories and to transformation theories, which is a generalization of Galois's theory of algebraic equations. We deal only with the application to homogeneous linear differential equations.

**Rationality group of a linear equation.**

In general a function of variables $x_1, x_2, \cdots$ is said to be rational when it can be formed from them and the integers 1, 2, 3 $\cdots$ by a finite number of additions, subtractions, multiplications, and divisions. We generalize this definition. Assume that we have assigned a fundamental series of quantities and functions of $x$, in which $x$ itself is included, such that all quantities formed by a finite number of additions, subtractions, multiplications, divisions, and differentiations in regard to $x$, of the terms of this series, are themselves members of this series. Then the quantities of this series, and only these, are called *rational*. And by a rational function of quantities $p, q, r \cdots$ is meant a function formed from them and any of the fundamental rational quantities by a finite number of the five fundamental operations. Thus it is a function which would be called, simply, rational if the fundamental series were widened by the addition to it of the quantities $p, q, r \cdots$ and those derivable from them by the five fundamental operations. A rational ordinary differential equation, with $x$ as independent and $y$ as dependent variable, is then one which equates to zero a rational function of $y$, the order $k$ of the differential equation being that of the highest differential coefficient $y^{(k)}$ which enters; only such equations are here discussed.

**Irreducibility of a rational equation.**

And such an equation $P=0$ is called *irreducible* when, firstly, being arranged as an integral polynomial in $y^{(k)}$, this polynomial is not the product of other polynomials in $y^{(k)}$ also of rational form; and, secondly the equation has no solution satisfying also a rational equation of lower order. From this it follows that if an irreducible equation $P=0$ have one solution satisfying another rational equation $Q=0$ of the same or higher order, then all the solutions of $P=0$ also satisfy $Q=0$. For from the equation $P=0$ we can by differentiation express $y^{(k+1)}, y^{(k+2)} \cdots$ in terms of $x, y, y^{(1)}, \cdots, y^{(k)}$, and so put the function Q rationally in terms of these quantities only. It is sufficient, then, to prove the result when the equation $Q=0$ is of the same order as $P=0$. Let both the equations be arranged as integral polynomials in $y^{(k)}$; their algebraic eliminant in regard to $y^{(k)}$ must then vanish identically, for they are known to have one common solution not satisfying an equation of lower order; thus the equation $P=0$ involves $Q=0$ for all solutions of $P=0$.

**The variant function for a linear equation.**

Now let $y^{(n)} = a_1 y^{(n-1)} + \cdots + a_n y$ be a given rational homogeneous linear differential equation; let $y_1 \cdots y_n$ be $n$ particular functions of $x$, unconnected by any equation with constant coefficients of the form $c_1 y_1 + \cdots + c_n y_n = 0$, all satisfying the differential equation; let $\eta_1 \cdots \eta_n$ be linear functions of $y_1 \cdots y_n$, say $\eta_i = A_{i1} y_1 + \cdots + A_{in} y_n$, where the constant coefficients $A_{ij}$ have a non-vanishing determinant; write $(\eta) = A(y)$, these being the equations of a general linear homogeneous group whose transformations may be denoted by A, B, $\cdots$. We desire to form a rational function $\phi(\eta)$, or say $\phi(A(y))$, of $\eta_1 \cdots \eta_n$, in which the $n^2$ constants $A_{ij}$ shall all be essential, and not reduce effectively to a fewer number, as they would, for instance, if the $y_1 \,.\,.\, y_n$ were connected by a linear equation with constant coefficients. Such a function is in fact given, if the solutions $y_1 \cdot y_n$ be developable in positive integral powers about $x=a$, by $\phi(\eta) = \eta_1 + (x-a)^n \eta_2 + \cdots + (x-a)^{(n-1)n} \eta_n$. Such a function, V, we call a *variant*.

**The resolvent equation.**

Then differentiating V in regard to $x$, and replacing $\eta_i^{(n)}$ by its value $a_1 \eta^{(n-1)} + \cdots + a_n \eta$, we can arrange $dV/dx$, and similarly each of $d^2V/dx^2 \cdots d^N V/dx^N$, where $N=n^2$, as a linear function of the N quantities $\eta_1 \cdots \eta_n \cdots \eta_1^{(n-1)} \cdots \eta_n^{(n-1)}$, and thence by elimination obtain a linear differential equation for V of order N with rational coefficients. This we denote by $F=0$. Further, each of $\eta_1 \cdots \eta_n$ is expressible as a linear function of V, $dV/dx \cdots d^{N-1}V/dx^{N-1}$, with rational coefficients not involving any of the $n^2$ coefficients $A_{ij}$, since otherwise V would satisfy a linear equation of order less than N, which is impossible, as it involves (linearly) the $n^2$ arbitrary coefficients $A_{ij}$, which would not enter into the coefficients of the supposed equation. In particular, $y_1 \cdots y_n$ are expressible rationally as linear functions of $\omega$, $d\omega/dx$, $\cdots d^{N-1}\omega/dx^{N-1}$, where $\omega$ is the particular function $\phi(y)$. Any solution W of the equation $F=0$ is derivable from functions $\zeta_1 \cdots \zeta_n$, which are linear functions of $y_1 \cdots y_n$, just as V was derived from $\eta_1 \cdots \eta_n$; but it does not follow that these functions $\zeta_1 \cdots \zeta_n$ are obtained from $y_1 \cdots y_n$ by a transformation of the linear group A, B, $\cdots$; for it may happen that the determinant $d(\zeta_1 \cdots \zeta_n)/d(y_1 \cdots y_n)$ is zero. In that case $\zeta_1 \cdots \zeta_n$ may be called a singular set, and W a singular solution; it satisfies an equation of lower than the N-th order. But every solution V, W, ordinary or singular, of the equation $F=0$, is expressible rationally in terms of $\omega$, $d\omega/dx$, $\cdots d^{N-1}\omega/dx^{N-1}$; we shall write, simply, $V = r(\omega)$. Consider now the rational irreducible equation of lowest order, not necessarily a linear equation, which is satisfied by $\omega$; as $y_1 \cdots y_n$ are particular functions, it may quite well be of order less than N; we call it the *resolvent equation*, suppose it of order $p$, and denote it by $\gamma(v)$. Upon it the whole theory turns. In the first place, as $\gamma(v)=0$ is satisfied by the solution $\omega$ of $F=0$, all the solutions of $\gamma(v)$ are solutions $F=0$, and are therefore rationally expressible by $\omega$; any one may then be denoted by $r(\omega)$. If this solution of $F=0$ be not singular, it corresponds to a transformation A of the linear group (A, B, $\cdots$), effected upon $y_1 \cdots y_n$. The coefficients $A_{ij}$ of this transformation follow from the expressions before mentioned for $\eta_1 \cdots \eta_n$ in terms of V, $dV/dx$, $d^2V/dx^2$, $\cdots$ by substituting $V = r(\omega)$; thus they depend on the $p$ arbitrary parameters which enter into the general expression for the integral of the equation $\gamma(v)=0$. Without going into further details, it is then clear enough that the resolvent equation, being irreducible and such that any solution is expressible rationally, with $p$ parameters, in terms of the solution $\omega$, enables us to define a linear homogeneous group of transformations of $y_1 \cdots y_n$ depending on $p$ parameters; and every operation of this (continuous) group corresponds to a rational transformation of the solution of the resolvent equation. This is the group called the *rationality group*, or the *group of transformations* of the original homogeneous linear differential equation.

The group must not be confounded with a subgroup of itself, the *monodromy group* of the equation, often called simply the group of the equation, which is a set of transformations, not depending on arbitrary variable parameters, arising for one particular fundamental set of solutions of the linear equation (see art. GROUPS).

**The fundamental theorem in regard to the rationality group.**

The importance of the rationality group consists in three propositions. (1) Any rational function of $y_1 \cdots y_n$ which is unaltered in value by the transformations of the group can be written in rational form. (2) If any rational function be changed in form, becoming a rational function of $y_1 \cdots y_n$, a transformation of the group applied to its new form will leave its value unaltered. (3) Any homogeneous linear transformation leaving unaltered the value of every rational function of $y_1 \cdots y_n$ which has a rational value, belongs to the group. It follows from these that any group of linear homogeneous transformations having the properties (1) (2) is identical with the group in question. It is clear that with these properties the group must be of the greatest

importance in attempting to discover what functions of $x$ must be regarded as rational in order that the values of $y_1 \cdot \cdot y_n$ may be expressed. And this is the problem of solving the equation from another point of view.

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($\zeta$) See also the six extensive articles in the second volume of the German *Encyclopædia of Mathematics.* (H. F. BA.)

**Diffraction Gratings.**—The grating is an optical instrument for the production of the spectrum; it now generally replaces the prism in a spectroscope where large dispersion is needed, or when the ultra-violet portion of the spectrum is to be examined, or when the spectrum is to be photographed. The transparent grating consists of a plate of glass covered with lampblack, gold leaf, opaque collodion or gelatine, the coating being scratched through in parallel lines ruled as nearly equidistant as possible. When the lines are to be ruled very close together, a diamond ruling directly on glass is used. Other transparent materials, such as fluor-spar, are sometimes substituted for glass. For certain researches on long waves the grating is made by winding a very fine wire, 1-1000th inch in diameter, in the threads of two fine screws placed parallel to each other, soldering the wire to the screws and then cutting it away on one side of the screws. As the value of a grating is dependent upon the number of lines ruled, it is very desirable to have their number great. Glass is so hard that the diamond employed for the ruling wears away rapidly; and hence the modern grating is generally a reflecting grating, which is made by ruling on a speculum metal surface finely ground and polished. On such a surface it is possible to rule 100,000 lines without damaging the diamond, although its point even then often wears away or breaks down. The lines are generally so close together as 15,000 or 20,000 to the inch, although it is feasible to rule them even closer—say 40,000 to 50,000 to the inch There is little advantage, however, in the higher number, and many disadvantages.

The grating produces a variety of spectra from a single source of light, and these are designated as spectra of the first, second, &c., order, the numbering commencing from the central or reflected image and proceeding in either direction from it. The dispersion depends upon the number of lines ruled in a unit of length, upon the order of the spectrum, and upon the angle at which the grating is held to the source of light. The defining power depends upon its width and the angles made by the incident and diffracted rays, and is independent of the number of lines per unit of length ruled on the grating. If this number is too small, however, the different order of the spectra will be too much mixed up with each other for easy vision. A convenient number is 15,000 to 20,000 lines to the inch, or from 6000 to 8000 to the centimetre. The defining power is defined as the ratio of the wave-length to the distance apart of the two spectral lines which can be just seen separate in the instrument. Thus the sodium or D lines have wave-lengths which differ from each other by ·597 $\mu\mu$, and their average wave-length is 589·3 $\mu\mu$. A spectroscope to divide them would thus require a defining power of 988. The most powerful gratings have defining powers from 100,000 to 200,000. Lord Rayleigh's formula for the defining power is

$$D = Nn,$$

where D is the defining power, N is the order of the spectrum, and $n$ is the total number of lines ruled on the grating. As the defining power increases with N, and since we can observe in a higher order as the number of lines ruled in a unit of length decreases, it is best to express the defining power in terms of the width of the grating, $w$. In this case we have for the maximum defining power $D' = 20{,}000\ w$ for small gratings, or $D' = 15{,}000\ w$ for extra fine large gratings, $w$ being the width of the gratings in centimetres. It is seldom that very large gratings are perfect enough to have a defining power of more than 10,000 $w$, owing to imperfection of surface or ruling. The relative brightness of the different orders of

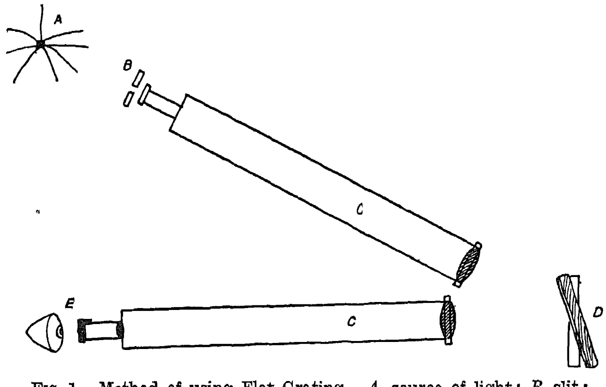


FIG. 1.—Method of using Flat Grating. *A*, source of light; *B*, slit; *C*, *C*, two telescopes, movable or fixed; *D*, grating, movable about its centre; *E*, eye-piece.

spectra depend upon the shape of the groove as ruled by the diamond. No two gratings are ever alike in this respect, but exhibit an infinite variety of distributions of brightness. Copies of glass gratings can be made by

photography, contact prints being taken on collodio-chloride of silver or other dry plates. Reflecting gratings can be copied by pouring collodion or gelatine over the grating and stripping off the films thus formed. The latter warp, however, and destroy the definition to a great extent. The grating always produces a brighter spectrum in the violet than a prism. In the green the reflecting speculum metal grating may be brighter than a prism spectroscope of five prisms, and for higher dispersion it surpasses the prism spectroscope both in definition and brightness in all portions of the spectrum.

To produce the pure spectrum from flat gratings, two telescopes are generally used, as in Fig. 1.

The telescopes are fixed, and the grating is turned on its axis to pass to different portions of the spectrum. As the glass of the telescopes absorbs the ultra-violet light, this portion of the spectrum is cut off entirely, unless quartz lenses are used. The concave grating avoids this trouble, and produces a spectrum without the aid of lenses, the lines being ruled on a concave surface instead of on a flat one. Such a grating, properly mounted, produces what has been called a normal spectrum, and is specially adapted to photographic purposes (Fig. 2).

A special form of grating of great defining power has

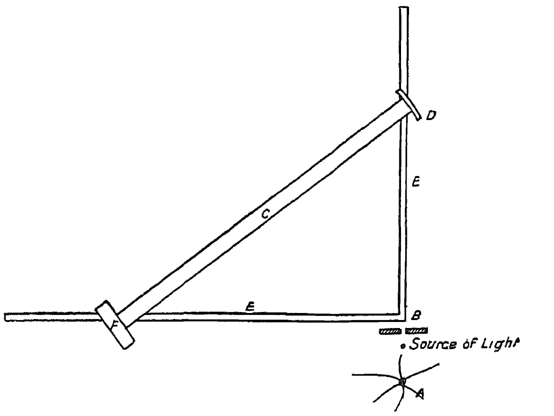


Fig. 2.—Method of using Concave Grating. *A*, source of light; *B*, slit; *D*, grating mounted in beam *C*, movable along the ways *E*, *E*; *F*, camera-box or eye-piece.

been invented by Professor Michelson of the University of Chicago, called the "echelon" spectroscope (see Spectroscopy). It is, however, of very limited application.

See an article on "Gratings in Theory and Practice" in *Astronomy and Astro-Physics*, 1893, xii. p. 129. (H. A. R.)

**Diffusion of Gases.**—When two gases are contained in different parts of the same vessel, at the same pressure and temperature without any currents being set up between them, a gradual mixing takes place which is called *diffusion*. Diffusion may also occur if the gases are separated by a thin membrane; it is then usually called osmosis or transpiration, and may give rise to differences of pressure on the two sides of the membrane. In the diffusion now considered such differences would cause the gas as a whole to move from the region of higher to that of lower pressure, hence the pressure of the mixture must be the same everywhere. By Dalton's law, the pressure of a mixture of two gases is the sum of the partial pressures of the components, or, in other words, the sum of the pressures which each would exert separately. The sum of the partial pressures of the two gases is thus uniform. If then one gas is moving by diffusion in one direction, say from A to B, its partial pressure will be decreasing at A and increasing at B. Hence the partial pressure of the second gas must be increasing at A and decreasing at B,—that is, it must be moving from B to A. Thus diffusion may be regarded as consisting of two streams of gas flowing in opposite directions.

Now it is natural to assume (at any rate as an approximation) that the rate of flow of either gas is proportional to the rate at which its partial pressure decreases in the direction of flow, or, as engineers term it, to the "pressure gradient" in this direction. This again is proportional to the rate of decrease of the density of the component in the same direction. We may define the *coefficient of diffusion* as the ratio of the total mass of either component which flows across a unit surface per unit time to the rate at which the density of that component decreases in a direction perpendicular to the said unit surface.

The equations of diffusion given in Clerk Maxwell's article Diffusion (*Ency. Brit.* 9th ed., vii. 216) need not be repeated here. According, however, to Meyer, Tait, and others, the coefficient of diffusion depends in general on the proportion of the two components contained in the mixture, and thus varies from point to point. The diffusion equation then becomes $dv_1/dt = (d/dx)(\mathrm{D}dv_1/dx)$, an integral of which has been found by Boltzmann. The equation of diffusion when gravity is taken into account has been integrated by Des Coudres.

Natanson has reduced diffusion and other irreversible phenomena to particular cases of a general principle which he calls the "thermokinetic principle," and which includes as a particular case the principle of least action of reversible dynamics. The "dissipation function," or expression for the rate at which heat is dissipated by diffusion is calculated, and from it are deduced equations similar to those in Maxwell's article.

***Kinetic theory.***

The discovery by Lord Rayleigh of an unpublished memoir "On the Physics of Media that are composed of free and perfectly elastic Molecules in a State of Motion," which paper had been deposited in the archives of the Royal Society, shows that much of the kinetic theory of gases, including the view that the temperature of a gas is proportional to the square of the molecular velocity, was first established by J. J. Waterston in 1845. The kinetic theory, in its general aspect, is supported by modern experiments in high vacua. In many of Dewar's experiments with liquid air a glass bulb placed in a mercury vacuum becomes coated with mercury in a surprisingly short time. The rate of deposition agrees fairly well with the formula for the total mass of molecules falling on a unit of area per unit time, viz., $\frac{1}{4}\rho q$ where $\rho$ = density, $q$ = mean molecular velocity. Sir William Crookes's observation, that if two unequally exhausted vacuum tubes are connected by a fine capillary tube, equalization of pressure takes place very slowly, accords with what we should naturally expect in a rarefied gas consisting of molecules moving in straight lines, and rebounding from the sides of the vessels with but rare collisions with each other; for the molecules would rarely chance to strike on the opening of the tube. The cathode rays have been attributed to a stream of molecules or particles projected by the cathode, and the fact that they only exist in high vacua accords with the view that at ordinary pressures the molecules of gas would collide with and obstruct them. In 1899 J. J. Thomson demonstrated the existence of such particles ("corpuscles" or "electrons") having masses much smaller than those of atoms; a similar conclusion was arrived at in connexion with the Becquerel rays by M. and Mme. Curie.

The presence of certain gases in the atmospheres of some planets and their absence from others admits in some cases of a ready explanation according to the kinetic theory, to which may be attributed in particular the absence of atmosphere from the moon. Those molecules which are moving away from a planet with velocity greater than that due to the planet's attraction tend to escape from the planet's atmosphere. Hence we should expect

the smaller planets to retain only the denser gases whose molecular velocity at a given temperature is least. Yet the present writer's calculations indicate that the molecular velocities assigned by the kinetic theory are insufficient in themselves to remove helium from our atmosphere, a point discussed by Stoney in 1897 and 1900. Very similar in principle is the explanation of *dissociation*. If we assume the molecules of a compound gas to be made up of atoms which are bound together by their mutual attraction, and adopt Boltzmann's hypothesis that the heat-energy of a molecule is due partly to translation and partly to rotation, it is evident that with increase of temperature there will be an increasing number of molecules, in which the "centrifugal force" due to rotation exceeds the force of attraction between the atoms, causing these atoms to break asunder. The kinetic theory of dissociation is treated at some length in Boltzmann's book.

**Boltzmann-Maxwell distribution.**

The distribution of velocity among the molecules of a gas, worked out by Watson and Burbury in their article MOLECULE (*Ency. Brit.*, 9th ed., xvi. 612), is called the Boltzmann-Maxwell distribution, and when it exists the gas is said by Tait to be in the "special state." There is abundant evidence that this distribution holds good in any gas in which (*a*) the actions between the molecules resemble the collisions of elastic bodies; (*b*) the sum of the volumes of the individual molecules is very small compared with the volume of the gas.

Much doubt still exists as to how far the distribution is applicable to gases whose molecules are of appreciable volume, or repel one another with finite forces which are functions of the distances between them. Burbury is of opinion that in such cases the motions of the molecules tend to become *correlated*, by which he means that two neighbouring molecules are more likely to move in the same than in opposite directions. For monatomic molecules (material particles or smooth spheres), he finds that the probability of the velocity components $(u_1,v_1,w_1)$, $(u_2,v_2,w_2)$... lying within the limits of the multiple differential $du_1dv_1dw_1 \cdot du_2dv_2dw_2$... is proportional to $e^{-hQ}$, where

$$Q = \tfrac{1}{2}\Sigma m(u_1^2+v_1^2+w_1^2) + \Sigma\Sigma b_{12}(u_1u_2+v_1v_2+w_1w_2)$$

$b_{12}$ being a negative function of the distance between the two molecules designated by the suffixes 1, 2, which is inappreciable except when this distance is small. The motion changes its character when Q ceases to be essentially positive, and this change may possibly be the condition for liquefaction. If the $b_{12}$ coefficients vanish we have the Boltzmann-Maxwell distribution.

The special case of the Boltzmann-Maxwell distribution for molecules regarded as non-spherical, elastic, rigid bodies, and capable of having angular velocities $\omega_1$, $\omega_2$, $\omega_3$ about their principal axis of inertia, besides translatory velocities $v$, $v$, $w$ of their centre of gravity, is interesting. The kinetic energy is given by

$$T = \tfrac{1}{2}m(u^2+v^2+w^2) + \tfrac{1}{2}(A\omega_1^2 + B\omega_2^2 + C\omega_3^2),$$

and the distribution being given by the expression

$$e^{-hT}\, du\, dv\, dw\, d\omega_1 d\omega_2 d\omega_3,$$

it follows that the mean values of $\frac{1}{2}mu^2$, $\frac{1}{2}mv^2$, $\frac{1}{2}mw^2$, $\frac{1}{2}A\omega_1^2$, $\frac{1}{2}B\omega_2^2$, $\frac{1}{2}C\omega_3^2$ are each equal to $1/h$. This is a particular case of a statement known as Maxwell's Law of Partition of Energy, according to which in certain cases, "if the kinetic energy of a system be expressed as a sum of squares, the mean values of these squares are equal." The applicability of this law to dynamical systems in general, and indeed to *any* systems other than groups of molecules arranged according to the Boltzmann-Maxwell distribution, has for many years been a source of controversy, and was discussed in 1900 by Lord Rayleigh. When $C=0$, or the molecule consists of a distribution of masses along a straight line, the energy is equally divided between the five remaining components; this gives a specific heat ratio of 1·4 approximating to that of most gases, while the specific heat ratio, on the hypothesis that the energy is wholly translational, is $1\frac{2}{3}$, or nearly that of argon. The tendency of the molecules of a gas to assume the Boltzmann-Maxwell distribution, if their velocities are initially distributed in any other manner, has been investigated by Boltzmann and Watson in a theorem known as Boltzmann's Minimum Theorem.

Let $fdv$ denote the probability that the co-ordinates and momenta of a molecule shall lie within the limits of the multiple differential $dv\,(=dp_1,...dq_n$ of Watson and Burbury's article MOLECULE). Let H denote the integral $\int\int \log fdv$, or for a mixture of gases let $H=\Sigma\int\int \log f dv$, the summation extending over the several components. Then it is proved in the Minimum Theorem that, as the result of intermolecular collisions or encounters, H tends to decrease until the "special state" is reached, when it becomes a minimum. This proposition is further shown by Boltzmann to admit of both mathematical and physical interpretations.

(1) According to the theory of probability, Boltzmann finds that if W is proportional to the probability that the distribution of co-ordinates and momenta may be defined by the function $f$, then log W is proportional to $-H$. Hence, as H decreases, W increases; in other words (*a*) the molecular motions tend to pass from less probable to more probable distributions, and (*b*) the Boltzmann-Maxwell distribution is the most probable of all distributions.

(2) The entropy of the gas is proportional to $-H+$ a constant, and the tendency of H to decrease to a minimum thus represents the physical property that the entropy of a system tends to increase to a maximum.

**Diffusion.**

When the molecules of a gas are thoroughly mixed (as assumed in the Minimum Theorem), it appears, from the calculations of Tait and Watson, that a very small fraction of a second is sufficient, in ordinary cases, to restore the molecules to the Boltzmann-Maxwell distribution. We now have to consider diffusion and allied phenomena in which the distribution, instead of being uniform, varies at different points of the gas. In such cases the process of equalization, which is comparatively slow, depends on the free paths of the molecules between collisions. We proceed to investigate the general problem by a method based on the work of Boltzmann and used subsequently by Burbury.

If a molecule A moving with velocity $w$ impinge normally on a stratum of gas of thickness $x$ containing $n$ molecules per unit volume, whose velocities are distributed about a mean velocity $q$, it is easy to see that, if $nx$ is small, the probability of its encountering another molecule in traversing the layer is proportional to $n\pi s^2x$, where $s$ is the sum of the radii of the impinging and interfering molecules when these are spherical, and $s$ is determined by the linear dimensions of the molecules in other cases. Since, moreover, the probability is evidently unaltered by increasing the velocities of the impinging and interfering molecules in the same ratio it may be written $n\pi s^2x\psi(w/q)$, where $\psi(w/q)$ is a function, calculated by Meyer, Tait, and others. If $nx$ is not small we divide the $nx$ molecules into a large number $r$ of equal groups, and the chance of A escaping collision is the *product* of its chances of escaping collision with the groups, and therefore

$$= \mathop{\mathrm{L}}_{r=\infty}\left\{1-\frac{nx\pi s^2}{r}\psi\left(\frac{w}{q}\right)\right\}^r = e^{-xn\pi s^2\psi(w/q)} = e^{-x/l} \text{ say.}$$

Here $l$ is the constant defined in the article MOLECULE (*Ency. Brit.* vol. xvi. p. 616). The *mean free path* may be found as in that article. Tait, on the other hand, defines the mean free path as the mean value of $l$, when the molecule A is replaced by a number of molecules in the "special state," and the value he finds for a simple gas is $0{\cdot}677/n\pi s^2$.

Now let G be any physical quantity (*e.g.*, mass, charge of electricity, momentum, energy, &c.) which may be carried by a molecule. Let the quantity of G per unit volume vary uniformly in the direction of the axis of $z$, and be denoted by $G(z)$; also let $f(w)dw$ denote the proportion of molecules whose translational speeds are between $w$ and $w+dw$. It is required to find the rate at which G is being carried across the plane $z=z_0$.

Now the total number of molecules crossing the plane $z_0$ in unit of time, and having their velocities between $w$ and $w+dw$, in directions at inclinations to the axis of $z$ between $\theta$ and $\theta+d\theta$ is

$$= \tfrac{1}{2}wf(w)\sin\theta\cos\theta\, d\theta\, dw.$$

The number of those that have travelled a distance between $\lambda$ and $\lambda+d\lambda$ since their last encounter is found by multiplying this number by $e^{-\lambda/l}d\lambda/l$. These molecules must have collided between the planes $z=z_0+\lambda\cos\theta$ and $z=z_0+(\lambda+d\lambda)\cos\theta$, and they are assumed to carry their average share of the quantity G between

these two planes, *i.e.*, $G(z_0+\lambda\cos\theta)$. Hence the total quantity of G carried across the plane $z=z_0$ in the negative direction is $\Gamma$, where

$$\Gamma=\int_0^\infty dw\int_0^\pi d\theta\int_0^\infty d\lambda\ wf(w)\ \tfrac{1}{2}\sin\theta\cos\theta\frac{e^{-\lambda/l}}{l}G(z_0+\lambda\cos\theta),$$

the integration between $\theta=0$ and $\theta=\frac{1}{2}\pi$ representing the part due to molecules coming from the positive side and between $\theta=\frac{1}{2}\pi$ and $\theta=\pi$, that due to molecules coming from the negative side. Making the assumption that G varies uniformly, or neglecting differential coefficients above the first, we obtain

$$G(z_0+\lambda\cos\theta)=G(z_0)+\lambda\cos\theta\frac{dG}{dz},$$

therefore

$$\Gamma=\frac{1}{3}\frac{dG}{dz}\int_0^\infty f(w)wl\,dw=\frac{1}{3}\overline{wl}\frac{dG}{dz}.$$

For the diffusion of two gases, A and B, in a mixture containing $N_a$ and $N_b$ molecules per unit volume of the two components, we put $G=N_a$ and $G=N_b$ in succession, and obtain

$$\Gamma_a=\frac{1}{3}\overline{wl_a}\frac{dN_a}{dz}\qquad\Gamma_b=\frac{1}{3}\overline{wl_b}\frac{dN_b}{dz}.$$

If $\overline{wl_a}$ and $\overline{wl_b}$ are unequal, $\Gamma_a$ and $\Gamma_b$ will be unequal. The formula gives more molecules flowing in one direction than in the other, and the pressure (which is proportional to $N_a+N_b$) would on this hypothesis soon cease to be uniform. Meyer assumes, therefore, that there is a counter current $\Gamma_b-\Gamma_a$, and, as in the article MOLECULE, the coefficient of diffusion becomes

$$\frac{1}{3}\frac{N_a\overline{wl_a}+N_b\overline{wl_b}}{N_a+N_b}.$$

If, however, we assume that the diffusion of the gas A is unaffected by its collisions with molecules of the same gas, and only depends on collisions with the B molecules, and similarly for the gas B, we get for the coefficient of diffusion

$$\frac{1}{3}\frac{\overline{wl_a}+\overline{wl_b}}{2}.$$

The last formula has been used by Stefan, but is objected to by Meyer. Both formulæ have been tested experimentally, but practical difficulties give rise to discrepancies in the observed results quite as great as the differences given by the formulæ. Where the gases are mixed in equal proportions the two formulæ become identical; and to decide between them it is necessary to examine diffusion in mixtures where one gas preponderates largely over the other. Such cases are, however, difficult of observation.

When the molecules are of the same size, shape, and mass $\overline{wl_a}=\overline{wl_b}$, and the coefficient of diffusion is $\frac{1}{3}\overline{wl}$ on either hypothesis. It is therefore everywhere constant.

***Tait's conclusions.***

Taking unequal spherical molecules, Tait, by evaluating the integrals depending on his form of $l$, arrives at the following conclusions:—(1) For molecules of equal mass, a difference of size, the mean of the diameters being unchanged, favours diffusion. (2) Diffusion is, however, but little affected by even a considerable disparity in size of the molecules, but depends mainly on the mean of the diameters. (3) Taking molecules of masses in the ratio 16 : 1, and of diameters in the ratios 3 : 1, 1 : 1, and 1 : 3, it is found that if the sum of the diameters is kept constant, diffusion is most rapid when the molecules of greater mass have the greater diameter. (4) A gas diffuses more quickly into one of different than into one of the same specific gravity. (5) If the diameters of the more massive molecules are decreased and of the lighter ones increased, keeping their sum constant, the rate of diffusion decreases to a minimum at first and then increases before the more massive molecules become infinitesimal compared with the others. (6) Owing to the smallness of the variations of the diffusion-coefficient, experiments on diffusion are not well suited for determining the relative size of the molecules of different gases.

***Viscosity and thermal conductivity.***

Next taking G to represent translational velocity in a plane perpendicular to the axis of $z$ and assuming it to be proportional to $z$, if the density be $\rho$, then $\rho\Gamma$ will represent the momentum carried across the plane $z=z_0$ per unit time, *i.e.*, the shearing force, and the coefficient of $dG/dz$ in $\rho\Gamma$ will be the *coefficient of viscosity*, which therefore $=\frac{1}{3}\rho\overline{wl}$.

In conduction of heat the mean translational energy T or $\frac{1}{2}m\overline{w^2}$ is a function of $z$. If $f(w)dw$ denote the proportion of molecules with speeds between $w$ and $w+dw$ at a point where this mean energy is $T_0$, $f(w)dw$ will at other points denote the proportion of molecules with speeds between $w\sqrt{(T/T_0)}$ and $(w+dw)\sqrt{(T/T_0)}$ We assume these molecules to carry with them translational energy $\frac{1}{2}mw^2T/T_0$, and rotational energy $\frac{1}{2}\beta m\overline{w^2}\ T/T_0$ where $\beta=2/(3k-3)-1$, and $k$ is the specific heat ratio. In calculating the true thermal conductivity we have to separate the transference of heat-energy due to conduction proper from that due to motion of the medium. By a method resembling Boltzmann's we find

$$\Gamma=\frac{1}{3T}\ \frac{dxT}{dz}\int\tfrac{1}{2}m(w^2+\beta\overline{w^2})wl\,dw=\frac{n}{3}\left\{\frac{\overline{w^3l}}{\overline{w^2}}+\beta\overline{wl}\right\}\frac{dT}{dz}.$$

Putting $\eta=\frac{1}{3}nm\overline{wl}$ we see that the thermal conductivity of a gas is proportional to its coefficient of viscosity $\eta$. The above, and other formulæ based on alternative assumptions, give in general for the conductivity an expression of the form

$$K=(Ak+B)\eta c_v,$$

$c_v$ being the specific heat at constant volume and A, B, con stants. Meyer finds $A=0{\cdot}795$, $B=0{\cdot}205$, giving for air at 0° C., $K=406.10^{-7}$ centigrade C.G.S. units. Boltzmann finds $A=\frac{75}{26}$, $B=-\frac{60}{26}$, giving $K=536.10^{-7}$. The values observed for air by Stefan and Winkelmann are $558.10^{-7}$ and $525.10^{-7}$ respectively. The thermal conductivity of gases is treated at considerable length by Verdet-Ruhlmann.

In the equation $\Gamma=\frac{1}{3}\overline{wl}\ dG/dz$ the coefficient of $dG/dz$, viz. $\frac{1}{3}\overline{wl}$, varies as the mean velocity $w$ and as the mean free path $l$. Now from the expression $n\pi s^2$ in the denominator of Tait's formula, or otherwise, we infer that for the same gas or mixture of gases $l$ varies inversely as $n$, and therefore directly as the volume. Hence on the hypothesis that the molecules are elastic bodies the coefficients of diffusion, viscosity, and conductivity vary as the volume and the square root of the absolute temperature. If the pressure $p$ and temperature T be taken as variables they will vary inversely as $p$ and directly as $T^{\frac{3}{2}}$. Now it appears from Maxwell's experiments that the coefficient of viscosity at constant density is proportional to T instead of $T^{\frac{1}{2}}$, and from Loschmidt's experiments it is not improbable that the coefficient of diffusion at constant pressure is proportional to $T^2$ instead of $T^{\frac{3}{2}}$. These considerations led Maxwell to consider a kinetic theory based on the hypothesis that the molecules of a gas repel one another with finite forces which are functions of the distance between them, and in particular to consider the case when the force varies inversely as the fifth power of the distance, in which case the viscosity varies as T. The phenomena of diffusion, viscosity, and conductivity and fluid motions, have been worked out on this hypothesis very fully by Boltzmann and others. The relation of the coefficient of diffusion to the temperature appears, however, difficult to determine experimentally. A "pressure balance" for this purpose has been described by M. Toepler.

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**Dignano** (Slavonic, *Vodnjan*), a town in the government district of Pola, Istria (Austria), about 8 miles north of Pola, on the railway from Trieste. It is situated on a gentle slope overlooking the Gulf of Venice, a few miles from the shore. The principal resource of the inhabitants (in 1890, 9151; in 1900, 9684—mostly Italian) is the cultivation of the vine, olive, fruit, and the silkworm, together with a considerable trade in timber. The so-called rose-vine, one of the best of the Istrian varieties, is grown in the vicinity.

**Dijon,** chief town of department Côte-d'Or, France, 196 miles south-east of Paris, on railway from Paris to Lyon. It is the seat of a court of appeal for the departments of Côte d'Or, Haute Marne, and Seine-et-Loire, and has schools of medicine and pharmacy. Since the Franco-Prussian War it has been strongly fortified, and it is now protected by eight forts. The bathing establishment or casino was rebuilt in ornate style in 1886. The manufacture of heavy iron goods and machinery has become extensive, and there are large soap works, while black-currant liqueur ("cassis de Dijon") is a speciality; cotton-spinning is still carried on, but textile industries are no longer of any account. Population (1881), 46,344; (1891), 55,673; (1901), 70,428.

**Dillmann, Christian Friedrich August** (1823–1894), German theologian and Orientalist, was born at Illingen, Würtemberg, 25th April 1823. He commenced the study of theology at Tübingen, where he was a favourite pupil of Ewald, who encouraged him to pursue the study of the Oriental languages, of which, after having for some years been a *Privat-docent*, he became extraordinary professor in 1853. In 1854 he removed to Kiel, where he was made regular professor in 1860. Having, however, signalized himself as a divine as well as an Oriental scholar, he was in 1864 invited to fill the post of professor of biblical exegesis at Giessen, and in 1869 succeeded the celebrated Hengstenberg as exegetical professor at Berlin. His lectures were much esteemed, but his principal distinction was gained by his researches in the Ethiopic language and literature, upon which he was regarded as the highest living authority. Between 1846 and 1848, and before his first appointment at Tübingen, he visited France and England as a student, and while in England prepared the seventh volume of the Bodleian catalogue of manuscripts, comprising the Ethiopic. This catalogue was published in 1848. Dillmann also catalogued the Ethiopic MSS. in the British Museum. In 1851 he edited the apocryphal Book of Enoch in the Ethiopic version, the only one in which it is extant, and published an annotated translation of it in 1853. In the same year he translated the Ethiopic Book of Adam, and in 1855 edited the ancient Ethiopic translation of the Old Testament. He was also the author of an Ethiopic grammar (1857) and lexicon (1862–65), standard works in their department of philology. Among his Ethiopic labours may also be reckoned two works on the history of the kingdom of Axum, published in 1879 and 1880. His principal theological writings are *On the Origin of the Religion of the Old Testament* (1865) and *On the Political Activity of the Old Testament Prophets* (1868). His investigations are characterized by a prevailing spirit of moderation and sobriety. He died at Berlin, 4th July 1894, leaving the reputation not merely of a great Ethiopic scholar, but of the reviver of a branch of Oriental study which had fallen into neglect. (R. G.)

**Dilolo, Lake.** See CONGO.

**Dimensions of Units.**—Measurable entities of different kinds cannot be directly compared. Each one must be specified in terms of a unit of its own kind; a single number attached to this unit forms its measure. Thus if the unit of length be taken to be L centimetres, a line whose length is $l$ centimetres will be represented in relation to this unit by the number $l/\mathrm{L}$; while if the unit is increased [L] times, that is, if a new unit is adopted equal to [L] times the former one, the numerical measure of each length must in consequence be divided by [L]. Measurable entities are either fundamental or derived For example, velocity is of the latter kind, being based upon a combination of the fundamental entities length and time; a velocity may be defined, in the usual form of language expressive of a limiting value, as the rate at which the distance from some fixed mark is changing per unit time. The element of length is thus involved directly and the element of time inversely in the derived idea of velocity; the meaning of this statement being that when the unit of length is increased [L] times and the unit of time is increased [T] times, the numerical value of any given velocity, considered as specified in terms of the units of length and time, is diminished [L]/[T] times. In other words, these changes in the units of length and time involve change in the unit of velocity determined by them, such that it is increased [V] times where $[\mathrm{V}]=[\mathrm{L}][\mathrm{T}]^{-1}$. This relation is conveniently expressed by the statement that velocity is of $+1$ dimension in length and of $-1$ dimension in time. Again, acceleration of motion is defined as rate of increase of velocity per unit time; hence the change of the units of length and time will increase the corresponding or derived unit of acceleration [V]/[T] times, that is $[\mathrm{L}][\mathrm{T}]^{-2}$ times: this expression thus represents the dimensions (1 in length and $-2$ in time) of the derived entity acceleration in terms of its fundamental elements length and time. In the science of dynamics all entities are derived from the three fundamental ones, length, time, and mass; for example, the dimensions of force (P) are those of mass and acceleration jointly, so that in algebraic form $[\mathrm{P}]=[\mathrm{M}][\mathrm{L}][\mathrm{T}]^{-2}$. This restriction of the fundamental units to three is therefore applicable to

all departments of physical science that are reducible to pure dynamics.

The mode of transformation of a derived entity, as regards its numerical value, from one set of fundamental units of reference to another set, is exhibited in the simple illustrations above given. When the numerical values of the new units, expressed in terms of the former ones, are substituted for the symbols, in the expression for the dimensions of the entity under consideration, the number which results is the numerical value of the new unit of that entity in terms of the former unit: thus all numerical values of entities of this kind must be divided by this number, in order to transfer them from the former to the latter system of fundamental units.

As above stated, physical science reduces the phenomena of which it treats to the common denomination of the positions and movements of masses. Before the time of Gauss it was customary to use a statical measure of force, alongside the kinetic measure depending on the acceleration of motion that the force can produce in a given mass. Such a statical measure could be conveniently applied by the extension of a spring, which, however, has to be corrected for temperature, or by weighing against standard weights, which has to be corrected for locality. On the other hand, the kinetic measure is independent of local conditions, if only we have absolute scales of length and time at our disposal. It has been found to be indispensable, for simplicity and precision in physical science, to express the measure of force in one way; and statical forces are therefore now generally referred in theoretical discussions to the kinetic unit of measurement. In mechanical engineering the static unit has largely survived; but the increasing importance of electrical applications is introducing uniformity there also. In the science of electricity two different systems of units, the electrostatic and the electrodynamic, still to a large extent persist. The electrostatic system arose because in the development of the subject statics came before kinetics; but in the complete synthesis it is even now found convenient to express the various quantities in terms of the electrokinetic system alone.

The system of measurement now adopted as fundamental in physics takes the centimetre as unit of length, the gramme as unit of mass, and the second as unit of time. The choice of these units was in the first instance arbitrary and dictated by convenience; for some purposes subsidiary systems based on multiples of these units by certain powers of ten are found convenient. There are certain absolute entities in nature, such as the constant of gravitation, the velocity of light in free space, and the constants occurring in the expression giving the constitution of the radiation in an enclosure that corresponds to each temperature, which are the same for all kinds of matter; these might be utilized, if known with sufficient accuracy, to establish a system of units of an absolute or cosmical kind. The wave-length of a given spectral line might be utilized in the same manner, but that depends on recovering the kind of matter which produces the line.

In physical science the uniformities in the course of phenomena are elucidated by the discovery of permanent or intrinsic relations between the measurable properties of material systems. Each such relation is expressible as an equation connecting the numerical values of entities belonging to the system. Such an equation, representing as it does a relation between actual things, must remain true when the measurements are referred to a new set of fundamental units. Thus, for example, the kinematical equation $v^2 = nf^2l$, if $n$ is purely numerical, contradicts the necessary relations involved in the definitions of the entities velocity, acceleration, and length which occur in it. For on changing to a new set of units as above the equation should still hold; it, however, then becomes $v^2/[V]^2 = n \cdot f^2/[F]^2 \cdot l/[L]$. Hence on division there remains a dimensional relation $[V]^2 = [F]^2[L]$, which is in disagreement with the dimensions above determined of the derived units that are involved in it. The inference follows either that an equation such as that from which we started is a formal impossibility, or else that the factor $n$ which it contains is not a mere number, but represents $n$ times the unit of some derived quantity which ought to be specified in order to render the equation a complete statement of a physical relation. On the latter hypothesis the dimensions $[N]$ of this quantity are determined by the dimensional equation $[V]^2 = [N][F]^2[L]$ where, in terms of the fundamental units of length and time, $[V] = [L][T]^{-1}$, $[F] = [L][T]^{-2}$; whence by substitution it appears that $[N] = [L]^{-1}[T]^2$. Thus, instead of being merely numerical, $n$ must represent in the above formula the measure of some physical entity, which may be classified by the statement that it has the conjoint dimensions of time directly and of velocity inversely.

It often happens that simple comparison of the dimensions of the quantities which determine a physical system will lead to important knowledge as to the necessary relations that subsist between them. Thus in the case of a simple pendulum the period of oscillation $\tau$ can depend only on the angular amplitude $a$ of the swing, the mass $m$ of the bob considered as a point, and the length $l$ of the suspending fibre considered as without mass, and on the value of $g$ the acceleration due to gravity, which is the active force; that is, $\tau = f(a, m, l, g)$. The dimensions must be the same on both sides of this formula, for, when they are expressed in terms of the three independent dynamical quantities mass, length, and time, there must be complete identity between its two sides. Now the dimensions of $g$ are $[L][T]^{-2}$; and when the unit of length is altered, the numerical value of the period is unaltered, hence its expression must be restricted to the form $f(a, m, l/g)$. Moreover, as the period does not depend on the unit of mass, the form is further reduced to $f(a, l/g)$; and as it is of the dimensions $+1$ in time, it must be a multiple of $(l/g)^{\frac{1}{2}}$, and therefore of the form $\phi(a)\sqrt{(l/g)}$. Thus the period of oscillation has been determined by these considerations except as regards the manner in which it depends on the amplitude $a$ of the swing. When a process of this kind leads to a definite result, it will be one which makes the unknown quantity jointly proportional to various powers of the other quantities involved; it will therefore shorten the process if we assume such an expression for it in advance, and find whether it is possible to determine the exponents definitely and uniquely so as to obtain the correct dimensions. In the present example, assuming in this way the relation $\tau = \mathrm{A}a^p m^q l^r g^s$, where A is a pure numeric, we are led to the dimensional equation $[T] = [a]^p[M]^q[L]^r[LT^{-2}]^s$, showing that the law assumed would not persist when the fundamental units of length, mass, and time are altered, unless $q = 0$, $s = -\frac{1}{2}$, $r = \frac{1}{2}$; as an angle has no dimensions, being determined by its numerical ratio to the *invariable* angle forming four right angles, $p$ remains undetermined. This leads to the same result, $\tau = \phi(a)l^{+\frac{1}{2}}g^{-\frac{1}{2}}$, as before.

As illustrating the power and also the limitations of this method of dimensions, we may apply it (after Lord Rayleigh, *Roy. Soc. Proc.*, March 1900) to the laws of viscosity in gases. The dimensions of viscosity ($\mu$) are (force/area) ÷ (velocity/length), giving $[ML^{-1}T^{-1}]$ in terms of the fundamental units. Now, on the dynamical theory of gases viscosity must be a function of the mass $m$ of a molecule, the number $n$ of molecules per unit volume, their velocity of mean square $\bar{v}$, and their effective radius $a$; it can depend on nothing else. The equation of dimensions cannot supply more than *three* relations connecting these four possibilities of

variation, and so cannot here lead to a definite result without further knowledge of the physical circumstances. And we remark conversely, in passing, that wherever in a problem of physical dynamics we know that the quantity sought can depend on only three other quantities whose dynamical dimensions are known, it must vary as a simple power of each. The additional knowledge required, in order to enable us to proceed in a case like the present, must be of the form of such an equation of simple variation. In the present case it is involved in the new fact that in an actual gas the mean free path is very great compared with the effective molecular radius. On this account the mean free path is inversely as the number of molecules per unit volume; and therefore the coefficient of viscosity, being proportional to these two quantities jointly, is independent of either, so long as the other quantities defining the system remain unchanged. If the molecules are taken to be spheres which exert mutual action only during collision, we therefore assume

$$\mu \propto m^x \bar{v}^y a^z,$$

which requires that the equation of dimensions

$$[ML^{-1}T^{-1}] = [M]^x [LT^{-1}]^y [L]^z$$

must be satisfied. This gives $x=1$, $y=1$, $z=-2$. As the temperature is proportional to $m\bar{v}^2$, it follows that the viscosity is proportional to the square root of the mass of the molecule and the square root of the absolute temperature, and inversely proportional to the square of the effective molecular radius, being, as already seen, uninfluenced by change of density. If the atoms are taken to be Boscovichian points exerting mutual attractions, the effective diameter $a$ is not definite; but we can still proceed in cases where the law of mutual attraction is expressed by a simple formula of variation—that is, *provided* it is of type $km^2r^{-s}$ where $r$ is the distance between the two molecules. Then, noting that, as this is a force, the dimensions of $k$ must be $[M^{-1}L^{s+1}T^{-2}]$, we can assume

$$\mu \propto m^x \bar{v}^y k^w,$$

provided $$[ML^{-1}T^{-1}] = [M]^x [LT^{-1}]^y [M^{-1}L^{s+1}T^{-2}]^w,$$

which demands and is satisfied by

$$x - w = 1,\ y + 2w = 1,\ y + (s+1)w = -1,$$

so that $$w = -\frac{2}{s-1},\ y = \frac{s+3}{s-1},\ x = \frac{s-3}{s-1}.$$

Thus, on this supposition,

$$\mu \propto m^{\frac{s-9}{2s-2}} k^{-\frac{2}{s-1}} \theta^{\frac{s+3}{2s-2}}$$

where $\theta$ represents absolute temperature. (See DIFFUSION OF GASES.)

In electrical science two essentially distinct systems of measurement were arrived at according as the development began with the phenomena of electrostatics or those of electrokinetics. An electric charge appears as an entity having different dimensions in terms of the fundamental dynamical units, in the two cases: the ratio of these dimensions proves to be the dimensions of a velocity. It was found, first by W. Weber, by measuring the same charge by its static and its kinetic effects, that the ratio of the two units is a velocity sensibly identical with the velocity of light, so far as regards experiments conducted in space devoid of dense matter. The emergence of a definite absolute velocity such as this, out of a comparison of two different ways of approaching the same quantity, entitles us to assert that the two ways can be consolidated into a single dynamical theory only by some development in which this velocity comes to play an actual part. Thus the hypothesis of the mere existence of some complete dynamical theory was enough to show, in the stage which electrical science had reached under Gauss and Weber, that there is a definite physical velocity involved in and underlying electric phenomena, which it would have been hardly possible to imagine as other than a velocity of propagation of electrical effects of some kind. The time was thus ripe for the reconstruction of electric theory by Faraday and Maxwell.

The power of the method of dimensions in thus revealing general relations has its source in the hypothesis that, however complicated in appearance, the phenomena are really restricted within the narrow range of dependence on the three fundamental entities. The proposition is also therein involved, that if a changing physical system be compared with another system in which the scale is altered in different ratios as regards corresponding lengths, masses, and times, then if all quantities affecting the second system are altered from the corresponding quantities affecting the first in the ratios determined by their physical dimensions, the stage of progress of the second system will always correspond to that of the first; under this form the application of the principle, to determine the correlations of the dynamics of similar systems, originated with Newton (*Principia*, lib. ii. prop. 32). For example, in comparing the behaviour of an animal with that of another animal of the same build but on a smaller scale, we may take the mass per unit volume and the muscular force per unit sectional area to be the same for both; thus [L], [M], . . . being now ratios of corresponding quantities, we have $[ML^{-3}] = 1$ and $[ML^{-1}T^{-2}] = 1$, giving $[L] = [T]$; thus the larger animal effects movements of his limbs more slowly in simple proportion to his linear dimensions, while the velocity of movement is the same for both. But this is only on the hypothesis that the extraneous force of gravity does not intervene, for that force does not vary in the same manner as the muscular forces. The result has thus application only to a case like that of fishes in which gravity is equilibrated by the buoyancy of the water. The limbs of a land animal have mainly to support his weight, which varies as the cube of his linear dimensions, while the sectional areas of his muscles and bones vary only as the square thereof. Thus the diameters of his limbs should increase in a greater ratio than that of his body,—theoretically in the latter ratio raised to the power $\frac{3}{2}$, if other things were the same. An application of this principle, which has become indispensable in modern naval architecture, permits the prediction of the behaviour of a large ship from that of a small-scale model. The principle is also of very wide utility in unravelling the fundamental relations in definite physical problems of such complexity that complete treatment is beyond the present powers of mathematical analysis; it has been applied, for example, to the motions of systems involving viscous fluids, in elucidation of wind and waves, by Helmholtz (*Akad. Berlin*, 1873 and 1889), and in the electrodynamics of material atomic systems in motion by Lorentz and by Larmor. (J. L*.)

**Dinajpur,** a town (with a population in 1891 of 12,204) and district of British India, in the Rajshahi division of Northern Bengal. The earthquake of 12th June 1897 caused serious damage to most of the public buildings of the town. There is a railway station; a Government high school, with 284 pupils in 1896–97; and five printing-presses, with one vernacular periodical. The district comprises an area of 4118 square miles. Its population in 1881 was 1,514,346, and in 1891 was 1,555,835, giving an average density of 378 persons per square mile, being the lowest in the plains of the province. Classified according to religion, Hindus numbered 740,442; Mahommedans, 802,597; aborigines, 10,694; Christians, 511, of whom 30 were Europeans; "others," 1291. In 1901 the population was 1,569,133, showing an increase of 6 per cent. The land revenue and rates were Rs.16,26,711; the number of police was 423; the number of boys at school in 1896–97 was 22,489, being 18·4 per cent. of the male population of school-going age; the registered death-rate in 1897 was 34·72 per thousand. The district is partly traversed by the main line of the Eastern Bengal Railway and by two branch lines.

**Dinan,** chief town of arrondissement, department of Côtes-du-Nord, France, 35 miles east by south of St Brieuc, on railway from that town to St Malo. In a suburb of the town are many English residents. The new lycée (1892)

is installed in a fine building, and the public library now contains about 90,000 volumes. The principal manufactures now are farming implements and earthenware. During the bathing season steamboats ply regularly between Dinan and St Malo. The old cemetery of the church of St Sauveur has been converted into a public garden. Population (1881), 7893; (1896), 7828, (comm.) 8462; (1901), 10,534.

**Dinapur,** a town of British India, in the Patna district of Bengal, on the right bank of the Ganges, 12 miles west of Patna city by rail. In 1881 it had a population of 37,893, and in 1891 of 44,419. It is the largest military cantonment in Bengal, with accommodation for two batteries of artillery, a European and a native infantry regiment.

**Dindigul,** a town of British India, in the Madura district of Madras, 880 feet above the sea, 40 miles from Madura by rail. In 1881 it had a population of 14,182, and in 1891 of 20,115; the municipal income in 1897–98 was Rs.32,070. Dindigul has risen into importance as the centre of a trade in tobacco and manufacture of cigars, which are exported to England. There are now two large European cigar factories here. It has manufactures of silk, muslin, and blankets, and an export trade in hides and cardamoms; and there is a large native Christian population, with two churches. It also has a municipal high school and two printing-presses.

**Dindorf, Wilhelm** (1802–1883), German classical scholar, was born at Leipzig, 2nd January 1802, and was the son of the university professor of Oriental languages. From his earliest years he showed a strong partiality for classical studies, and after completing Invernizzi's edition of Aristophanes at an early age, and editing several grammarians and rhetoricians, was in 1828 appointed professor of literary history in his native city. Finding, however, that the duty of lecturing interfered too much with his philosophical pursuits, he resigned this office in 1833, and devoted himself entirely to Hellenic studies. His attention was at first chiefly given to Athenæus, whom he edited in 1827, and to the Greek dramatists, all of whom he edited separately and combined in his *Poetae Scenici Graeci* (1830). He also wrote a work on the metres of the dramatic poets, and compiled special lexicons to Æschylus and Sophocles. He edited Procopius and other historians for Niebuhr's great *Corpus* of the Byzantine writers, and between 1846 and 1851 brought out at Oxford a highly important edition of Demosthenes; he also edited Lucian and Josephus for the Didot Classics. His last important editorial labour was his *Eusebius of Cæsarea* (1867–71). Much of his attention was occupied by the great republication of Stephanus's *Thesaurus* (Paris, 1832–65), chiefly executed by him and his brother Ludwig, a work of prodigious labour and utility. His reputation suffered somewhat through the imposture practised upon him by the Greek Constantine Simonides, who succeeded in deceiving him by a fabricated fragment of the Greek historian Uranius. The book was printed, and a few copies had been circulated, when the forgery was discovered, just in time to prevent its being given to the world under the auspices of the University of Oxford. Dindorf died on 1st August 1883.—His brother LUDWIG (1805–1871) was born at Leipzig on 3rd January 1805, and died there on 6th September 1871. Like Wilhelm, he declined academical office, and he secluded himself so entirely for study that many doubted his existence, and affirmed that he was a mere pseudonym. The important share which he took in the edition of Stephanus's *Thesaurus* is nevertheless authenticated by his own signature to his contributions, and he published valuable editions of Polybius, Dion Cassius, and other Greek historians. (R. G.)

**D'Indy, Paul-Marie-Théodore-Vincent** (1851– ——), French musical composer, was born in Paris, 27th March 1851. He studied composition under César Franck, the organ at the Paris Conservatoire, and obtained the Grand Prize offered by the city of Paris in 1885 with *Le Chant de la Cloche*, a dramatic legend after Schiller. His principal works, beside the above, are the symphonic trilogy *Wallenstein*, the symphonic works entitled *Sauge fleuri*, *La Forêt enchantée*, *Istar*, *Symphonie sur un air montagnard français*; overture to *Anthony and Cleopatra*; *Ste Marie Magdeleine*, a cantata; *Attendez moi sous l'orme*, a one-act opera; *Fervaal*, a musical drama in three acts. Vincent d'Indy is perhaps the most prominent among the disciples of César Franck. Imbued with very high aims, he has always been guided by a lofty ideal, and very few musicians have attained so complete a mastery over the art of instrumentation. His music, however, lacks simplicity, and can never become popular in the widest sense. His opera *Fervaal*, which is styled "action musicale," is constructed upon the system of *Leit motifs*. Its legendary subject recalls both *Parsifal* and *Tristan*, and the music is also suggestive of Wagnerian influence. D'Indy can scarcely be considered so typical a representative of modern French music as his juniors Alfred Bruneau, the composer of *Le Rêve*, *L'Attaque du Moulin*, *Messidor*, or Gustave Charpentier, the author of *Louise*, who have chosen subjects of modern life for their operatic works. He nevertheless occupies a distinguished position as one of the most gifted among the musicians of his country.

**Dineir,** a small town in Asia Minor, built amidst the ruins of Celænæ-Apamea, near the sources of the Mæander (Mendere), is the terminus of the Smyrna-Aidin-Dineir Railway. The population numbers 1400. (See APAMEA.)

**Dingelstedt, Franz von,** BARON (1814–1881), German poet and dramaturgist, was born at Halsdorf, in Hesse Cassel, 30th June 1814. In 1836 he became a teacher at the Government school at Cassel, from which, having given offence to the authorities, he was transferred to Fulda in 1838. Despairing of being reinstated, he resolved to abandon his profession for literature, and in 1841 obtained an appointment on the staff of the *Augsburger Allgemeine Zeitung*. He had previously, in 1839 and 1840 respectively, produced a novel, *Unter der Erde*, which obtained considerable success, and a play, *Gespenst der Ehre* ("The Phantom of Honour"), which proved an utter failure. In 1841 appeared the book by which he is likely to be best remembered, the *Lieder eines kosmopolitischen Nachtwächters*, a most effective contribution to the political poetry of the day, animated with a spirit of bitter opposition to the prevalent despotism and distinguished by great sarcastic power. Extreme, therefore, was the surprise when, in 1844, the satirist of German princes accepted the appointment of private librarian to the King of Wurtemberg, and he was unanimously denounced as a renegade. In reality, his political convictions had never been very deep, and his hostile attitude towards the rulers was chiefly inspired by a spirit of scepticism and irony, to which the Liberals were as obnoxious as their opponents. His marriage in 1843 with the celebrated actress Jenny Lutzer probably had much influence on his decision. In 1845 he published a volume of poems, some of which, treating of modern life, possessed great literary rather than strictly poetical merit. A subsequent collection, published in 1852, attracted little attention. In 1850 a tragedy on the House of Barneveldt obtained

great success, and it still ranks as one of the best German plays of the period. In the following year he accepted an invitation to undertake the direction of the Royal Theatre at Munich. He proved one of the ablest managers that Germany had ever seen, but incurred the animosity of the Jesuit clique about the court, and in 1856 was suddenly dismissed on the most frivolous charges. A similar engagement was soon offered to him at Weimar through the influence of Liszt, and, although not altogether easy in his situation, he remained there until 1867. His administration was most successful, and he especially distinguished himself by putting all Shakespeare's historical plays upon the stage. In 1867 he removed to Vienna, and directed the Imperial Theatre there until his death in 1881. Among his other works may be noticed an autobiographical sketch of his Munich career, entitled *Münchener Bilderbogen* (1879), *Die Amazone*, an art novel of considerable merit (1869), translations of several of Shakespeare's comedies, and a treatise on the theatrical administration which he understood so well. His life, founded on his posthumous papers, was written by Julius Rodenberg in 1890. He was ennobled by the Emperor of Austria. Dingelstedt possessed few qualifications for the higher walks of poetry, but his style both in prose and verse was admirable, and he might have been the poet of modern social life. It is probable that the imputation of political apostasy under which he laboured impeded the full exercise of his abilities. (R. G.)

**Dingwall,** a market-town, royal and parliamentary burgh (Wick group), railway station, and county town of Ross-shire, Scotland, on the north-west shore of the Cromarty Firth, 13½ miles north-west of Inverness. A small harbour opens on to the Peffer river. There are county buildings, militia barracks, public hall, a cottage hospital, and a public park. There is an academy. Population (1891), 2300; (1901), 2519.

**Dinkar Rao, Sir,** Raja (1819–1896), Indian statesman, was born in Ratnagiri on 20th December 1819, being a Maratha Brahman. At fifteen he entered the service of the Gwalior state, in which his ancestors had served. Rapidly promoted to the responsible charge of a division, he displayed unusual talents in reorganizing the police and revenue departments, and in reducing chaos to order. In 1852 Dinkar Rao became Dewan. The events which led to the British victories of Maharajpur and Panniar in 1844 had filled the state with mutinous soldiery, ruined the finances, and weakened authority. With a strong hand the Dewan suppressed disorder, abolished ruinous imposts, executed public works, and by a reduction of salaries, including his own, turned a deficit into a surplus. When the contingent mutinied, he never wavered in loyalty; and although the state troops also mutinied in June 1858 on the approach of Tantia Topi, he adhered to the British cause, retiring with the Maharaja Sindhia to the Agra fort. After the restoration of order he remained minister until December 1859, when he resigned. In 1873 he was appointed guardian to the minor Rana of Dholpur, but soon afterwards he resigned, owing to ill-health. In 1875 the Viceroy selected him as a Commissioner, with the Maharajas Sindhia and Jaipur, and three British colleagues, to try the Gaekwar of Baroda on a charge of attempting to poison the British Resident. No higher honour could have been conferred on a British subject. He served in the Legislative Council of India, and was frequently consulted by Viceroys on difficult questions. An estate was conferred upon him, and the hereditary title of Raja, for his eminent services, and he also received the decoration of K.C.S.I. He died on 9th January 1896. No Indian statesman of the 19th century gained a higher reputation, yet he possessed none of the qualifications which entitled Salar Jung, Madava Rao, Ranga Charlu, or Sheshadri Aiyar to fame. He only commenced the study of English at the age of forty, and was never able to converse fluently in it; his orthodoxy resented social reforms; he kept aloof from the Congress, and he had received no training in British administration. Finally he resigned the service in Gwalior and Dholpur just when his work seemed likely to bear most fruit. But the verdict of posterity has endorsed the favourable opinion entertained by his contemporaries. (W. L.-W.)

**Diognetus, Epistle to.**—The one manuscript which contained this letter perished by fire at Strasburg in 1870, but happily it had been accurately collated by Reuss nine years before. It formed part of a collection of works supposed to be by Justin Martyr, and to this mistaken attribution its preservation is no doubt due. The end of it is lost, but there followed in the codex the end of a homily, which was attached without a break to the epistle: this points to the loss in some earlier codex of pages containing the end of the letter and the beginning of the homily.

Diognetus has expressed a desire to know what Christianity really means—"What is this new race" of men who are neither pagans nor Jews? "What is this new interest which has entered into men's lives now and not before?" The answer begins with a refutation of the folly of worshipping idols, fashioned by human hands and needing to be guarded if of precious material. The repulsive smell of animal sacrifices is enough to show their monstrous absurdity. Next Judaism is attacked. Jews abstain from idolatry and worship one God, but they fall into the same error of repulsive sacrifice, and have absurd superstitions about meats and sabbaths, circumcision and new moons. So far the task is easy; but the mystery of the Christian religion "think not to learn from man." A passage of great eloquence follows, showing that Christians have no obvious peculiarities that mark them off as a separate race. In spite of blameless lives they are hated. Their home is in heaven, while they live on earth. "In a word, what the soul is in a body, this the Christians are in the world. . . . The soul is enclosed in the body, and yet itself holdeth the body together: so Christians are kept in the world as in a prison-house, and yet they themselves hold the world together." This strange life is inspired in them by the almighty and invisible God, who sent no angel or subordinate messenger to teach them, but His own Son by whom He created the universe. No man could have known God, had He not thus declared Himself. "If thou too wouldst have this faith, learn first the knowledge of the Father. For God loved men, for whose sake He made the world . . . Knowing Him, thou wilt love Him and imitate His goodness; and marvel not if a man can imitate God: he can, if God will." By kindness to the needy, by giving them what God has given to him, a man can become "a god of them that receive, an imitator of God." "Then shalt thou on earth behold God's life in heaven; then shalt thou begin to speak the mysteries of God." A few lines after this the letter suddenly breaks off.

Even this rapid summary may show that the writer was a man of no ordinary power. Both his thought and his language mark him off entirely from Justin Martyr. Bishop Lightfoot, who speaks of the letter as "one of the noblest and most impressive of early Christian apologies," places it *c.* 150 A.D., and inclines to identify Diognetus with the tutor of M. Aurelius. Harnack would place it later, perhaps in the 3rd century. There are some striking parallels in method and language to the Apology of Aristides, and also to the early "Preaching of Peter,"

of which Aristides also has made considerable use (see ARISTIDES, APOLOGY OF).

The Epistle may be read in Lightfoot's *Apostolic Fathers* (ed. min.), where there is also a translation into English.

(J. A. R.)

**Diomedes, The.**—Two small islands situated in the middle of Bering Strait, about a mile apart, between which passes the boundary line between the possessions of Russia and the United States. They are granite domes without a harbour, and are occupied by a small tribe of Eskimo (85 in 1890), who have plied the trade of middlemen between Asia and America from prehistoric times. They are situated in N. lat. 65° 46′; the western is called by the natives Nunárbook, and the eastern, Ignálook. They were discovered by Deshneff in 1648.

**Diósgyör,** a market-town of Northern Hungary, $5\frac{1}{2}$ miles west of Miskolcz. Population (1891), 6537; (1900), 11,526. The state has here some of the largest iron and steel works in the country, employing regularly, in company with the mines, 6000 men. To accommodate these, two large barracks have been erected, besides numerous houses; also schools, hospitals, and other institutions. A large paper-mill likewise deserves mention. The Hungarian kings in old times used often to visit the now dismantled fortress.

**Diphtheria.**—Great attention has been paid to diphtheria in recent years, with some striking results. Its cause and nature have been definitely ascertained, the conditions which influence its prevalence have been elucidated, and a specific "cure" has been found. In the last respect it occupies a unique position at the present time. In the case of several other zymotic diseases much has been done by way of prevention, little or nothing for treatment; in the case of diphtheria prevention has failed, but treatment has been revolutionized by the introduction of antitoxin, which constitutes the most important contribution to practical medicine as yet made by bacteriology.

*Causation.*

The exciting cause of diphtheria is a micro-organism, identified by Klebs and Löffler in 1883. A description of it will be found under the heading of PATHOLOGY (*Parasitic Diseases*). It has been shown by experiment that the symptoms of diphtheria, including the after-effects, are produced by a toxin derived from the micro-organisms which lodge in the air-passages and multiply in a susceptible subject. The natural history of the organism outside the body is not well understood, but there is some reason to believe that it lives in a dormant condition in suitable soils. Recent research does not favour the theory that it is derived from defective drains or "sewer gas," but these things, like damp and want of sunlight, probably promote its spread, by lowering the health of persons exposed to them, and particularly by causing an unhealthy condition of the throat, rendering it susceptible to the contagion. Defective drainage, or want of drainage, may also act, by polluting the ground, and so providing a favourable soil for the germ, though it is to be noted that "the steady increase in the diphtheria mortality has coincided, in point of time, with steady improvement in regard of such sanitary circumstances as water supply, sewerage, and drainage" (Thorne Thorne). Cats and cows are susceptible to the diphtheritic bacillus, and fowls, turkeys, and other birds have been known to suffer from a disease like diphtheria, but other domestic animals appear to be more or less resistant or immune. In human beings the mere presence of the germ is not sufficient to cause disease; there must also be susceptibility, but it is not known in what that consists. Individuals exhibit all degrees of resistance up to complete immunity. Children are far more susceptible than adults, but even children may have the Klebs-Löffler bacillus in their throats without showing any symptoms of illness. Altogether there are many obscure points about this micro-organism, which is apt to assume a puzzling variety of forms. Nevertheless its identification has greatly facilitated the diagnosis of the disease, which was previously a very difficult matter, often determined in an arbitrary fashion on no particular principles. Diphtheria, as at present understood, may be defined as sore throat in which the bacillus is found; if it cannot be found, the illness is regarded as something else, unless the clinical symptoms are quite unmistakable. One result of this is a large transference of registered mortality from other throat affections, and particularly from croup, to diphtheria. Croup, which never had a well-defined application, and is not recognized by the College of Physicians as a synonym for diphtheria, appears to be dying out from the medical vocabulary in Great Britain. In France the distinction has never been recognized.

*Prevalence.*

Diphtheria is endemic in all European and American countries, and is apparently increasing, but the incidence varies greatly. It is far more prevalent on the Continent than in England, and still more so in the United States and Canada. The following table, compiled from figures collected by Dr Newsholme, shows how London compares with some foreign cities. The figures give the mean death-rate from diphtheria and croup for the term of years during which records have been kept. The period varies in different cases, and therefore the comparison is only a rough one.

*Mean Death-Rates from Diphtheria and Croup per Million living.*

| | | | |
|---|---|---|---|
| New York | 1610 | Munich | 990 |
| Chicago | 1400 | Milan | 990 |
| Buenos Aires | 1360 | Florence | 830 |
| Trieste | 1300 | Vienna | 770 |
| Dresden | 1290 | Stockholm | 720 |
| Berlin | 1190 | St Petersburg | 650 |
| Boston | 1160 | Moscow | 640 |
| Marseilles | 1130 | Paris | 630 |
| Christiania | 1090 | Hamburg | 490 |
| Budapest | 1880 | London | 386 |

There is comparatively little diphtheria in India and Japan, but in Egypt, the Cape, and Australasia it prevails very extensively among the urban populations. The mortality varies greatly from year to year in all countries and cities. In Berlin, for instance, it has oscillated between a maximum of 2420 in 1883 and a minimum of 340 in 1896; in New York between 2760 in 1877 and 680 in 1868; in Christiania between 3290 in 1887 and 170 in 1871. In some American cities still higher maxima have been recorded. In other words, diphtheria, though always endemic, exhibits at times a great increase of activity, and becomes epidemic or even pandemic. The following table shows fairly well the periodical rise and fall in England and Wales. Diphtheria and croup are given both separately and together, showing the increasing transference from one to the other of late years. Diphtheria was first entered separately in the year 1859, with which the table begins.

*Deaths from Diphtheria and Croup per Million living in England and Wales.*

| Years. | Diphtheria. | Croup. | Diphtheria and Croup. |
|---|---|---|---|
| 1859 | 517 | 286 | 803 |
| 1860 | 261 | 220 | 481 |
| 1861–70 | 185 | 246 | 431 |
| 1871–80 | 121 | 168 | 289 |
| 1881–90 | 163 | 144 | 307 |
| 1891–95 | 254 | 70 | 324 |
| 1896–97 | 269 | 43 | 312 |
| 1898 | 244 | 27 | 271 |
| 1899 | 293 | 32 | 325 |

Several facts are roughly indicated by this table. It begins with an extremely severe epidemic, which has not been approached since. Then follows a fall extending over twenty years. On the whole this diminution was progressive, though not in reality so steady as the decennial grouping makes it appear, being interrupted by smaller oscillations in single years and groups of years. Still the main fact holds good. After 1880 an opposite movement began, likewise interrupted by minor oscillations, but on the whole progressive, and culminating in the year 1893 with a death-rate of 389, the highest recorded since 1865. After 1896 a marked fall again took place. This is partly accounted for by the use of antitoxin, which only began on a considerable scale in 1895, and did not become general until a year or two later at least. Probably its effects are only now being fully felt, and they undoubtedly affect the Registrar-General's returns, which record mortality, not prevalence—that is to say, the number of deaths, not of cases. The factor, therefore, must not be forgotten, but it can hardly account for the whole of the diminution.

On the whole, we get clear evidence of an epidemic rise and fall, which may serve to dispose of some erroneous conceptions. The belief, held until recently, that diphtheria is steadily increasing in Great Britain was obviously premature; it did rise over a series of years, but has now ebbed again. Moreover, the general prevalence during the last thirty years has been notably less than in the previous twelve years. Yet it is during years since 1870 that compulsory education has been in existence and main drainage chiefly carried out. It follows that neither school attendance nor sewer gas exercises such an important influence over the epidemicity of diphtheria as some other conditions. What are those conditions? Dr Newsholme has advanced the theory, based on an elaborate examination of statistics in various countries, that the activity of diphtheria is connected with the rainfall, and he lays down the following general induction from the facts: "Diphtheria only becomes epidemic in years in which the rainfall is deficient, and the epidemics are on the largest scale when three or more years of deficient rainfall follow each other." He points out that the comparative rarity of diphtheria in tropical climates, which are characterized by excessive rainfall, and its greater prevalence in continental than in insular countries, confirm his theory. His observations seem quite contrary to the view laid down by various authorities, and hitherto generally accepted, that wet weather favours diphtheria. The two, however, are not irreconcilable. The key to the problem—and possibly to many other epidemiological problems—may perhaps be found in the movements of the subsoil water. It has been suggested by different observers, and particularly by Mr M. A. Adams, who has for some years made a study of the subsoil water at Maidstone, that there is a definite connexion between it and diphtheria. In England the underground water normally reaches its lowest level at the end of the summer; then it gradually rises, fed by percolation from the winter rains, reaching a maximum level about the end of March, after which it gradually sinks. This maximum level Mr Adams calls the annual spring cleaning of the soil, and his observations go to show that when the normal movement is arrested or disturbed, diphtheria becomes active. Now that is what happens in periods of drought. The underground water does not rise to its usual level, and there is no spring cleaning. The hypothesis, then, is this: The diphtheria bacillus lives in the soil, but is "drowned out" in wet periods by the subsoil water. In droughty ones it lives and flourishes in the warm, dry soil; then when rain comes, it is driven out with the ground air into the houses. This process will continue for some time, so that epidemic outbreaks may well seem to be associated with wet. But they begin in drought, and are stopped by long-continued periods of copious rainfall. This is quite in keeping with the observed fact that diphtheria is a seasonal disease, always most prevalent in the last quarter of the year. The summer develops the poison in the soil, the autumnal rains bring it out. The fact that the same cause does not produce the same effect in tropical countries may perhaps be explained by the extreme violence of the alternations, which are too great to suit this particular micro-organism, or possibly the regularity of the rainfall prevents its development.

The foregoing hypothesis is supported by a good deal of evidence, and notably by the concurrence of the great epidemic or pandemic prevalence in Great Britain, culminating in 1859, with a prolonged period of exceptionally deficient rainfall. Again, the highest death-rate registered since 1865 was in 1893, a year of similarly exceptional drought. But it is no more than an hypothesis, and the fate of former theories is a warning against drawing conclusions from statistics and records extending over too short a period of time. The warning is particularly necessary in connexion with meteorological conditions, which are apt to upset all calculations. As it happens, a period of deficient rainfall even greater than that of 1854–58 has recently been experienced. It began in 1893 and culminated in the extraordinary season of 1899. The dry years were 1893, 1895, 1896, 1898, and 1899, and the deficiency of rainfall was not made good by any considerable excess in 1894 and 1897. It surpassed all records at Greenwich; streams and wells ran dry all over the country, and the flow of the Thames and Lea was reduced to the lowest point ever recorded. There should be, according to the theory, at least a very large increase in the prevalence of diphtheria. To a certain extent it has held good. There was a marked rise in 1893–96 over the preceding period, though not so large as might have been expected, but it was followed by a decided fall in 1897–98. The experience of 1898 contradicts, that of 1899 supports, the theory. Further light is therefore required; but perhaps the failure of the recent drought to produce results at all comparable with the epidemic of the 'fifties may be due to variations in the resistance of the disease, which differs widely in different years. It may also be due in part to improved sanitation, to the notification of infectious diseases, the use of isolation hospitals, which have greatly developed in quite recent years, and, lastly, to the beneficial effects of antitoxin. If these be the real explanations, then scientific and administrative work has not been thrown away after all in combating this very painful and fatal enemy of the young.

***Dissemination.***

The conditions governing the general prevalence of diphtheria, and its epidemic rise and fall, which have just been discussed, do not touch the question of actual dissemination. The contagion is spread by means which are in constant operation, whether the general amount of disease is great or small. Water, so important in some epidemic diseases, is believed not to be one of them, though a negative proof based on absence of evidence cannot be accepted as conclusive. On the other hand, milk is undoubtedly a means of dissemination. Several outbreaks of an almost explosive character, besides minor extensions of disease from one place to another, have been traced to this cause. Milk may be contaminated in various ways,—at the dairy, for instance, or on the way to customers,—but several cases, investigated by the officers of the Local Government Board and others, have been thought to point to infection from cows suffering from a diphtheritic affection of the udder. The part played by aerial convection is undetermined, but there is no reason to suppose that the infecting material is conveyed any distance by wind or air currents. Instances which seem to point to the contrary

may be explained in other ways, and particularly by the fact, now fully demonstrated, that persons suffering from minor sore throat, not recognized as diphtheria, may carry the disease about and introduce it into other localities. Human intercourse is the most important means of dissemination, the contagion passing from person to person either by actual contact, as in kissing, or by the use of the same utensils and articles, or by mere proximity. In the last case the germs must be supposed to be air-borne for short distances, and to enter with the breath. Rooms appear liable to become infected by the presence of diphtheritic cases, and so spread the disease among other persons using them. At a small outbreak which occurred at Darenth Asylum in 1898 the infection clung obstinately to a particular ward, in spite of the prompt removal of all cases, and fresh ones continued to occur until it had been thoroughly disinfected, after which there were no more. The part played by human intercourse in fostering the spread of the disease suggests that it would naturally be more prevalent in urban communities, where people congregate together more, than in rural ones. This is at variance with the conclusion laid down by some authorities, that in this country diphtheria used to affect chiefly the sparsely populated districts, and though tending to become more urban, is still rather a rural disease. That view is based upon an analysis of the distribution by counties in England and Wales from 1855 to 1880, and it has been generally accepted and repeated until it has become a sort of axiom. Of course the facts of distribution are facts, but the general inference drawn from them, that diphtheria peculiarly affects the country and is changing its *habitat*, may be erroneous. Dr Newsholme, by taking a wider basis of experience, has arrived at the opposite conclusion, and finds that diphtheria does not, in fact, flourish more in sparsely peopled districts. "When a sufficiently long series of years is taken," he says, "it appears clear that there is more diphtheria in urban than in rural communities." The rate for London has always been in excess of that for the whole of England and Wales. Its distribution at any given time is determined by a number of circumstances, and by their incidental co-operation, not by any property or predilection for town or country inherent in the disease. There are the epidemic conditions of soil and rainfall, previously discussed, which vary widely in different localities at different times; there is the steady influence of regular intercourse, and the accidental element of special distribution by various means. These things may combine to alter the incidence. In short, accident plays too great a part to permit any general conclusion to be drawn from distribution, except from a very wide basis of experience. The variations are very great and sometimes very sudden. For instance, the county of London has for years headed the list, having a far higher death-rate than any other. In 1898 it dropped to the fifth place, and was surpassed by Rutland, a purely rural county, which had the lowest mortality of all in the previous year and very nearly the lowest for the previous ten years. Again, South Wales, which had a low mortality for some years, has recently and rapidly become a diphtheria district, and in 1898 had the highest death-rate in the whole country. Staffordshire and Bedfordshire show a similar rise, the one an urban, the other a rural, county. All the northern counties, both rural and urban,—namely, Northumberland, Durham, Cumberland, Westmorland, Lancashire, Yorkshire, Cheshire, and Lincolnshire,—had a very high rate in 1861–70, and a low one in 1896–98. It is obviously unsafe to draw general conclusions from distribution data on a small scale. Diphtheria appears to creep about very slowly, as a rule, from place to place, and from one part of a large town to another; it forsakes one district and appears in another; occasionally it attacks a fresh locality with great energy, presumably because the local conditions are exceptionally favourable, which may be due to the soil or, possibly, to the susceptibility of the inhabitants, who are, so to speak, virgin ground. But through it all personal infection is the chief means of spread.

The acceptance of this doctrine has directed great attention to the practical question of school influence. There is no doubt whatever that it plays a very considerable part in spreading diphtheria. The incidence of the disease is chiefly on children, and nothing so often and regularly brings large numbers together in close contact under the same roof as school attendance. Nothing, in fact, furnishes such constant and extensive opportunities for personal infection. Many outbreaks have definitely been traced to schools. In London the subject has been very fully investigated by Dr Shirley Murphy, the Medical Officer of Health to the County Council, and by Dr W. R. Smith, who fills the same post for the London School Board. Dr Murphy has shown that a special incidence on children of school age began to manifest itself after the adoption of compulsory education, and that the summer holidays are marked by a distinct diminution of cases, which is succeeded by an increase on their return to school. Dr W. R. Smith's observations are directed rather to minimizing the effect of school influence, and to showing that it is less important than other factors; which is doubtless true, as has been already remarked. It appears that the heaviest incidence falls upon infants under school age, and that liability diminishes progressively after school age is reached. But this by no means disposes of the importance of school influence, as the younger children at home may be infected by older ones, who have picked up the contagion at school, but, being less susceptible, are less severely affected and exhibit no worse symptoms than a sore throat. From a practical point of view the problem is a difficult one to deal with, as it is virtually impossible to ensure the exclusion of all infection, on account of the deceptively mild forms it may assume; but considering how very often outbreaks of diphtheria necessitate the closing of schools, it would probably be to the advantage of the authorities to discourage, rather than to compel, the attendance of children with sore throats. A fact of some interest revealed by statistics is that in the earliest years of life the incidence of diphtheria is greater upon male than upon female children, but from three years onwards the position is reversed, and with every succeeding year the relative female liability becomes greater. This is probably due to the habit of kissing maintained among females, but more and more abandoned by boys from babyhood onwards. It emphasizes the part played by personal infection.

All these considerations suggest the importance of segregating the sick in isolation hospitals. Of late years this preventive measure has been carried out with increasing efficiency, owing to the better provision of such hospitals and the greater willingness of the public to make use of them; and probably the improvement so effected has had some share in keeping down the prevalence of the disease to comparatively moderate proportions. Unfortunately, the complete segregation of infected persons is hardly possible, because of the mild symptoms, and even absence of symptoms, exhibited by some individuals. A further difficulty arises with reference to the discharge of patients. It has been proved that the bacillus may persist almost indefinitely in the air-passages in certain cases, and in a considerable proportion it does persist for several weeks after convalescence. On returning home such cases may, and often do, infect others.

Since antitoxin was introduced in 1894 it has overshadowed all other methods of treatment. We owe this drug originally to the Berlin school of bacteriologists, and particularly to Dr Behring. The idea of making use of serum arose about 1890, out of researches made in connexion with Metschnikoff's theory of phagocytosis, by which is meant the action of the phagocytes or white corpuscles of the blood in destroying the bacteria of disease. It was shown by the German bacteriologists that the serum or liquid part of the blood plays an equally or more important part in resisting disease, and the idea of combating the toxins produced by pathogenic bacteria with resistant serum injected into the blood presented itself to several workers. The idea was followed up and worked out independently in France and Germany, so successfully that by the year 1894 the serum treatment had been tried on a considerable scale with most encouraging results. Some of these were published in Germany in the earlier part of that year, and at the International Hygienic Congress, held in Budapest a little later, Dr Roux, of the Institut Pasteur, whose experience was somewhat more extensive than that of his German colleagues, read a paper giving the result of several hundred cases treated in Paris. When all allowance for errors had been made, they showed a remarkable and even astonishing reduction of mortality, fully confirming the conclusions drawn from the German experiments. This consensus of independent opinion proved a great stimulus to further trial, and before long one *clinique* after another told the same tale. The evidence was so favourable that Professor Virchow—the last man to be carried away by a novelty—declared it "the imperative duty of medical men to use the new remedy" (*The Times*, 19th October 1894). Since then an enormous mass of facts has accumulated from all quarters of the globe, all testifying to the value of antitoxin in the treatment of diphtheria. The experience of the hospitals of the London Metropolitan Asylums Board for five years may be given as a particularly instructive illustration, because it represents a prolonged experiment on an immense scale, and because the mortality was already comparatively low in those hospitals before the use of antitoxin.

*Treatment.*

*Annual Case Mortality in Metropolitan Asylums Board's Hospitals.*

| Before Antitoxin. | | After Antitoxin. | |
|---|---|---|---|
| Year. | Mortality per cent. | Year. | Mortality per cent. |
| 1890 | 33·55 | 1895 | 22·85 |
| 1891 | 30·61 | 1896 | 21·20 |
| 1892 | 29·51 | 1897 | 17·79 |
| 1893 | 30·42 | 1898 | 15·37 |
| 1894 | 29·29 | 1899 | 13·95 |

The number of cases dealt with in the five antitoxin years was 32,835, or an average of 6567 a year, and the broad result is a reduction of mortality by more than one-half. It is a fair inference that the treatment saves the lives of about 1000 children every year in London alone. This refers to all cases. Those which occur in the hospitals as a sequel to scarlet fever, and consequently come under treatment from the commencement, show very much more striking results. The case mortality, which was 46·8 per cent. in 1892 and 58·8 per cent. in 1893, has been reduced to 3·6 per cent. since the introduction of antitoxin. But the evidence is not from statistics alone. The beneficial effect of the treatment is equally attested by clinical observation. Dr Roux's original account has been confirmed by a cloud of witnesses year after year. "One may say," he wrote, "that the appearance of most of the patients is totally different from what it used to be. The pale and leaden faces are scarcely seen in the wards; the expression of the children is brighter and more lively." Adult patients have described the relief afforded by inoculation; it acts like a charm, and lifts the deadly feeling of oppression off like a cloud in the course of a few hours. Finally, the counteracting effect of antitoxin in preventing the disintegrating action of the diphtheritic toxin on the nervous tissues has been demonstrated pathologically. There are some who still affect scepticism as to the value of this drug. They cannot be acquainted with the evidence, for if the efficacy of antitoxin in the treatment of diphtheria has not been proved, then neither can the efficacy of any treatment for anything be said to be proved. Prophylactic properties are also claimed for the serum; but protection is necessarily more difficult to demonstrate than cure, and though there is some evidence to support the claim, it has not been fully made out.

Authorities.—Adams. *Public Health*, vol. vii. — Thorne Thorne. *Milroy Lectures*, 1891. — Newsholme. *Epidemic Diphtheria.*—W. R. Smith. *Harben Lectures*, 1899.— Murphy. *Report to London County Council*, 1894.—Sims Woodhead. *Report to Metropolitan Asylums Board*, 1901. (A. Sl.)

**Dirschau,** a town of Prussia, province of West Prussia, on the left bank of the Vistula, 20 miles south from Danzig and at the junction of important lines of railway. The river is here crossed by two fine iron bridges. The older structure dating from the year 1857, originally used for the railway, is now given up to road traffic, and the railway carried by a new bridge completed in 1891. Dirschau has railway workshops and manufactories of sugar, agricultural implements, and cement. During the war with Poland, Gustavus Adolphus made it his headquarters for many months after its capture in 1626. Population (1885), 11,146; (1900), 12,808.

**Distribution.** See Zoological Distribution.

**District of Columbia.** See Washington, the capital of the United States.

**Dittersbach,** a village of Prussia, prov. Silesia, 3 miles by rail south-east from Waldenburg and 50 miles south-west from Breslau. It has coal-mines, bleachfields, and match factories. Population (1900), 9371.

**Diu,** an island and town of India, belonging to Portugal, and situated at the south extremity of the peninsula of Kathiawar. Area of district, 20 square miles. Population, 13,206. Many of the inhabitants are the well-known Banyan merchants of the East Coast of Africa and Arabia. Native spirits are distilled from the palm, salt is made, and fish caught.

**Dividend,** the net profit periodically divisible among the proprietors of a joint-stock company in proportion to their respective holdings of its capital. Dividend is not interest, although the word dividend is frequently applied to payments of interest; and a failure to pay dividends to shareholders does not, like a failure to pay interest on borrowed money, lay a company open to being declared bankrupt. In bankruptcy a dividend is the proportionate share of the proceeds of the debtor's estate received by a creditor. The Companies Act, 1862, provides that no dividend shall be payable except out of the profits arising from the business of the company, but, in the case of companies incorporated by special Act of Parliament for the construction of railways and other public works which cannot be completed for a considerable time, it is sometimes provided that interest may during construction be paid to the subscribers for shares out of capital. All dividends are payable in cash, while the divi-

dends on the shares of a few American railroad companies are occasionally made payable either in cash or in new shares of the company at the proprietor's option. Most companies divide their capital into at least two classes, called "preference" shares and "ordinary" shares, of which the former are entitled out of the profits of the company to a preferential dividend at a fixed rate, and the latter to whatever remains after payment of the preferential dividend and any fixed charges. Before, however, a dividend is paid, a part of the profits is often carried to a "reserve fund." The dividend on preference shares is either "cumulative" or contingent on the profits of each separate year or half-year. When cumulative, if the profits of any one year are insufficient to pay it in full, the deficiency has to be made good out of subsequent profits. A cumulative preferential dividend is sometimes said to be "guaranteed," and preferential dividends payable by all companies registered under the Companies Acts, 1862 to 1900, are cumulative unless stipulated to be otherwise. Certain public companies are forbidden by Parliament to pay dividends in excess of a prescribed maximum rate, but this restriction has been happily modified in some instances, notably in the case of gas companies, by the institution of a sliding scale, under which a gas company may so regulate the price of gas to be charged to consumers that any reduction of an authorized standard price entitles the company to make a proportionate increase of the authorized dividend, and any increase above the standard price involves a proportionate decrease of dividend. Dividends are usually declared yearly or half-yearly; and before any dividend can be paid it is, as a rule, necessary for the directors to submit to the shareholders, at a general meeting called for the purpose, the accounts of the company, with a report by the directors on its position and their recommendation as to the rate of the proposed dividend. The articles of association of a company usually provide that the shareholders may accept the directors' recommendation as to dividend or may declare a lower one, but may not declare a higher one than the directors recommend. Directors frequently have power to pay on account of the dividend for the year, without consulting the shareholders, an "interim dividend," which on ordinary shares is generally at a much lower rate than the final or regular dividend. An exceptionally high dividend is often distributed in the shape of a dividend at the usual rate supplemented by an additional dividend or "bonus." Payment of dividends is made by means of cheques sent by post, called "dividend warrants." All dividends are subject to income-tax, and by most companies dividends are paid "less income-tax," in which case the tax is deducted from the amount of dividend payable to each proprietor. When paid without such deduction a dividend is said to be "free of income-tax." In the latter case, however, the company has to make provision for payment of the tax before declaring the dividend, and the amount of its divisible profits and the rate of dividend which it is able to declare are consequently to that extent reduced. In respect of consols and certain other securities, holders of amounts of less than £1000 may instruct the Bank of England or Bank of Ireland to receive and invest their dividends. With few exceptions, the prices of securities dealt in on the Stock Exchange include any accruing dividend not paid up to the date of purchase. As soon as a price ceases to include any accruing dividend, it is marked "ex dividend" or "x.d." The expression "cum dividend" is used to signify that the price of the security dealt in includes a dividend which, in the absence of any stipulation, might be supposed to belong to the seller of the security. (S. D. H.)

# DIVORCE.

DIVORCE is the dissolution, in whole or in part, of the tie of marriage. It includes both the complete abrogation of the marriage relation known as a divorce *a vinculo matrimonii*, which carries with it a power on the part of both parties to the marriage to remarry other persons or each other, and also that incomplete severance not involving powers to remarry, which was formerly known as divorce *a mensâ et thoro*, and has in England been termed "judicial separation." Less strictly, divorce is commonly understood to include judicial declarations of nullity of marriage, which, while practically terminating the marriage relation, proceed in law on the basis of the marriage never having been legally established. The conditions under which, in different communities, divorce has at different times been permitted, vary with the aspects in which the relation of marriage has been regarded. When marriage has been deemed to be the acquisition by the husband of property in the wife, or when it has been regarded as a mere agreement between persons capable both to form and to dissolve that contract, we find that marriage has been dissoluble at the will of the husband, or by agreement of the husband and wife. Yet even in these cases the interest of the whole community in the purity of marriage relations, in the pecuniary bearings of this particular contract, and the condition of children, has led to the imposition of restrictions on, and the attachment of conditions to, the termination of the obligations consequent on a marriage legally contracted. But the main restrictions on liberty of divorce have arisen from the conception of marriage entertained by religions, and especially by one religion. Christianity has had no greater practical effect on the life of mankind than in its belief that marriage is no mere civil contract, but a vow in the sight of God binding the parties by obligations of conscience above and beyond those of civil law. Translating this conception into practice, Christianity not only profoundly modified the legal conditions of divorce as formulated in the Roman civil law, but in its own canon law defined its own rule of divorce, going so far as in the Western (at least in its unreformed condition), though not the Eastern, branch of Christendom to forbid all complete divorces, that is to say, all dissolutions of marriage carrying with them the right to remarry.

*The Roman Law of Divorce before Justinian.*—The history of divorce, therefore, practically begins with the law of Rome. It took its earliest colour from that conception of the *patria potestas*, or the power of the head of the family over its members, which enters so deeply into the jurisprudence of ancient Rome. The wife was transferred at marriage to the authority of her husband, *in manus*, and consequently became so far subject to him that he could, at his will, renounce his rule over her, and terminate his companionship, subject at least to an adjustment of the pecuniary rights which were disturbed by such action. So clearly was the power of the husband derived from that of the father, that for a long period a father, in the exercise of his *potestas*, could take his daughter from her husband against the wishes of both. It may be presumed that this power, anomalous as it appears, was not unexercised, as we find that a constitution of Antoninus Pius prohibited a father from disturbing a harmonious union, and Marcus Aurelius afterwards limited this prohibition by allowing the interference of a father for strong

and just cause. *Magnâ et justâ causâ interveniente.* Except in so far as it was restrained by special legislation, the authority of a husband in the matter of divorce was absolute. As early indeed, however, as the time of Romulus, it is said that the State asserted its interest in the permanence of marriage by forbidding the repudiation of wives unless they were guilty of adultery or of drinking wine, on pain of forfeiture of the whole of an offender's property, one-half of which went to the wife, the other to Ceres. But the law of the XII. Tables, in turn, allowed freedom of divorce. It would appear, however, that the sense of the community was so far shocked by the inhumanity of treating a wife as mere property, or the risk of regarding marriage as a mere terminable contract, that, without crystallizing into positive enactment, it operated to prevent the exercise of so harsh and dangerous a power. It is said that for 500 years no husband took advantage of his power, and it was then only by an order of a Censor, however obtained, that Spurius Carvilius Ruga repudiated his wife for barrenness. We may, however, be permitted to doubt the genuineness of this Censorial order, or at least to conjecture the influence under which the Censor was induced to intervene, when we find that in another instance, that of L. Antonius, a Censor punished an unjust divorce by expulsion from the Senate, and that the exercise of their power by husbands increased to a great and alarming extent. Probably few of the admirers of the greatest of Roman orators have not regretted his summary and wholly informal repudiation of Terentia. At last the *lex Julia de adulteriis*, while recognizing a power of divorce both in the husband and in the wife, imposed on it, in the public interest, serious restrictions and consequences. It required a written bill of divorce (*libellus repudii*) to be given in the presence of seven witnesses, who must be Roman citizens of age, and the divorce must be publicly registered. The act was, however, purely an act of the party performing it, and no idea of judicial interference or contract seems to have been entertained. It was not necessary for either husband or wife giving the bill to acquaint the other with it before its execution, though it was considered proper to deliver the bill, when made, to the other party. In this way a wife could divorce a lunatic husband, or the *paterfamilias* of a lunatic wife could divorce her from her husband. But the *lex Julia* was also the first of a series of enactments by which pecuniary consequences were imposed on divorce both by husbands and wives, whether the intention was to restrain divorce by penalties of this nature, or to readjust pecuniary relations settled on the basis of marriage and disturbed by its rupture. It was provided that if the wife was guilty of adultery, her husband in divorcing her could retain one-sixth of her *dos*, but if she had committed a less serious offence, one-eighth. If the husband was guilty of adultery, he had to make immediate restitution of her dowry, or if it consisted of land, the annual proceeds for three years; if he was guilty of a less serious offence, he had six months within which to restore the *dos*. If both parties were in fault, no penalty fell on either. The *lex Julia* was followed by a series of acts of legislation extending and modifying its provisions. The legislation of Constantine, A.D. 331, specified certain causes for which alone a divorce could take place without the imposition of pecuniary penalties. There were three causes for which a wife could divorce her husband with impunity: (1) murder, (2) preparation of poisons, (3) violation of tombs; but if she divorced him for any other cause, such as drunkenness, or gambling, or immoral society, she forfeited her dowry and incurred the further penalty of deportation. There were also three causes for which a husband could divorce his wife without incurring any penalty: (1) adultery, (2) preparation of poisons, (3) acting as a procuress. If he divorced her for any other cause, he forfeited all interest in her dowry; and if he married again, the first wife could take the dowry of the second.

In A.D. 421 the emperors Honorius and Theodosius enacted a law of divorce which introduced limitations on the power of remarriage as an additional penalty in certain cases. As regards a wife: (1) if she divorced her husband for grave reasons or crime, she retained her dowry and could remarry after five years; (2) if she divorced him for criminal conduct or moderate faults, she forfeited her dowry, became incapable of remarriage, and liable to deportation, nor could the emperor's prerogative of pardon be exerted in her favour. As regards a husband: if he divorced his wife (1) for serious crime, he retained the dowry, and could remarry immediately; (2) for criminal conduct, he did not retain the dowry, but could remarry; (3) for mere dislike, he forfeited the property brought into the marriage, and could not remarry.

In A.D. 449 the law of divorce was rendered simpler and certainly more facile by Theodosius and Valentinian. It was provided that a wife could divorce her husband without incurring any penalty if he was convicted of any one of twelve offences: (1) treason, (2) adultery, (3) homicide, (4) poisoning, (5) forgery, (6) violating tombs, (7) stealing from a church, (8) robbery, (9) cattle-stealing, (10) attempting his wife's life, (11) beating his wife, (12) introducing immoral women to his house. If the wife divorced her husband for any other cause, she forfeited her dowry, and could not marry again for five years. A husband could divorce his wife without incurring a penalty for any of these reasons except the last, and also for the following reasons: (1) going to dine with men other than her relations without the knowledge or against the wish of her husband; (2) going from home at night against his wish without reasonable cause; (3) frequenting the circus, theatre, or amphitheatre after being forbidden by her husband. If a husband divorced his wife for any other reason, he forfeited all interest in his wife's dowry, and also any property he brought into the marriage.

The above sketch of the legislation prior to the time of Justinian, while it indicates a desire to place the husband and wife on something like terms of equality as regards divorce, indicates also, by its forbidding remarriage and by its pecuniary provisions in certain cases, a sense in the community of the importance in the public interest of restraining the violation of the contract of marriage. But to the Roman marriage was primarily a contract, and therefore side by side with this legislation there always existed a power of divorce by mutual consent. We must now turn to those principles of the Christian religion which, in combination with the legislation above described, produced the law formulated by Justinian.

*The Christian View of Divorce.*—The Christian law of divorce as enunciated by its Founder was expressed in a few words, but these, unfortunately, by no means of agreed interpretation. To appreciate them it is necessary to consider the enactment of the Mosaic law, which also was expressed in few words, but of a meaning involved in much doubt. The phrase in Deut. xxiv. 1–4, which is translated in the Authorized Version "some uncleanness," but in the Revised Version "some unseemly thing," and which is the only cause stated to justify the giving of a "bill of divorcement," was limited by the school of Shanmai to moral delinquency, but was extended by the rival school of Hillel to causes of trifling importance, or even to motives of caprice. The wider interpretation would seem to be supported by the words of Christ (Matt. v. 31), who, in indicating His own doctrine in contradistinc-

tion to the law of Moses, said, "Whosoever shall put away his wife, saving for the cause of fornication (πορνείας), causeth her to commit adultery; and whosoever shall marry her that is divorced committeth adultery." The meaning of these words of Christ Himself have been involved in controversy, which perhaps was nowhere carried on with greater acuteness or under more critical conditions than within the walls of the British Parliament during the passage of the Divorce Act of 1857. That they justify divorce of a complete kind for moral delinquency of some nature is supported by the opinion probably of every competent scholar. But scholars of eminence have sought to restrict the meaning of the λόγος πορνείας to antenuptial incontinence concealed from the husband, and to exclude adultery. The effect of this view commends itself to the adherents of the Church of Rome, because it places the right to separation between husband and wife, not on a cause supervening after a marriage, which that Church seeks to regard as absolutely indissoluble, but on invalidity in the contract of marriage itself, and which may therefore render the marriage liable to be declared void without impugning its indissoluble character when rightly contracted. The narrower view of the meaning of πορνείας has been maintained by, among others, Dr Döllinger (*First Ages of the Church*, ii. 226); but those who will consider the arguments of Professor Conington in reply to Dr Döllinger (*Contemp. Review*, May 1869) will probably assign the palm to the English scholar. A more general view points in the same direction. It is quite true that under the Mosaic law antenuptial incontinence was, as was also adultery, punishable with death. But when we consider the effect of adultery not only as a moral fault, but as violating the solemn contract of marriage and vitiating its objects, it is inconceivable that Christ, in employing a term of general import, intended to limit it to one kind, and that the less serious, of incontinence.

*Effect of Christianity on the Law of Rome.*—The modification in the civil law of Rome effected by Justinian under the joint influence of the previous law of Rome and that of Christianity was remarkable. Gibbon has summed up the change effected in the law of Rome with characteristic accuracy: "The Christian princes were the first who specified the just causes of a private divorce; their institutions from Constantine to Justinian appear to fluctuate between the customs of the empire and the wishes of the Church; and the author of the Novels too frequently reforms the jurisprudence of the Code and Pandects." Divorce by mutual consent, hitherto, as we have seen, absolutely free, was prohibited (Nov. 117) except in three cases: (1) when the husband was impotent; (2) when either husband or wife desired to enter a monastery; and (3) when either of them was in captivity for a certain length of time. It is obvious that the two first of these exceptions might well commend themselves to the mind of the Church, the former as being rather a matter of nullity of marriage than of divorce, the latter as admitting the paramount claims of the Church on its adherents, and not inconsistent with the spirit of the words of St Paul himself, who clearly contemplated a separation between husband and wife as allowable in case either of them did not hold the Christian faith (1 Cor. vii. 12). At a later period Justinian placed a further restriction or even prohibition on divorce by consent by enacting that spouses dissolving a marriage by mutual consent should forfeit all their property, and be confined for life in a monastery, which was to receive one-third of the forfeited property, the remaining two-thirds going to the children of the marriage. The cause stated for this remarkable alteration of the law, and the abandonment of the conception of marriage as a civil contract *ut non Dei judicium contemnatur* (Nov. 134), indicates the influence of the Christian idea of marriage. That influence, however, did not long continue in its full force. The prohibitions of Justinian on divorce by consent were repealed by Justin (Nov. 140), his successor. "He yielded," says Gibbon, "to the prayers of his unhappy subjects, and restored the liberty of divorce by mutual consent; the civilians were unanimous, the theologians were divided, and the ambiguous word which contains the precept of Christ is flexible to any interpretation that the wisdom of a legislature can demand." It was difficult, the enactment stated, "to reconcile those who once came to hate each other, and who, if compelled to live together, frequently attempted each other's lives."

Justinian further re-enacted, with some modifications, the power of divorce by a husband or wife against the will of the other. Divorce by a wife was allowed in five cases (Nov. 117): (1) the husband being party or privy to conspiracy against the State; (2) attempting his wife's life, or failing to disclose to her plots against it; (3) attempting to induce his wife to commit adultery; (4) accusing his wife falsely of adultery; (5) taking a woman to live in the house with his wife, or, after warning, frequenting a house in the same town with any woman other than his wife. If a wife divorced her husband for one of these reasons, she recovered her dowry and any property brought into the marriage by her husband for life with reversion to her children, or if there were no children, absolutely. But if she divorced him for any other reason, the provisions of the enactment of Theodosius and Valentinian were to apply. A husband was allowed to divorce his wife for any one of seven reasons: (1) failure to disclose to her husband plots against the State; (2) adultery; (3) attempting or failing to disclose plots against her husband's life; (4) frequenting dinners or balls with other men against her husband's wishes; (5) remaining from home against the wishes of her husband, except with her parents; (6) going to the circus, theatre, or amphitheatre without the knowledge or contrary to the prohibition of her husband; (7) procuring abortion. If the husband divorced his wife for any one of these reasons he retained the dowry absolutely, or if there were children, with reversion to them. If he divorced her for any other reason, the enactments of Theodosius and Valentinian applied. In any case of a divorce, if the father or mother of either spouse had advanced the dowry and it would be forfeited by an unreasonable divorce, the consent of the father or mother was necessary to render the divorce valid.

*Effect of Divorce on Children in the Law of Rome.*—The custody of the children of divorced parents was dealt with by the Roman law in a liberal manner. A constitution of Diocletian and Maximian left it to the judge to determine in his discretion to which of the parents the children should go. Justinian enacted that divorce should not impair the rights of children either as to inheritance or maintenance. If a wife divorced her husband for good cause, and she remained unmarried, the children were to be in her custody, but to be maintained by the father; but if the mother was in fault, the father obtained the custody. If he was unable, from want of means, to support them, but she was able to do so, she was obliged to take them and support them. It is interesting to compare these provisions as to children with the practice at present under English law, which in this respect reflects so closely the spirit of the law of Rome.

*The Canon Law of Divorce.*—The canon law of Rome was based on two main principles: (1) That there could be no divorce *a vinculo matrimonii*, but only *a mensâ et thoro*. The rule was stated in the most absolute terms:

"*Quamdiu vivit vir licet adulter sit, licet sodomita, licet flagitiis omnibus coopertus, et ab uxore propter hæc scelera derelictus, maritus ejus reputatur, cui alterum vivum accipere non licet*" (Caus. 32, Quæst. 7, c. 7). (2) That no divorce could be had at the will of the parties, but only by the sentence of a competent, that is to say, an ecclesiastical, court. In this negation of a right to divorce *a vinculo matrimonii* lies the broad difference between the doctrines of the Eastern and Western Churches of Christendom. The Greek Church, understanding the words of Christ in the broader sense above mentioned, has always allowed complete divorce with a right to remarry for the cause of adultery. And it is said that the form at least of an anathema of the Council of Trent was modified out of respect to difference on the part of the Greek Church (see Pothier 5. 6. 21). The papal canon law allowed a divorce *a mensâ et thoro* for six causes: (1) adultery or unnatural offences; (2) impotency; (3) cruelty; (4) infidelity; (5) entering into religion; (6) consanguinity. The Church, however, always assumed to itself the right to grant licenses for an absolute divorce; and further, by claiming the power to declare marriages null and void, though professedly this could be done only in cases where the original contract could be said to be void, it was, and is to this day, undoubtedly extended in practice to cases in which it is impossible to suppose the original contract really void, but in which a complete divorce is on other grounds desirable.

### Divorce in England.

In England the law of divorce, originally based on the canon law of Rome, underwent some, though little, permanent change at the Reformation, but was profoundly modified by the exercise of the power of the State through legislation. From the canon law was derived the principle that divorce could legally take place only by sentence of the court, and never at the will of the parties. Complete divorce has never been governed by any other principle than this; and in so far as an incomplete divorce has become practicable at the will of the parties, it has been by the intervention of civil tribunals and contrary to the law of the ecclesiastical courts. Those courts adopted as ground for divorce *a mensâ et thoro* the main grounds allowed by Roman canon law, adultery and cruelty (Ayliffe, 22; Co. Lit. 102; 1 Salk. 162; Godolphin Abridg. 495). The causes of heresy and of entering with religion, if ever they were recognized in England, ceased to exist at the Reformation.

The principles upon which the English ecclesiastical courts proceeded in divorce *a mensâ et thoro* are those which are still in force, and which (with some modification by statutory enactment) have been administered by judicial tribunals down to the present day. The courts by which the ecclesiastical law, and therefore the law of divorce, was administered were, until 1857, the courts of the various dioceses, including that of the Archbishop of Canterbury, known as the Arches Court, and that of the Archbishop of York, known as the Consistory Court of York; but by statute a suitor was prevented from taking proceedings in any court except that determined by the residence of the person against whom proceedings were taken (23 Hen. VIII. c. 9). From these courts an appeal lay to delegates appointed in each case by the Crown, until the establishment of the Judicial Committee of the Privy Council in 1836, when the appeal was given to the Crown as advised by that body.

The proof of adultery (to which Isydon in his *Book of Etymologies* gives the fanciful derivation of "*ad alterius thorum*") was not by the canon law as received in England restricted by the operation of arbitrary rules. It was never, for example, required, as by the law of Mahomet, that the act should have been actually seen by competent witnesses, nor even that the case should be based on any particular kind of proof. It was recognized that the nature of the offence almost inevitably precluded direct evidence. One rule, however, appears to have commended itself to the framers of the canon law as too general in its application not to be regarded as a principle. The mere confession of the parties was not regarded as a safe ground of conviction; and this rule was formulated by a decretal epistle of Pope Celestine III., and, following it, by the 105th of the Canons of 1604. This rule has now been abrogated; and no doubt it is wiser not to fetter the discretion of the tribunal charged with the responsibility of deciding particular cases, but experience of divorce proceedings tends to confirm the belief that this rule of the canon law was founded on an accurate appreciation of human nature.

Although, therefore, with the above exception, no strict rules of the evidence necessary to establish adultery have ever been established in the English courts, experience has indicated, and in former days judges of the ecclesiastical courts often expressed, the lines upon which such proof may be expected to proceed. It is necessary and sufficient, in general, to prove two things—first the guilty affection towards each other of the persons accused, and, secondly, an opportunity or opportunities on which, if so minded, their passion may have been gratified. It is obvious that any strong proof on either of these points renders strict proof on the other less needful; but when proof on both is afforded, the common sense of a tribunal, acting with a knowledge of human nature, may be trusted to draw the inevitable conclusion.

The definition of cruelty accepted by the ecclesiastical courts as that of the canon law is the same as that which prevails at the present time; and the view of the law taken by the House of Lords in a recent case, by which the subject is now governed (*Russell* v. *Russell*, 1897 App. Cas. 395), was expressly based on the view of cruelty taken by the authorities of the ecclesiastical law. The best definition by our older writers is probably to be found in Clarke's *Praxis* (p. 144): "Si maritus fuerit erga uxorem crudelis et ferax ac mortem comminatus et machinatus fuerit, vel eam inhumaniter verbis et verberibus tractaverit, et aliquando venenum loco potûs paraverit vel aliquod simile commiserit, propter quod sine periculo vitæ cum marito cohabitare aut obsequia conjugalia impendere non audeat . . . consimili etiam causâ competit viro contra mulierem." Lord Stowell, probably the greatest master of the civil and canon law who ever sat in an English court of justice, has in one of his most famous judgments (*Evans* v. *Evans*, 1 *Hagg. Consist.* 35) echoed the above language in words often quoted, which have constituted the standard exposition of the law to the present day. "In the older cases," he said, "of this sort which I have had the opportunity of looking into, I have observed that the danger of life, limb, or health is usually insisted as the ground upon which the court has proceeded to a separation. This doctrine has been repeatedly applied by the court in the cases which have been cited. The court has never been driven off this ground. It has always been jealous of the inconvenience of departing from it, and I have heard no one case cited in which the court has granted a divorce without proof given of a reasonable apprehension of bodily hurt. I say an apprehension, because assuredly the court is not to wait till the hurt is actually done; but the apprehension must be reasonable: it must not be an apprehension arising from an exquisite and diseased sensibility of mind. Petty vexations applied to such a constitution of mind may certainly in time wear out the animal machine, but still

they are not cases of legal relief; people must relieve themselves as well as they can by prudent resistance, by calling in the succours of religion and the consolation of friends; but the aid of courts is not to be resorted to in such cases with any effect." The risk of personal danger in cohabitation constituted, therefore, the foundation of legal cruelty. But this does not exclude such conduct as a course of persistent ill-treatment, though not amounting to personal violence, especially if such ill-treatment has in fact caused injury to health. But the person complaining must not be the author of his or her own wrong. If, accordingly, one of the spouses by his or her conduct is really the cause of the conduct complained of, recourse to the court would be had in vain, the true remedy lying in a reformation of the real cause of the disagreement.

In addition to a denial of the charge or charges, the canon law allowed three grounds of answer: (1) *Compensatio criminis*, a set-off of equal guilt or recrimination. This principle is no doubt derived from the Roman law, and it had the effect of refusing to one guilty spouse the remedy of divorce against the other although equally guilty. It was always accepted in England, although not in other countries, such as France and Scotland, which also followed the canon or civil law. In strictness, recrimination applied to a similar offence having been committed by the party charging that offence. But a recent decision of the English courts shows that a wife who had committed adultery could not bring a suit against her husband for cruelty (*Otway* v. *Otway*, 13 P. D. 141). (2) *Condonation*. If the complaining spouse has, in fact, forgiven the offence complained of, that constitutes a conditional bar to any proceedings. The main and usual evidence of such forgiveness is constituted by a renewal of marital intercourse, and it is difficult—perhaps impossible—to imagine any case in which such intercourse would not be held to establish condonation. But condonation may be proved by other acts, or by words, having regard to the circumstances of each case. Condonation is, however, always presumed to be conditional on future good behaviour, and misconduct even of a different kind revives the former offence. (3) *Connivance* constitutes a complete answer to any charge. Nor need the husband be the active agent of the misconduct of the wife. Indifference or neglect imputable to a corrupt intention are sufficient. It will be seen presently that modern statute law has gone further in this direction. It is to be added that the connivance need not be of the very act complained of, but may be of an act of a similar kind. A learned judge, recalling the classical anecdote of Mæcenas and Galba, said, "A husband is not permitted to say *non omnibus dormio.*" The ecclesiastical courts also considered themselves bound to refuse relief if there was shown to be *collusion* between the parties. In its primary and most general sense collusion was understood to be an agreement between the parties for the purpose of deceiving the court by false or fictitious evidence; for example, an agreement to commit, or appear to commit, an act of adultery. Collusion, however, is not limited to the imposing of other than genuine evidence on the court. It extends to an agreement to withhold any material evidence; and indeed is carried farther, and held to extend to any agreement which may have the effect of concealing the real and complete truth from the court (see *Churchward* v. *Churchward*, 1894, P. 161). This doctrine was of considerable importance even in the days when only divorces *a mensâ et thoro* were granted, because at that time the parties were not permitted to separate by consent. At the present day it has become, with regard to divorce *a vinculo matrimonii*, a rule of greater and of more far-reaching importance.

The canon law as accepted in England, while allowing divorces of the nature and for the causes above mentioned, actively interfered to prevent separation between husband and wife in any other manner. A suit known as a suit for restitution of conjugal rights could be brought to compel cohabitation; and on evidence of the desertion of either spouse, the court ordered a return to the matrimonial home, though it carried no further its authority as to the matrimonial relations within the home. To this suit an agreement between the parties constituted no answer. But an answer was afforded by any conduct which would have supported a decree of divorce *a mensâ et thoro*. It is a question whether, indeed, the ecclesiastical courts would not have gone farther, and refused a decree of restitution of conjugal rights on grounds which might appear adequate to justify such refusal, though not sufficient on which to ground a decree of divorce. Recently the view of the Court of Appeal and the House of Lords has given some colour to this opinion, and certainly the Court of Appeal has held, although perhaps somewhat hastily, that the effect of a modern statute has been to allow the court to refuse restitution of conjugal rights for causes falling short of what would constitute ground for divorce (*Russell* v. *Russell*, 1895, p. 315).

The ecclesiastical courts provided for the pecuniary rights of the wife by granting to her alimony during the progress of the suit, and a proper allowance after its termination in cases in which she was successful. Such payments were dependent on the pecuniary means, or *faculties*, as they were termed, of the husband, and were subject to subsequent increase or diminution in proper cases. But the ecclesiastical courts did not deal with the custody of the children of the marriage, it being probably considered that that matter could be determined by the common law rights of the father, or by the intervention of the Court of Chancery.

The canon law fixed no period of limitation, either in respect of a suit for divorce or for restitution of conjugal rights; but, as regards at least suits for divorce, any substantial delay might lead to the imputation of acquiescence or even condonation. To that extent, at least, the maxim *vigilantibus non dormientibus jura subveniunt* applied.

It is remarkable that desertion by either party to a marriage, except as giving rise to a suit for restitution, was not treated as an offence by canon law in England. It formed no ground for a suit for divorce, and constituted no answer to such a suit by way of recrimination. It might indeed deprive a husband of his remedy if it amounted to connivance, or perhaps even if it amounted only to culpable neglect.

The canon law, as administered in England, has kept clear the logical distinction which exists between dissolving a marriage and declaring it null and void. The result has been that, in England at least, the two proceedings have never been allowed to pass into one another, and a complete divorce has not been granted on pretence of a cause really one for declaring the marriage void *ab initio*. But for certain causes the courts were prepared to declare a marriage null and void on the suit of either party. There is, indeed, a distinction to be drawn between a marriage void or only voidable, though in both cases it became the subject of a similar declaration. It was void in the cases of incapacity of the parties to contract it, arising from want of proper age, or consanguinity, or from a previous marriage, or from absence of consent, a state of things which would arise if the marriage were compelled by force or induced by fraud as to the nature of the contract entered into or the personality of the parties. It is to be remarked that, in England at least, the idea of fraud as

connected with the solemnization of marriage has been kept within these narrow limits. Fraud of a different kind, such as deception as to the property or position of the husband or wife, or antecedent impurity of the wife, even if resulting in a concealed pregnancy, has not in England (though the last-mentioned cause has in other countries) been held a ground for the vitiation of a marriage contract. A marriage was voidable, and could be declared void, on the ground of physical incapacity of either spouse, the absence of intercourse between the parties after a sufficient period of opportunity being almost, if not quite, conclusive on this subject.

With regard to one cause of nullity the legislation interfered from consideration, it is said, of a case of special hardship. Before an Act of 1835 (5 & 6 Will. IV. c. 54) marriages within the prohibited degrees of consanguinity and affinity were only voidable by a decree of the court, and remained valid unless challenged during the lifetime of both the parties. But this Act, while providing that no previous marriage between persons within the prohibited degrees should be annulled by a decree of the ecclesiastical court pronounced in a suit depending at the time of the passing of the Act, went on to render all such marriages thereafter contracted in England "absolutely null and void to all interests and purposes whatever."

Another suit was allowed by the ecclesiastical courts which should be mentioned, although its bearing on divorce is indirect. This was the suit for *jactitation of marriage*, which in the case of any person falsely asserting his or her marriage to another, allowed such person to be put to perpetual silence by an order of the court. This suit, which has been of rare occurrence, although an instance of it has recently been known, does not appear to have been used for the purpose of determining the validity of a marriage. The legislature has, however, in the Legitimacy Declaration Act of 1858, provided a ready means by which the validity of marriages and the legitimacy of children can be determined, and the procedure provided has repeatedly been utilized.

It should be added, as a matter closely akin to the proceedings in the ecclesiastical courts, that the common law took cognizance of one phase of matrimonial relations by allowing an action by the husband against a paramour, known as an action for criminal conversation. In such an action a husband could recover damages estimated according to the loss he was supposed to have sustained by the seduction and loss of his wife, the punishment of the seducer not being altogether excluded from consideration. Although this action was not unfrequently (and indeed, for the purposes of a divorce, necessarily) brought, it was one which naturally was regarded with disfavour.

*Effect of the Reformation.*—Great as was the indirect effect of the Reformation upon the law of divorce in England, the direct effect was small. It might, indeed, have been supposed that the disappearance of the sacramental idea of marriage entertained by the Roman Church would have ushered in the greater freedom of divorce which had been associated with marriage regarded as a civil contract. And to some extent this was the case. It was for some time supposed that the sentences of divorce pronounced by the ecclesiastical courts acquired the effect of allowing remarriage, and such divorces were in some cases granted. In *Lord Northampton's* case in the reign of Edward VI. the delegates pronounced in favour of a second marriage after a divorce *a mensâ et thoro*. It was, however, finally decided in *Foljambe's* case, in the 44th year of Elizabeth, that a marriage validly contracted could not be dissolved for any cause. But the growing sense of the right to a complete divorce for adequate cause, when no longer any religious law to the contrary could be validly asserted, in time compelled the discovery of a remedy. The commission appointed by Henry VIII. and Edward VI. to reform the ecclesiastical law drew up the elaborate report known as the *Reformatio Legum*, and in this they recommended that divorces *a mensâ et thoro* should be abolished, and in their place complete divorce allowed for the causes of adultery, desertion, and cruelty. These proposals, however, never became law. In 1669 a private Act of Parliament was granted in the case of Lord de Roos, and this was followed by another in the case of the Duke of Norfolk in 1692. Such Acts were, however, rare until the accession of the House of Hanover, only five Acts passing before that period. Afterwards their number considerably increased. Between 1715 and 1775 there were sixty such Acts, in the next twenty-five years there were seventy-four, and between 1800 and 1850 there were ninety. In 1829 alone there were seven, and in 1830 nine.

The jurisdiction thus assumed by Parliament to grant absolute divorces was exercised with great care. The case was fully investigated before a committee of the House of Lords, and not only was the substance of justice so secured, but the House of Lords further required that application to Parliament should be preceded by a successful suit in the ecclesiastical courts resulting in a decree of divorce *a mensâ et thoro*, and in the case of a husband being the applicant, a successful action at common law and the recovery of damages against the paramour. In this way, and also, if needful, on its own initiative, the House of Lords provided that there should be no connivance or collusion. Care was also taken that a proper allowance was secured to the wife in cases in which she was not the offending party. This procedure is still pursued in the case of Irish divorces.

It is obvious, however, that the necessity for costly proceedings before the Houses of Parliament imposed great hardship on the mass of the population, and there can be little doubt that this hardship was deeply felt. Repeated proposals were made to Parliament with a view to reform of the law, and more than one commission reported on the subject. It is said that the final impetus was given by an address to a prisoner by Mr Justice Maule. The prisoner's wife had deserted him with her paramour, and he married again during her lifetime. He was indicted for bigamy, and convicted, and Mr Justice Maule sentenced him in the following words:—"Prisoner at the bar: You have been convicted of the offence of bigamy, that is to say, of marrying a woman while you had a wife still alive, though it is true she has deserted you and is living in adultery with another man. You have, therefore, committed a crime against the laws of your country, and you have also acted under a very serious misapprehension of the course which you ought to have pursued. You should have gone to the ecclesiastical court and there obtained against your wife a decree *a mensâ et thoro*. You should then have brought an action in the courts of common law and recovered, as no doubt you would have recovered, damages against your wife's paramour. Armed with these decrees, you should have approached the legislature and obtained an Act of Parliament which would have rendered you free and legally competent to marry the person whom you have taken on yourself to marry with no such sanction. It is quite true that these proceedings would have cost you many hundreds of pounds, whereas you probably have not as many pence. But the law knows no distinction between rich and poor. The sentence of the court upon you, therefore, is that you be imprisoned for one day, which period has already been exceeded, as you have been in custody since the commencement of the assizes." The grave irony of the learned judge was felt to

represent truly a state of things well-nigh intolerable, and a reform in the law of divorce was felt to be inevitable. The hour and the man came in 1857, the man in the person of Sir Richard Bethell, then Attorney-General.

*The Act of 1857.*—Probably few measures have been conceived with such consummate skill and knowledge, and few conducted through Parliament with such dexterity and determination. The leading opponent of the measure was Mr Gladstone, backed by the zeal of the High Church party and inspired by his own matchless subtlety and resource. But the contest proved to be unequal, and after debates in which every line, almost every word, of the measure was hotly contested, especially in the House of Commons, the measure emerged substantially as it had been introduced. Not the least part of the merit and success of the Act of 1857 is due to the skill which while effecting a great social change, did so with the smallest possible amount of innovation. The Act embodied two main principles: 1. The constitution of a lay court for the administration of all matters connected with divorce. 2. The transfer to that court, with as little change as possible, of the powers exercised in matrimonial matters by (*a*) the House of Lords, (*b*) the ecclesiastical courts, (*c*) the courts of common law.

*The Constitution of the Court.*—The new court, termed "The Court for Divorce and Matrimonial Causes," was constituted by the Lord Chancellor, the chiefs and the senior puisne judges of the three courts of common law, and the judge of the Court of Probate (which was also established in 1857), but the functions of the court were practically entrusted to the judge of the Court of Probate, termed the "Judge Ordinary," who thus in matters of probate and divorce became the representative of the former ecclesiastical jurisdiction. The Judge Ordinary was empowered either to sit alone or with one or more of the other judges to constitute a full court. The parties to a suit obtained the right of trial by jury of all disputed questions of fact; and the rules of evidence of the common law courts were made to apply. An appeal to the full court was given in all matters, which the Judge Ordinary was enabled to hear sitting alone.

1. To this court was transferred all the powers of the ecclesiastical courts with regard to suits for divorce *a mensâ et thoro*, to which the name was given of suits for "judicial separation," nullity, restitution of conjugal rights, and jactitation of marriage, and in all such proceedings it was expressly enacted (sec. 22) that the court should act on principles and rules as nearly as possible conformable to the principles and rules of the ecclesiastical courts. Judicial separation could be obtained by either husband or wife for adultery, or cruelty, or desertion continued for two or more years.

2. There were also transferred to the court powers equivalent to those exercised by the legislature in granting absolute divorce. The husband could obtain a divorce for adultery, the wife could obtain a divore for adultery coupled with cruelty or desertion for two or more years, and also for incestuous or bigamous adultery, or rape, or unnatural offences. The same conditions as had been required by the legislature were insisted on. A petition for dissolution (sec. 30) was to be dismissed in case of connivance, condonation, or collusion; and further, the court had power, though it was not compelled, to dismiss such petition if the petitioner had been guilty of adultery, or if there had been unreasonable delay in presenting or prosecuting the petition, or if the petitioner had been guilty of cruelty or desertion without reasonable excuse, or of wilful neglect or misconduct conducing to the adultery. The exercise of these discretionary powers of the court, just and valuable as they undoubtedly are, has been attended with some difficulty. But the view of the legislature has on the whole been understood to be that the adultery of a petitioner should not constitute a bar to his or her proceeding, if it has been caused by the misconduct of the respondent, and that cruelty should not constitute such a bar unless it has caused or contributed to the misconduct of the respondent. But the court, while regarding its powers as these of a judicial and not an arbitrary discretion, has declined to fetter itself by any fixed rule of interpretation or practice.

It is to be observed that this Act assigned a new force to desertion. The ecclesiastical law regarded it only as suggestive of connivance or culpable neglect. But the Act of 1857 made it (1) a ground of judicial separation if continued for two years, (2) a ground in part of dissolution of marriage if continued for the same period, (3) a bar, in the discretion of the Court, to a petition for dissolution, though it was not made in a similar way any bar to a suit for judicial separation. It is also to be observed that the Act was confined to causes of divorce recognized by the ecclesiastical law as administered in England. It did not either extend the causes of a suit for nullity by adding such grounds as antenuptial incontinence, even if accompanied with pregnancy, nor did it borrow from the civil law of Rome either lunacy or crime as grounds for divorce.

Much comment has been made on the different grounds on which divorce is allowed to a husband and to a wife,—it being necessary to prove infidelity in both cases, but a wife being compelled to show either an aggravation of that offence or an addition to it. Opinions probably will always differ whether the two sexes should be placed on an equality in this respect, abstract justice being invoked, and the idea of marriage as a mere contract pointing in one direction, and social considerations in the other. But the reason of the legislature for making the distinction is clear. It is that the wife is entitled to an absolute divorce only if her reconciliation with her husband is neither to be expected nor desired. This was no doubt the view taken by the House of Lords. In 1801 a Mrs Addison claimed an absolute divorce on the ground of her husband's incest with her sister. The matter was long debated, but Lord Thurlow, who appeared in the House of Lords for the last time in order to support the Bill, turned the scale by arguing that it was improper that the wife should under such circumstances return to her husband (see Campbell, *Lives of the Chancellors*, vii. 145). "Why do you," he said, "grant to the husband a divorce for the adultery of the wife? Because he ought not to forgive her, and separation is inevitable. Where the wife cannot forgive, and separation is inevitable by reason of the crime of the husband, the wife is entitled to the like remedy."

The Act (sec. 32) provided, in case of dissolution, for maintenance of the wife by the husband on principles similar to those recognized by the ecclesiastical courts, and (sec. 45) for the settlement of the property of a guilty wife on her husband or children; but this enactment was imperfect, as provision was made only for a settlement and not for payment of an allowance, and none was made for altering settlements made in view or in consequence of a marriage. The Act (sec. 35) provides also in all divorce proceedings, and also in those of nullity, for provision for the custody, maintenance, and education of children by the court: provisions of great value, which were unfortunately for some time limited by an erroneous view of the court that the age of the children to which such provisions applied should be considered limited to sixteen. The Act of 1857 also transferred to the new court the powers exercised by the common law courts in the action for

criminal conversation. It was made obligatory to join an alleged adulterer in the suit, and damages (sec. 33) might be claimed against him, and he might be ordered to pay the costs of the proceedings (sec. 34). The latter provision, however, has been considerably curtailed by a recent decision of the Court of Appeal.

The Act of 1857 in one respect went beyond a transfer of the powers exercised by the ecclesiastical courts or the legislature. It provided (sec. 21) that a wife deserted by her husband might apply to a magistrate in petty sessions and obtain an order which had the effect of protecting her earnings and property, and during the currency of such order of protection a wife was to be in the same position as if she had obtained an order for judicial separation. The effect of this section appears to have been small; but further legislation in 1895 has afforded a cheap and speedy remedy to all classes of the community.

The framers of the Act of 1857 were careful to avoid offending the scruples of clergymen who disapproved of the complete dissolution of marriage by a lay court. It was provided (secs. 57 and 58) that no clergyman should be compelled to solemnize the marriage of any person whose former marriage had been dissolved on the ground of his or her adultery, but should permit any other clergyman to solemnize the marriage in any church or chapel in which the parties were entitled to be married. It is to be feared that this concession, ample as it appears, has not allayed conscientious objections, which are perhaps from their nature insuperable. The Act made no provision as to the name to be borne by a wife after a divorce; and this omission has led to litigation in the case of a peer's wife.

*Modifications of the Act of 1857.*—Subsequent legislation has made good many of the defects of the Act of 1857. In 1859 power was given to the court, after a decree of dissolution or of nullity of marriage, to inquire into the existence of ante- and post-nuptial settlements, and to make orders with respect to the property settled either for the benefit of children of the marriage or their parents; and a subsequent Act (41 & 42 Vict. c. 19, s. 3) removed a doubt which was entertained whether these powers could be exercised if there were no children of the marriage. In 1860 a very important change was made, having for its object a practical mode of preventing divorces in cases of connivance and collusion or of misconduct of the petitioner. It was provided that a claim of dissolution (a provision afterwards extended to decrees of nullity) should in the first instance be a decree *nisi*, which should not be made absolute until the expiration of a period then fixed at not less than three, but by subsequent legislation enlarged to not less than six, months. During the interval which elapsed between the decree *nisi* and such decree being made absolute, power was given to any person to intervene in the suit and show cause why the decree should not be made absolute, by reason of the same having been obtained by collusion, or by reason of material facts not brought before the court; and it was also provided that, at any time before the decree was made absolute, the Queen's Proctor, if led to suspect that the parties were acting in collusion for the purpose of obtaining a divorce contrary to the justice of the case, might under the direction of the Attorney-General intervene and allege such case of collusion. This enactment (extended in the year 1873 to suits for nullity) was ill drawn and unskilfully conceived. The power given to any person whomsoever to intervene is no doubt too wide, and practically has had little or no useful effect as employed by friends or enemies of parties to a suit. The limitation in terms of the express power of the Queen's Proctor to intervene to cases of collusion was undoubtedly too narrow. But the Queen's Proctor, or the official by whom that officer was afterwards represented, has in practice availed himself of the general authority given to any person to show cause why a decree *nisi* should not be made absolute, and has thus been enabled to render such important service to the administration of justice that it is difficult to imagine the due execution of the law of divorce by a court without such assistance. In 1866 power was given to the court to order an allowance to be paid by a guilty husband to a wife on a dissolution of marriage. This Act also can hardly be considered to have been drawn with sufficient care, inasmuch as while it provides that if the husband's means diminish, the allowance may be diminished or suspended, it makes no corresponding provision for increase of the allowance if the husband's means increase; nor, apparently, does it permit of an allowance in addition to, but only in substitution for, a settlement. The Act makes no provision for allowance to a guilty wife, and it certainly is a serious defect that the power to grant an allowance does not extend to cases of nullity. In 1868 an appeal to the House of Lords was given in cases of decree for dissolution or nullity of marriage.

The great changes effected by the Judicature Acts included the Court for Divorce and Matrimonial Causes. Under their operation a division of the High Court of Justice was constituted, under the designation of the Probate Division and Admiralty Division, to which was assigned that class of legal administration governed mainly by the principles and practice of the canon and civil law. The division consists of a President, and a Justice of the High Court, with registrars representing each branch of the jurisdiction. Appeals lie to the Court of Appeal, and thence to the House of Lords.

In 1884 the legislature interfered to prevent imprisonment being the result of disobedience to an order for restitution of conjugal rights. That mode of enforcing the order of the court was abolished, and the matter was left to a proper adjustment of the pecuniary relations of the husband and wife; and a respondent disobeying such an order was held to be guilty of desertion without reasonable cause, such desertion having further given to it a similar effect to that assigned to desertion for two years or upwards. The effect of this provision has been that the suit for restitution of conjugal rights is most frequently brought for the purpose of shortening the time within which a wife can obtain a decree for dissolution of marriage.

Proceedings in the Divorce Court have shown the improvement in the law of evidence which has been effected with regard to other legal proceedings. The Act of 1857 made an inroad on the former law, which prohibited evidence being given by parties interested in the proceedings, by allowing a petitioner (sec. 43) to be called and examined by order of the court, absolving such petitioner, however, from the necessity of answering any question tending to show that he or she had been guilty of adultery. In the next year power was given to the court to dismiss any person, with whom a party to the suit was alleged to have committed adultery, from the suit if there should not appear to be sufficient evidence against him or her, the object being to allow such person to give evidence; and in 1859 it was provided that, on a petition by a wife for a divorce on the grounds of cruelty or desertion with adultery, the husband and wife were rendered competent and compellable witnesses as to the cruelty or desertion. A few years later, however, in 1869, the subject was finally dealt with by repealing all previous rules which limited the powers to give evidence on questions of adultery, with the safeguard that no witness in any proceeding can be asked or bound to

answer any question tending to show that he or she has been guilty of adultery, unless in the same proceeding such witness shall have given evidence in disproof of his or her alleged adultery. It has been held that the principles of these enactments apply to interrogatories as well as to evidence given in court.

It is a most remarkable omission in the Act of 1857, especially when we remember the high legal authority from whom it proceeded, that the Act nowhere defines the class of persons with regard to whom the jurisdiction of the court should be exercised. This omission has given rise to a misapprehension of the law which, though now set at rest, prevailed for a considerable period, and has undoubtedly led to the granting of divorce in several cases in which it could not legally be given. It was supposed that the court could grant a dissolution of marriage to all persons who had anything more than a casual and fleeting residence within the jurisdiction of the court; and this view, although its correctness was doubted by Lord Penzance, the judge of the Divorce Court, was upheld by a majority of the judges of the Court of Appeal in the case of *Niboyet* v. *Niboyet* (4 P. D. 1). It was supposed that such residence gave what was termed a matrimonial domicile. But this view was undoubtedly erroneous as regards dissolution of marriage, although probably correct as regards judicial separation, and the true view is no doubt that indicated with great learning and ability by Lord Watson in a judgment given by him in the Privy Council in the case of *Le Mesurier* v. *Le Mesurier* (1895, App. Cas. 517), that the only true test of jurisdiction for a decree of divorce altering the status of the parties to a marriage is to be found in the domicile of the spouses—that is to say, of the husband, as the domicile of a wife follows that of her husband—at the time of the divorce. The legal definition of domicile is the subject of elaborate rules. It is sufficient to say here that domicile means a person's permanent home, the place at which he resides, with no intention of making his home elsewhere, and if he leaves it, with the intention of returning to it.

It is now also clearly recognized as the law of England that the English courts will not recognize a divorce purporting to be made by a foreign tribunal with regard to persons domiciled in England. For a considerable time doubt appears to have clouded the law on this subject. In a famous case known as *Lolley's* case, decided in 1812, the judges of England (the point arose in connexion with a criminal charge) unanimously held "that no sentence or act of any foreign country or any state could dissolve an English marriage *a vinculo matrimonii* for grounds on which it was not liable to be dissolved *a vinculo matrimonii* in England." This case has been frequently understood as deciding that a marriage celebrated in England cannot be dissolved elsewhere, and on this point the courts of Scotland differ from the view supposed to be taken by the English judges. But the matter has been fully explained in one of the most masterly of Lord Hannen's judgments (*Harvey* v. *Fairnie*, 5 P. D. 154), afterwards upheld by the House of Lords in 1882 (8 App. Cas. 43); and it is now clear that while the parties are domiciled in this country no decree of any foreign court dissolving their marriage will be recognized here, unless it proceed on the grounds on which a divorce may be obtained in this country, and even the exception just mentioned appears to rest rather on reasoning and principle than on the authority of any decided case. This principle has received the highest sanction in a recent prosecution of Earl Russell for bigamy before the House of Lords.

*Summary Proceedings for Separation.*—The legislature has sought to extend the relief afforded by the courts in matrimonial causes by a procedure fairly to be considered within the reach of all classes. In 1895 an Act was passed which re-enacted in an improved form the provisions of an Act of 1878 of similar effect. By the Act of 1895 power was given to a married woman whose husband (1) has been guilty of an aggravated assault upon her within the Offences against the Person Act, 1861, or (2) convicted on indictment of an assault on her and sentenced to pay a fine of more than £5 or to imprisonment for more than two months, or (3) shall have deserted her, or (4) been guilty of persistent cruelty to her or wilful neglect to maintain her or her infant children, and by such cruelty or neglect shall have caused her to leave and live apart from him, to apply to a court of summary jurisdiction and to obtain an order containing all or any of the following provisions: (1) that the applicant be not forced to cohabit with her husband, (2) that the applicant have the custody of any children under sixteen years of age, (3) that the husband pay to her an allowance not exceeding £2 a week. The Act provides that no married woman guilty of adultery should be granted relief, but with the very important proviso, altering as it does the rule of the common law, that the husband has not conduced or connived at, or by wilful neglect or misconduct conduced to, such adultery. The provisions of this Act have been largely put in force, and no doubt to the great advantage of the poorer classes of the community. It will be observed that the Act is unilateral, and affords no relief to a husband against a wife; and the complaint is often heard that no misconduct of the wife, except adultery, relieves the husband from the necessity of maintaining her and allowing her to share his home, unless he can obtain access to the High Court.

*Separation Deeds.*—Although nothing in the development of the law of divorce has tended to give to married persons the right absolutely to dissolve their marriage by consent, and, on the contrary, any such agreement would be held to be strong evidence of collusion, the view of the Church expressed in the ecclesiastical law has been entirely departed from as regards agreements for separation. Such agreements were embodied in deeds, and usually contained mutual covenants not to sue in the ecclesiastical courts for restitution of conjugal rights. The ecclesiastical courts, however, wholly disregarded such agreements, and considered them as affording no answer to a suit for restitution of conjugal rights. For a considerable period the Court of Chancery refused to enforce the covenant in such deeds by restraining the parties from proceeding to the ecclesiastical courts. But at last a memorable judgment of Lord Westbury asserted the right (*Hunt* v. *Hunt*, 4 De G. F. & J. 221; see also *Marshall* v. *Marshall*, 5 P. D. 19) of the Court of Chancery to maintain the claim of good faith in this as in other cases, and restrained a petitioner from suing in the ecclesiastical court contrary to his covenant. Thereafter these deeds became common, and no doubt often afford a solution of matrimonial difficulties of very great value. When the courts of the country became united under the Judicature Acts, it became practicable to set up in the Divorce Division a separation deed in answer to a suit for restitution of conjugal rights without the necessity of recourse to any other tribunal.

*Statistics.*—The statistics of divorce in England have for some years been regularly published in the volumes of judicial statistics published annually by the Home Office—that published in 1901 bringing the figures down to 1899.

The number of petitions for divorce (including in the term both divorce *a mensâ et thoro* and divorce *a*

*vinculo*) for the years from 1858 to 1899 inclusive are as follows:—

| | | | | | |
|---|---|---|---|---|---|
| 1858 | 326 | 1872 | 374 | 1886 | 708 |
| 1859 | 291 | 1873 | 416 | 1887 | 662 |
| 1860 | 272 | 1874 | 469 | 1888 | 680 |
| 1861 | 236 | 1875 | 451 | 1889 | 654 |
| 1862 | 248 | 1876 | 536 | 1890 | 644 |
| 1863 | 298 | 1877 | 551 | 1891 | 632 |
| 1864 | 297 | 1878 | 632 | 1892 | 629 |
| 1865 | 284 | 1879 | 555 | 1893 | 645 |
| 1866 | 279 | 1880 | 615 | 1894 | 652 |
| 1867 | 294 | 1881 | 589 | 1895 | 683 |
| 1868 | 303 | 1882 | 481 | 1896 | 772 |
| 1869 | 351 | 1883 | 561 | 1897 | 781 |
| 1870 | 351 | 1884 | 647 | 1898 | 750 |
| 1871 | 384 | 1885 | 541 | 1899 | 727 |

It is probably impossible to account for the variations which the above table discloses. It was no doubt natural that the year immediately succeeding the passing of the Act which originated facilities for divorces *a vinculo* should exhibit a larger number of divorces than its successors for a considerable period. But there does not appear to be any adequate cause for the comparative increase which seems to have prevailed in the decade between 1878 and 1888, unless it be found in the increase of marriages which culminated in 1873 and 1883, falling after each of those years. The number of marriages again rose high in 1891 and 1892, and this may account for the increased number of divorces in 1896 and the following years. But it may certainly be said with confidence that as compared with the growth of population the number of divorces in England, especially in recent years, shows no alarming increase.

The total number of petitions in matrimonial causes presented by husbands exceed those presented by wives, but in no marked degree. This excess would seem to be due to the fact that the larger number of petitions for dissolution presented by husbands, owing no doubt to the difference in the law affecting the two sexes, is not entirely counterbalanced by the much larger number of petitions for judicial separation presented by wives. The following figures for the years 1895 to 1899 inclusive may be taken as typical:—

| | 1895. | 1896. | 1897. | 1898. | 1899. |
|---|---|---|---|---|---|
| Petitions for Dissolution— | | | | | |
| Presented by husbands | 353 | 393 | 414 | 401 | 383 |
| Presented by wives | 220 | 280 | 269 | 243 | 262 |
| Petitions for Judicial Separation— | | | | | |
| Presented by husbands | 4 | 3 | 2 | 4 | 4 |
| Presented by wives | 106 | 96 | 96 | 102 | 78 |
| Total: Presented by husbands | 357 | 396 | 416 | 405 | 387 |
| Presented by wives | 326 | 376 | 365 | 345 | 340 |

Speaking generally, it may be said that about 70 per cent. of the petitions presented are successful and result in decrees. This percentage has tended to rise in recent years.

Attempts have been made to ascertain the classes which supply the petitioners for divorce, but this cannot be done with such certainty as to warrant any but the most general conclusions. It may, however, safely be said that while all classes, professions, and occupations are represented, it is certainly not those highest in the scale that are the largest contributors. The principles of the Act of 1857 have beyond question been justified by the relief required by and afforded to the poorer members of the community.

### Other European Countries.

We may now turn to the law of divorce as administered in the other countries of the modern world. On the main question whether marriage is to be considered indissoluble they will be found to range themselves on one side or the other according to the influence upon them of the Church of Rome and its canon law.

In *Scotland* it has long been the law that marriage can be dissolved at the instance of either party by judicial sentence on the grounds of adultery or of desertion, termed non-adherence, and the spouses could in such case remarry, except with the person with whom the adultery was committed. A divorce *a mensâ et thoro* could also be granted for cruelty. By an Act of Parliament (11 Geo. IV. and 1 Will. IV. c. 69) the jurisdiction in divorce was transferred from a body of commissaries to the Court of Session.

By the law of *Holland* complete divorce could be granted by judicial sentence on the grounds of adultery or of wilful and malicious desertion, to which were added unnatural offences and imprisonment for life, and such divorce gave the power of remarriage, except with the person with whom adultery was proved to have been committed, but there would seem to be a doubt whether this power extended to the guilty party (Voet, *de Divortiis*, lit. 24 tit. 2). Divorce *a mensâ et thoro* could be granted on the grounds allowed by the canon law.

The Code of *Prussia* of 1794 contained elaborate provisions which gave great facility of divorce. A complete divorce could be obtained by judicial sentence for the following causes: (1) Adultery or unnatural offences; and adultery by a husband formed no bar to his obtaining a divorce against his wife for adultery; and even an illicit intimacy, from which a presumption of adultery might arise, was held sufficient for a divorce. (2) Wilful desertion. (3) Obstinate refusal of the rights of marriage, which was considered as equivalent to desertion. (4) Incapacity to perform the duties of marriage, even if arising subsequent to the marriage; and the same effect was assigned to other incurable bodily defects that excited disgust and horror. (5) Lunacy, if after a year there was no reasonable hope of recovery. (6) An attempt on the life of one spouse by the other, or gross and unlawful attack on the honour or personal liberty. (7) Incompatibility of temper and quarrelsome disposition, if rising to the height of endangering life or health. (8) Opprobrious crime for which either spouse has suffered imprisonment, or a knowingly false accusation of such crime by one spouse of the other. (9) If either spouse by unlawful transactions endangers the life, honour, office, or trade of the other, or commences an ignominious employment. (10) Change of religion. In addition to these causes, marriages, when there were no children, could be dissolved by mutual consent if there be no reason to suspect levity, precipitation, or compulsion; and a judge had also power to dissolve a marriage in cases in which a strongly-rooted dislike appeared to him to exist. In all cases of divorce, but sometimes subject to the necessity of obtaining a license, remarriage was permissible (see Burge, *Commentaries on Colonial and Foreign Law*, vol. i. 649).

By the law of *Denmark*, according to the Code of King Christian the Fifth, complete divorce could be obtained for incest; for leprosy, whether contracted before or after marriage; for transportation for crime or flight from justice, after three years, though not for crime itself; and for exile not arising from crime, after seven years.

In *Sweden* complete divorce is granted by judicial sentence for adultery, and in *Russia* for that cause and also for incompatibility of temper (Ayliffe, Par. 49). On the other hand, in *Spain* marriage is indissoluble, and the ecclesiastical courts have retained their exclusive cognizance of matrimonial causes. In *Italy* certain articles of the Civil Code deal with separation, voluntary and judicial, but divorce is not allowed in any form.

In *France* the law of divorce has had a chequered history. Before the Revolution the Roman canon law prevailed, marriage was considered indissoluble, and only divorce *a mensâ et thoro*, known as *la separation d'habitation*, was permitted; though it would appear that in the earliest age of the monarchy divorce *a vinculo matrimonii* was allowed. *La separation d'habitation* was granted at the instance of a wife for cruelty by her husband or false accusation of a capital crime, or for habitual treatment with contempt before the inmates of the house; but a wife could not obtain a separation for adultery by her husband, although he had his remedy in case of adultery by his wife. In every case the sentence of a judicial tribunal, which took precautions against collusion, was necessary. But the Revolution may be said to have swept away marriage among the institutions which it overwhelmed, and by the law of 20th September 1792 so great facility was given for divorce *a vinculo matrimonii* as practically to terminate the obligations of marriage. A reaction came with the Code Napoléon, yet even under that system of law divorce remained comparatively easy. Mutual consent, expressed in the manner and continued for a period specified by the law, was cause for a divorce (the principle of the Roman law being adopted on this point), but such consent could not take place unless the husband was twenty-five years of age and the wife twenty-one, unless they had been married for two years, nor after twenty years of marriage, nor after the wife had completed her forty-fifth year; and further, the approval of the parents of both parties was required. In case of divorce by consent, the law required that a proper agreement should be made for the maintenance of the wife and the custody of the children. A husband could obtain a divorce *a vinculo matrimonii* for adultery, but the wife had no such power unless the husband had brought his mistress to the home. Both husband and wife could claim divorce on the ground of outrage, or grievous bodily injury, or condemnation for an infamous crime. If the divorce was for adultery, the erring party could not marry the partner of his or her guilt. A divorce *a mensâ et thoro* could be obtained on the same grounds as a divorce *a vinculo*, but not by mutual consent; and if the divorce *a mensâ et thoro* continued in force for three years, the defendant party could claim a divorce *a vinculo*. On the restoration of royalty in 1816 divorce *a vinculo* was abolished, and pending suits for divorce *a vinculo* were converted into suits for separation only.

Divorce in France, after the repeal of the provisions respecting it in the Code Napoléon in 1816, was re-enacted by a law of 27th July 1884, the provisions of which were simplified by a further law of April 20, 1886. But a wide departure was made by these laws from the terms of the Code Napoléon. Divorce by consent disappeared, and the following became the causes for which divorce was allowed: (1) Adultery by either party to the marriage at the suit of the other, without, in the case of adultery by the husband, the aggravation of introduction of the concubine into the home required by the Code; (2) violence (*excés*) or cruelty (*sévices*); (3) *injures graves*; and (4) *peine afflictive et infamante*. *Excés* is defined by Locié as "a generic expression comprising all acts tending to compromise the safety of the person, without distinction as to their object or motive, premeditation as well as furious anger, attempts upon life as well as serious woundings." *Sévices* are acts of ill-treatment less grave in character, which, while not endangering life, render existence in common intolerable (Kelly's *French Law of Marriage*, p. 122). *Injures graves*, as to which the courts have considered themselves entitled to exercise a wide discretion, have been defined as acts, writings, or words which reflect upon the honour or the reputation of the party against whom they are directed. The courts have held that retraction at the trial does not relieve the party from the consequences of an *injure grave*, and that publicity is an aggravating but not a necessary element. A letter from one spouse to the other may constitute an *injure*, and the courts have further held themselves at liberty to consider letters written after divorce proceedings have been commenced. *Injures graves* have also been considered to include material injuries, and among these have been classed habitual and groundless refusal of matrimonial rights, communication of disease, and refusal to consent to a religious cèremony of marriage. Habitual but not occasional drunkenness has also been held to fall within the definition of an *injure grave*. *Peine afflictive et infamante* signifies a legal punishment involving corporal confinement and moral degradation.[1]

In addition to its recognition of full divorce, the French law recognizes separation of two kinds, one *séparation de biens* and the other *séparation de corps*. The effect of *séparation de biens* is merely to put an end to the community of goods between the spouses. It necessarily follows, but may be decreed independently of *séparation de corps*. The grounds of *séparation de corps* are the same as those for a divorce; and if a *séparation de corps* has existed for three years, it may be turned into a divorce upon the application of either party to the court.

Until 1893 a wife *séparée de corps* obtained only the capacity attaching to a concomitant *séparation de biens;* that is to say, she recovered the enjoyment and management of her separate property, but could not deal with real property, nor take legal proceedings, without the sanction of her husband or of the court. But by a law of 6th February 1893 a wife *séparée de corps* obtains "the full exercise of her civil capacity, so that she shall not need to resort to the authority of her husband or of the court." In case of reconciliation, the wife returns to the limited capacity of a wife *séparée de biens*, and after the prescribed notification of such change of status it becomes binding on third persons.

The provisions of French law with regard to the custody of the children of a dissolved marriage, and with regard to property, do not differ materially from those prescribed by the English Acts. The custody of children is given to the party who has obtained the divorce, unless the court, on the application of the family, or the *ministère public*, consider it better, in the interests of the children, that custody should be given to the other party or a third person; but in every case the right of both father and mother to supervise the maintenance and education of the children, and their liability to contribute to their support, are continued.

The law in France as to property on a divorce has been accurately stated as follows:—

> "Divorce in France effects a dissolution of the matrimonial *régime* of property as well as of the marriage itself. The decree appoints a notary, who is charged with the settlement of the pecuniary interests of the parties. By a stereotyped form of procedure the appointment is made invariably for the purpose of liquidating *la communauté ayant existé entre les epoux*, irrespective of whether the *régime* really was that of community or another. In the case of aliens, therefore, married under the rule of separate property, it is necessary carefully to set this out in the notarial deed of liquidation, in order to

[1] It is interesting to observe how, according to the latest decision of the House of Lords above referred to, cruelty, according to English law, includes some but not others of the forms of injury for which, under the term of *injures graves*, the French law affords a remedy. It may well be doubted whether the view taken by the minority of the peers, which would have included in the definition of cruelty all, or nearly all, of that which the French law deems either *sévices* or *injures graves*, would not have better satisfied both the principles of English jurisprudence and the feelings of modern life.

defeat the presumption which might be raised by the wording of the decree that a community really did exist. The party against whom the divorce has been pronounced loses the benefit of all settlements made upon him or her by the other party, either by the marriage contract or since the marriage. On the other hand, the party in whose favour the divorce has been pronounced preserves the benefit of all settlements made in his or her favour by the unsuccessful party. If no such settlements were made, or if those made appear inadequate to ensure the subsistence of the successful party, the court may grant him or her permanent alimony out of the property of the other party, not to exceed one-third of the income, and revocable in case it ceases to be necessary" (Kelly, p. 130).

On a divorce both parties are at liberty to remarry, the husband at once, the wife after an interval of ten months. A divorced husband may remarry his divorced wife, but if he does so, he cannot be again divorced, except on the ground of a sentence to a *peine afflictive et infamante* passed on one of them since their remarriage. There is, however, this limitation on the power of remarriage of divorced persons, that the party to the marriage against whom the decree has been pronounced is not allowed to marry the person with whom his or her guilt has been established. Such person, however, has no such rights as are recognized in him or her according to English law, and cannot take any part in the proceedings. But his or her name is referred to in the proceedings only by an initial; and French law goes even further in the avoidance of publicity, inasmuch as the publication of divorce proceedings in the press is forbidden, under heavy penalties.

By a law of 6th February 1893 French jurisprudence, more complete at least, and perhaps wiser, than English, dealt with a matter previously in controversy, and decided that after a divorce the wife shall resume her maiden name, and may not continue to use the name of her divorced husband; nor may the husband, for business or other purposes, continue to use the name of his wife.

By the law of 1886 the special procedure in divorce previously in force under the Code and under the law of 1884 was abolished, and it was provided that matrimonial causes should be tried according to the ordinary rules of procedure. The action therefore, when brought, follows the methods of procedure common to other civil proceedings. But there still remain certain necessary preliminaries to an action of divorce. A petition must be presented by a petitioner in person to the President of the court sitting in chambers, with the object of a reconciliation being effected. This is known as the *première comparation.* If the petitioner still determines to proceed, there follows the *seconde comparation*, on which occasion both parties appear before the President. If the President fails to effect a reconciliation, he makes an order permitting the petitioner to proceed, and deals with the matters necessary to be dealt with *pendente lite*, such matters being (1) separate residence, (2) alimony, (3) possession of personal effects, (4) custody of children. As regards residence, the wife is compelled to adhere during the proceedings to the residence assigned to her, but no similar restriction is placed on the husband. Alimony *pendente lite* is in the discretion of the court, having regard to the means of the parties, and includes a proper provision for costs. As regards the custody of children, the Code and the law of 1884 gave it to the husband, unless the court otherwise orders, but the law of 1886 leaves the matter wholly in the discretion of the court.

There are certain technical rules of evidence on the trial of a divorce action. It is a general principle of the French law of evidence that documentary evidence is the best evidence, and oral testimony only secondary. In divorce cases adultery *flagrante delicto* can be proved by the official certificate of the commissary of police. Letters between the husband and wife are admissible in evidence. As to letters between the parties and third persons, the law, which has been doubtful, now appears to be that the wife may produce only such letters from third parties to her husband as have come into her possession accidentally, and without any ruse or artifice on her part; but the husband may put in evidence any letters written to or by his wife which he has obtained by any, short of criminal, means. If the documents put in evidence are not sufficient to satisfy the court, there follows an investigation by means of witnesses, termed an *enquête.* A schedule of allegations is drawn up, and a judge, termed a *juge-commissaire*, is specially appointed to conduct the inquiry. Relatives and servants, though not competent witnesses in ordinary civil actions, are so in divorce proceedings. Cross petitions may be entered; the substantiation of a cross petition, however, does not have the effect, in some cases given to it by English law, of barring a divorce, but a divorce may be, and often is, granted in favour of and against both parties *pour torts reciproques.* When a case comes on for trial, it is in the power of the court to order an adjournment for a period not exceeding six months, which is termed a *temps d'epreuve*, in order to afford an opportunity for reconciliation. It is said, however, that this power is seldom exercised. An appeal may be brought against a decree of divorce within two months; and a decree made on appeal is subject to revision by the Court of Cassation within two months. Both references to the Court of Appeal and the Court of Cassation operate as a stay of execution. A decree must, by the law of 1886, be transcribed on the register of marriages within two months from its date, and failing this transcription, the decree is void. The transcription must be made at the place of celebration of the marriage, or, if the parties are married abroad, at the place where the parties were last domiciled in France. If the parties, after having married abroad, return to France, it has been provided, by a circular of the *Procureur de la République* in 1887, that the transcription may be made at the place of their actual domicile at the time of action brought, a rule which has been held to apply to the divorce of aliens in France. The effect of transcription does not relate back to the date of the decree.

Opinions may differ as to the relative merits of the English and French law relating to divorce. But it cannot be denied that the French law presents a singularly complete and well-considered system, and one which, obviously with the English system in view, has endeavoured to graft on it provisions supplementing its omissions, and modifying certain of its terms in accordance with the light afforded by experience and the changed feelings of the modern world. The effect of the laws of 1884 and 1886 in France has been great. During the five years from 1884 to 1888 the courts granted divorces in 21,064 cases, rejecting applications for divorce in 1524. In addition, there were 12,242 applications for judicial separation, of which 10,739 were granted. A distinguished French writer, the author of a work of singular completeness and accuracy on the judicial system of Great Britain, has compared these figures with the corresponding result of the English Act of 1857. His conclusion is expressed in these words: "On voit qu'en cinq années nos tribunaux ont prononcé trois fois plus de divorces que la haute Cour d'Angleterre n'en a prononcé en trente ans. Je n'insiste pas sur les conclusions morales à tirer de ce rapprochement" (Comte de Franqueville, *Le Système Judiciare de la Grande Bretagne*, ii. p. 171). It is, however, practically impossible to compare the number of divorces in France and in England with exact justice, because, as will have been seen above, the causes of divorce in France materially exceed those recognized by English law; and the absence in France of any official performing

the functions assigned to the King's Proctor by the English Act cannot but have great influence on the number of applications for divorce, as well as on their results.

(F. H. J.)

### United States.

Divorce is the termination by proper legal authority, sometimes legislatively but usually judicially, of a marriage which up to the time of the decree was legal and binding. It is to be distinguished from a decree of nullity of marriage, which is simply a legal determination that no legal marriage has ever existed between the two parties. It is also to be distinguished from a decree of separation, which permits or commands the parties to live apart, but does not completely and for all purposes sever the marriage tie. Upon the subject of divorce in the United States, and, to some extent, in foreign countries, a careful investigation has been made by the American Department of Labour, and its report, covering the years 1867 to 1886, is the main source of information. There is no reason to suspect that if the returns for the following ten or fifteen years were known they would discredit the main conclusions of the report. The number of divorces granted in the United States was in 1886 over 25,000, and unless the rate of increase has materially slackened, which is improbable, it is now 30,000. This is about equal to the number reported from all the rest of the Christian world. As divorce presupposes a legal marriage, the amount of divorce, or the divorce-rate, is best stated as the ratio between the number of divorces decreed during a year and the number of subsisting marriages or married couples. The usual basis is 100,000 married couples. In 1886 the divorce-rate in the United States was 250 to 100,000 married couples. This is equivalent to more than one divorce annually to each 2500 people. The several states differ in divorce-rate, from South Carolina (*q.v.*), with no provision for legal divorce, to some of the Rocky Mountain states, where the rate is from three to four times the average for the country. In general the rate is greater in the North than in the South, and in the West than in the East; but to this rule the New England states, Louisiana, New Mexico, and Arizona are exceptions. The New England states have a far higher rate than their geographical position would lead one to expect in accordance with the preceding statement; and the other three, owing doubtless, in part at least, to the influence of the Roman Catholic Church, have a lower rate than the states about them. The several state groups had the following divorce-rates in 1886: South Atlantic, 106; North Atlantic, 149; South Central, 296; North Central, 334; Western, 527. The divorce-rate in the United States has increased rapidly and steadily in twenty years from 173 in 1867 to 250 in 1886. But distinct tendencies are traceable in different regions. In the North Atlantic group the rate fell in twenty years; in all other groups it rose—in the North Central by 21 per cent., in the Western by 54 per cent., in the South Atlantic by 100 per cent., and in the South Central by over 200 per cent. The great increase in the South was mainly due to the spread of divorce among the emancipated negroes.

The ground pleaded for a divorce is seldom an index to the motives which caused the suit to be brought. This is determined by the character of the law rather than by the state of mind of the parties; and so far as the individuals are concerned, the ground alleged is thus a cloak rather than a clue or revelation. Still those causes which have been enacted into law by the various state legislatures do indicate the pleas which have been endorsed by the social judgment of the respective communities. In the United States there are fifty-two different jurisdictions in the matter of divorce. Six out of every seven allow divorce for desertion, adultery, or cruelty; and of the divorces reported with their causes during the twenty years, of which there were 315,547 in the United States, nearly 78 per cent. were granted for some one of these three causes, viz., 40 per cent. for desertion, 21 per cent. for adultery, and 16 per cent. for cruelty. Probably nearly 10 per cent. more were for some combination of these causes. Three other grounds for divorce are admitted as legal in many or most American states, viz., imprisonment in 39, habitual drunkenness in 38, and neglect to provide in 22. About 98 per cent. of American divorces are granted on some one or more of these six grounds. In general the legislation on the subject of the causes allowed for divorce is most restrictive in the states on the Atlantic coast, from New York to South Carolina inclusive, and is least so in the Western states. The slight expense of obtaining a divorce in many of the states, and the lack of publicity which is given to the suit, are also important reasons for the great number of decrees issued. The importance of the former consideration is reflected in the fact that the divorce-rate for the United States as a whole shows clearly, in its fluctuations, the influences of good and bad times. When times are good and the income of the working and industrial classes likely to be assured, the divorce-rate rises. In periods of industrial depression it falls, fluctuating thus in the same way and probably for the same reason that the marriage-rate in industrial communities fluctuates. In two-thirds of the divorce suits the wife is the plaintiff, and the proportion increased in the twenty years. In the Northern states the percentage issued to wives is 69, while in the Southern states it is only 55. But where both parties desire a decree, and each has a legal ground to urge, a jury will usually listen more favourably to a woman's suit.

Divorce is probably especially frequent among the native population of the United States, and among these probably more common in the city than in the country. This statement cannot be established absolutely, since statistics afford no means of distinguishing the native from the foreign-born applicants. It is, however, the most obvious reason for explaining the fact that, while in Europe the city divorce-rate is from three to five times as great as that of the surrounding country, the difference in the United States between the two regions is very much less. In other words, the great number of foreigners in American cities tend to obscure by their low divorce-rate the high rate of the native population. Divorce is certainly more common in the New England states than in any others on the Atlantic coast north of Florida, and it is not unlikely that wherever the New England families have gone divorce is more frequent than elsewhere. For example, it is much more common in the northern counties of Ohio than in the southern counties settled from the Middle Atlantic states.

There are two statements frequently made regarding divorce in the United States which do not find warrant in the statistics on the subject. The first is, that the real motive for divorce with one or both parties is the desire for marriage to a third person. The second is, that a very large proportion of divorces are granted to persons who move from one jurisdiction to another in order to avail themselves of lax divorce laws. On the first point the American statistics are practically silent, since, in issuing a marriage license to parties one or both of whom have been previously divorced, no record is generally made of the fact. In Connecticut, however, for a number of years this information was required; and, if the statements were trustworthy, the number of persons remarrying each

year was about one-third the total number of persons divorcing, which is probably a rate not widely different from that of widows and widowers of the same age. Foreign figures for Switzerland, Holland, and Berlin indicate that in those regions the proportion of the divorced who remarry speedily is about the same as that of widows and widowers. What evidence there is on the subject therefore tends to discredit this popular opinion. The evidence on the second point is more conclusive, and has gone far towards decreasing the demand for a constitutional amendment allowing a federal marriage and divorce law. About four-fifths of all the divorces granted in the United States were issued to parties who were married in the state in which the decree was later made; and when from the remaining one-fifth are deducted those in which the parties migrated for other reasons than a desire to obtain an easy divorce, the remainder would constitute a very small, almost a negligible, fraction of the total number.

It is difficult, perhaps impossible, to say how far the frequency of divorce in the United States has been or is a social injury; how far it has weakened or undermined the ideal of marriage as a lifelong union between man and woman. In this respect the question is very like that of illegitimacy; and as the most careful students of the latter subject agree that almost no trustworthy inference regarding the moral condition of a community can be derived from the proportion of illegitimate children born, so one may say regarding the prevalence of divorce that from this fact almost no inferences are warranted regarding the moral or social condition of the population. It is by no means impossible, for example, that the spread of divorce among the negro population in the South marks a step in advance from the condition of largely unregulated and illegal unions characteristic of the race immediately after the war. The prevalence of divorce in the United States among the native population, in urban communities, among the New England element, in the middle classes of society, and among those of the Protestant faith, indicates how closely this social phenomenon is interlaced with much that is characteristic and valuable in American civilization. In this respect, too, the United States perhaps represent the outcome of a tendency which has been at work in Europe at least since the Reformation. Certainly the divorce-rate is increasing in nearly every civilized country. Decrees of nullity of marriage and decrees of separation not absolutely terminating the marriage relation are relatively far less prevalent than they were in the mediæval and early modern period, and many persons who under former conditions would have obtained relief from unsatisfactory unions through one or the other of these avenues now resort to divorce. The increasing proportion of the community who have an income sufficient to pay the requisite legal fees is also a factor of great importance. The belief in the family as an institution ordained of God, decreed to continue "till death us do part," and in its relations typifying and perpetuating many holy religious ideas, probably became weakened in the United States during the 19th century, along with a weakening of other religious conceptions; and it is yet to be determined whether a substitute for these ideas can be developed under the guidance of the motive of social utility or individual desire. In this respect the United States is, as Mr Gladstone once wrote, a *tribus prœrogativa*, but one who knows anything of the family and home life of America will not readily despond of the outcome.

Bibliography.—The only important source of statistical information is the governmental report of over 1000 octavo pages, *A Report on Marriage and Divorce in the United States, 1867 to 1886, including an Appendix relating to Marriage and Divorce in Certain Countries of Europe*, by Carroll D. Wright, Commissioner of Labour. The student may perhaps obtain a copy by applying to the Commissioner of Labour. The statistics contained in this volume have been analysed and interpreted in W. F. Willcox's *The Divorce Problem: A Study in Statistics*, published by Columbia University, New York City, in 1891 and again in 1897. Further interpretations are contained in an article in the *Political Science Quarterly* for March 1893, entitled "A Study in Vital Statistics." The best legal treatise is probably Bishop on *Marriage, Divorce, and Judicial Separation.* (W. F. W.)

**Dix, John Adams** (1798–1879), American soldier and politician, was born at Boscawen, N.H., and died in New York City, 21st April 1879. His early training was military, and as a boy he participated in the war of 1812. Afterwards he studied law and was admitted to the Bar. In 1830 he became adjutant-general of New York, and was soon one of the Democratic managers of the State. From 1845 to 1849 he was a United States senator of New York. In May 1860 he became postmaster of New York City, and from 10th January until 5th March 1861 he was Secretary of the Treasury of the United States. He rendered important services in hurrying forward troops in 1861, and was appointed major-general of volunteers. In 1872 he was elected governor of New York as a Republican by a large majority, but was defeated for re-election. He had great energy and administrative ability, and became president of the Mississippi and Missouri Railway in 1853, and was first president of the Union Pacific Railway, 1863–1868.

**Dixon**, capital of Lee county, Illinois, U.S.A., on the Rock river, at an altitude of 725 feet. Its site is level and its street plan regular. It is at the intersection of branches of the Chicago and North-Western and the Illinois Central Railways. Population (1880), 3658; (1890), 5161; (1900), 7917, of whom 879 were foreign-born and 59 negroes.

**Dixon, Richard Watson** (1833–1900), English poet and divine, son of Dr James Dixon, a well-known Wesleyan minister, was born 5th May 1833. He was educated at King Edward's School, Birmingham, and on proceeding to Pembroke College, Oxford, became one of the famous "Birmingham group" there, who shared with William Morris and Burne-Jones in the Pre-Raphælite movement. He only took a second class in Moderations in 1854, and a third in *Literæ Humaniores* in 1856; but in 1858 he won the Arnold Prize for an historical essay, and in 1863 the English Sacred Poem Prize. He was ordained in 1858, was second master of Carlisle High School, 1863–1868, and successively vicar of Hayton, Cumberland, and Warkworth, Northumberland. He became Honorary Canon of Carlisle in 1874, and died at Warkworth, 23rd January 1900. Canon Dixon's first two volumes of verse, *Christ's Company* and *Historical Odes*, were published in 1861 and 1863 respectively; but it was not until 1883 that he attracted conspicuous notice with *Mano*, an historical poem in *terza rima*, which was enthusiastically praised by Mr Swinburne. This success he followed up by three privately printed volumes, *Odes and Eclogues*, 1884, *Lyrical Poems*, 1886, and *The Story of Eudocia*, 1888. Dixon's poems were during the last fifteen years of his life recognized as scholarly and refined exercises, touched with both dignity and a certain severe beauty, but he never attained any general popularity as a poet. The appeal of his poetry is addressed directly to the scholar and the man of erudition. A great student of history, his studies in that direction colour much of his poetry. He is at his best in poetic narrative, where he combines fancy and fact with much skill and grace. The romantic atmosphere is remarkably preserved in *Mano*, which is also a highly successful metrical exercise in the difficult *terza rima*. His typical

poems have charm and melody, without introducing any new note or variety of rhythm. A strong love of nature, with much felicity in interpreting natural beauty, informs all his descriptive passages. He is contemplative, sober, and finished in literary workmanship, a very typical example of the Oxford school. Pleasant as his poetry is, however, he will probably be longest remembered by the work to which he gave the best years of his life, his *History of the Church of England from the Abolition of Roman Jurisdiction*, of which at the time of his death four volumes had appeared, covering the period from 1529 to 1588. This fine work is not only built upon elaborate research, but also presents a trustworthy and unprejudiced survey of a subject in the treatment of which freedom from bias is exceedingly rare and difficult. (A. WA.)

**Dobeln**, a town of Germany, on the Mulde, 42 miles south-east by rail of the town and in the circle of Leipzig, kingdom of Saxony. There are an agricultural and a commercial school. The industries include wool-spinning, iron-founding, carriage, agricultural implement, and metal printing and stamping works. Population (1890), 13,892; (1895), 15,760.

**Dobsina** (German, *Dobschau*), a corporate town of Northern Hungary, 42 miles west by north of Kassa. The most remarkable feature in connexion with it is a large cavern some $3\frac{3}{4}$ miles to the north-west, in which is an ice-field nearly 2 acres in extent containing formations which are at once most curious and strikingly beautiful. Population, (1900), 5115.

**Dobson, Henry Austin** (1840-——), English poet and man of letters, was born at Plymouth 18th January 1840, being the eldest son of George Clarisse Dobson, a civil engineer, and on his grandmother's side of French descent. When Mr Austin Dobson was about eight years old the family moved to Holyhead, and his first school was at Beaumaris, in the Isle of Anglesea. He was afterwards educated at Coventry, and the Gymnase, Strasburg, whence he returned at the age of sixteen with the intention of becoming a civil engineer. He had a taste for art, and in his earlier years at the office continued to study it at South Kensington, at his leisure, but without definite ambition. In December 1856 he entered the Board of Trade, gradually rising to a principalship in the Harbour Department, from which he withdrew in the autumn of 1901. He married in 1868 Frances Mary, daughter of Nathaniel Beardmore of Broxbourne, Herts, and settled at Ealing. His official career was industrious though uneventful, but as poet and biographer he stands among the most distinguished of his time. The student of Mr Austin Dobson's work will be struck at once by the fact that it contains nothing immature: there are no *juvenilia* to criticize or excuse. It was about 1864 that Mr Dobson first turned his attention to composition in prose and verse, and some of his earliest known pieces remain among his best. It was not until 1868 that the appearance of *St Paul's*, a magazine edited by Anthony Trollope, afforded Mr Dobson an opportunity and an audience; and during the next six years he contributed to its pages some of his favourite poems, including "Tu Quoque," "A Gentleman of the Old School," "A Dialogue from Plato," and "Une Marquise." Many of his poems in their original form were illustrated—some, indeed, actually written to support illustrations. By the autumn of 1873 Mr Dobson had produced sufficient verse for a volume, and put forth his *Vignettes in Rhyme*, which quickly passed through three editions. During the period of their appearance in the magazine the poems had received unusual attention, George Eliot, among others, extending generous encouragement to the anonymous author. The little book at once introduced him to a larger public. The period was an interesting one for a first appearance, since the air was full of metrical experiment. Mr Swinburne's bold and dithyrambic excursions into classical metre had given the clue for an enlargement of the borders of English prosody; and, since it was hopeless to follow him in his own line without necessary loss of vigour, the poets of the day were looking about for fresh forms and variations. It was early in 1876 that a small body of English poets lit upon the French forms of Theodore de Banville, Marot, and Villon, and determined to introduce them into English verse. Mr Austin Dobson, who had already made successful use of the triolet, was at the head of this movement, and in May 1876 he published in *The Prodigals* the first original ballade written in English. This he followed by English versions of the rondel, rondeau, and villanelle. An article in the *Cornhill Magazine* by Mr Edmund Gosse, "A Plea for Certain Exotic Forms of Verse," appearing in July 1877, simultaneously with Mr Dobson's second volume, *Proverbs in Porcelain*, drew the general eye to the possibilities and achievements of the movement. The experiment was extremely fortunate in its introduction. Mr Dobson is above all things natural, spontaneous, and unaffected in poetic method; and in his hands a sheaf of metrical forms, essentially artificial and laborious, was made to assume the colour and bright profusion of a natural product. An air of pensive charm, of delicate sensibility, pervades the whole of these fresh revivals; and it is perhaps this personal touch of humanity which has given something like stability to one side of a movement otherwise transitory in influence. The fashion has faded, but the flowers of Mr Dobson's French garden remain bright and scented.

In 1883 Mr Dobson published *Old-World Idylls*, a volume which contains some of his most characteristic work. By this time his taste was gradually settling upon the period with which it has since become almost exclusively associated; and the spirit of the 18th century is revived in "The Ballad of Beau Brocade" and in "The Story of Rosina," as nowhere else in modern English poetry. In "Beau Brocade," indeed, the pictorial quality of his work, the dainty economy of eloquent touches, is at its very best: every couplet has its picture, and every picture is true and vivacious. The touch has often been likened to that of Randolph Caldecott, with which it has much in common; but Mr Dobson's humour is not so "rollicking," his portraiture not so broad, as that of the illustrator of "John Gilpin." The appeal is rather to the intellect, and the touches of subdued pathos in the "Gentleman" and "Gentlewoman of the Old School" are addressed directly to the heart. We are in the 18th century, but see it through the glasses of to-day; and the soft intercepting sense of change which hangs like a haze between ourselves and the subject is altogether due to the poet's sympathy and sensibility. *At the Sign of the Lyre* (1885) was the next of Mr Dobson's separate volumes of verse, although he has added to the body of his work in a volume of *Collected Poems* (1897). *At the Sign of the Lyre* contains examples of all his various moods. The admirably fresh and breezy "Ladies of St James's" has precisely the qualities we have traced in his other 18th-century poems; there are ballades and rondeaus, with all the earlier charm; and in "A Revolutionary Relic," as in "The Child Musician" of the *Old-World Idylls*, the poet reaches a depth of true pathos which he does not often attempt, but in which, when he seeks it, he never fails. At the pole opposite to these are the light occasional verses, not untouched by the influence of Praed, but also quite individual, buoyant, and

happy. But the chief novelty in *At the Sign of the Lyre* was the series of "Fables of Literature and Art," founded in manner upon Gay, and exquisitely finished in scholarship, taste, and criticism. It is in these perhaps, more than in any other of his poems, that we see with how much felicity Mr Dobson interpenetrates the literature of fancy with the literature of judgment. Since 1885 Mr Dobson has been engaged principally upon critical and biographical prose, by which he has added very greatly to the general knowledge of his favourite 18th century. His biographies of *Fielding* (1883), *Bewick* (1884), *Steele* (1886), *Goldsmith* (1888), *Walpole* (1890), and *Hogarth* (1879–98) are studies marked alike by assiduous research, sympathetic presentation, and sound criticism. It is particularly noticeable that Mr Dobson in his prose has always added something, and often a great deal, to our positive knowledge of the subject in question; his work as a critic has never been solely æsthetic. In *Four Frenchwomen* (1890), in the three series of *Eighteenth-Century Vignettes* (1892–94–96), and in *The Paladin of Philanthropy* (1899), which contain unquestionably his most delicate prose work, the accurate detail of each study is relieved by a charm of expression which could only be attained by a poet. In 1901 he collected his hitherto unpublished poems in a volume entitled *Carmina Votiva.* Possessing an exquisite talent of defined range, Mr Austin Dobson has, in his own words, "held his pen in trust to Art" with a service sincere and distinguished.

**Docks.**—The development within recent years of vessels of enormous carrying capacity and great speed has rendered necessary various improvements in the facilities for dealing with the traffic at different ports, including the enlargement of old docks and the construction of new ones. In tidal docks, where the shipping can be accommodated at open quays, the improvements generally consist of deepening the approaches by dredging, providing deeper water alongside the quays, and extending and enlarging the quay space. This has been the case to a large extent at such ports as Southampton, Glasgow, Dublin, and Belfast. In closed docks the chief improvements are the enlargement of old basins and the construction of entirely new ones with deeper sills and improved entrances, as at Liverpool, London, Hull, the Tyne, and various ports in South Wales and other parts of the coast.

The position, shape, and general arrangement of docks are determined by local features and the nature of the traffic carried on. At Liverpool, for instance, there are certain local features which account for the dock arrangements differing from those at many other large ports. The channel forming the approach from the sea used to be blocked at the sea end by a bar of sand on which there was a depth of water of only 10 feet at low water of spring tides, though at high water there was 40 feet; the time, therefore, during which ships could cross was limited to a few hours at high water. This, together with the great accumulation of sand in front of the docks, was apparently the reason why until the year 1873 their sills (with the exception of a few on the Birkenhead side) were not formed deeper than the level of low water of spring tides. The consequence was that the largest steamers could not enter the docks at neap tides until some of their cargo had been discharged, and vessels loading in the docks had to move into the river to complete their loading from barges. Within the last few years the bar of the Mersey has been improved by dredging, and the depth increased to 28 feet at low water of spring tides. The improvements in the docks themselves were necessary to enable the port to reap the full benefit of the deepening of the bar and to compete successfully with other places. These improvements have been chiefly at the north end, where there was most room for extension and where new large basins have been constructed. Some of the old docks have been grouped together to form large basins, new entrances and locks have been provided to suit the new arrangements of docks inside, and the sills of entrances have been lowered, the deepest being now 12 feet below low water. New and extensive graving docks have also been constructed. The Alexandra Dock, 44 acres in extent, is one of the latest and largest basins, and was designed to accommodate the biggest steamers, having special features to meet their requirements. It forms one of a line of basins opening into each other and having one common entrance from the river. Its shape is that which is found generally the most convenient for traffic, being practically rectangular, with piers projecting from one side into the

***Liverpool docks.***

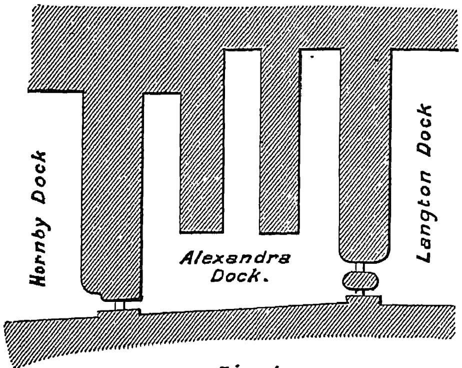



Fig 1.

water area, leaving sufficient open space near the entrance for vessels to turn. This arrangement largely increases the length of quayage (Fig. 1). In the ordinary course of trade, goods landed at the docks have to be warehoused in Liverpool, and it is found that cargoes on being discharged can be most conveniently and expeditiously dealt with by sorting them under sheds on the quays and removing them by carts to their various destinations. Hence many of the quays differ from those at most docks in not being provided with railways.

Compared with the docks on the Mersey, those on the Thames are larger in extent. They are not in one continuous line as at Liverpool, but are situated at various points on the river. The individual docks or basins are also larger than those at Liverpool. The trade at London is greater than at Liverpool taken altogether, for though the export trade is less, the import is much greater. The range of tide in the Thames is smaller than in the Mersey, and there is a deep and uninterrupted waterway from the docks to the sea. In these different circumstances the arrangements of the docks are somewhat different. The sills of the chief entrance basins are generally fixed at such a depth that ships can enter and leave them at any state of the tide, and the quays are well provided with storehouses and railways, so that cargoes can be loaded direct into railway trucks. Amongst the latest additions to the London docks are those at Tilbury, which consist of a tidal basin of 21 acres with a wide trumpet-shaped entrance to the river, having a depth of 26 feet at low water. A lock connects this basin with the main dock, which is rectangular, with a water space of about 50 acres and a depth of 38 feet at high water. From the side opposite the lock project three piers, each 350 feet wide; one is provided with a double row of storehouses, railways, &c. Parallel with the lock are two graving docks, each opening into the tidal basin and the main dock, and divided into unequal lengths by a caisson; these can be used either as four short docks, or two long docks, or two locks.

***London docks.***

Docks situated in the neighbourhood of the large coal-fields in Scotland, the North of England, and South Wales, which provide almost entirely for the loading of coals, require arrangements different from those which deal with the ordinary trade of such ports as London and Liverpool. Barry docks may be mentioned as an illustration. Entirely constructed within the last few years, and devoted almost exclusively to the export of coal, they are fitted with all the latest improvements for the accommodation of ships and for rapidly loading them with coal. In selecting the site, every natural advantage has been considered and made use of, not only for the docks themselves, but also for the approach and entrance. The latter is 80 feet wide, with a single pair of wrought-iron gates, and gives access to a basin 500 feet wide and 600 feet long. Between this basin and the main dock is a passage 80 feet wide, with a pair of gates, so that the basin is used as a large lock. The main dock is 3400 feet long by 1100 feet wide, and is divided longitudinally at one end by a wide projecting pier. Another large wet dock and two graving docks have been added, also a deep lock alongside the entrance basin. In South Wales coal is conveyed from the collieries in waggons containing about 10 tons, with a door at one end; the full waggons on arrival at the dock are shunted into sidings, and then taken one by one over a weigh-bridge to the coal-tips, which are erected on masonry towers, or on the quay walls, at intervals along the sides of the dock. At the tip the waggon enters an iron cradle or platform, which is raised or lowered and tilted as required by hydraulic power, and the coal is discharged from the end of the waggon along a shoot to the hatchway of the vessel. The empty

***Docks for coal export.***

waggon on leaving the cradle runs down an incline to a second weigh-bridge, and thence to the sidings provided for empty waggons. A similar expeditious system is adopted at other South Wales ports and at Hull, variations in the details of the tips being introduced to meet local requirements. A somewhat different method is practised on the Tyne and at other north-country ports, where there are no hoists, but the waggons, which carry about 4 tons and discharge through a door at the bottom, are brought on to the tipping staiths at a level high enough to suit any vessel. Each staith is provided with two or three spouts so as to load at two or three hatchways of a vessel simultaneously, the spouts being arranged to swing to the extent of about 15 feet on either side of their centres. Modifications of these systems are adopted at most of the various coal-ports. The speed of the coaling depends greatly upon the rapidity with which the loaded and empty waggons can be brought to and from the staiths or tips, and also upon the trimming of coal in the hold of the vessel. For loading and discharging ordinary cargoes steam or hydraulic travelling cranes are provided by some dock companies; at other docks the cargoes are worked by steam winches and derricks on the ships themselves; while at others, again, the quays are leased to various steam shipping companies, who provide their own cranes or other gear for working their cargoes.

***Dock walls.***

Dock walls may be considered as generally partaking of the nature of retaining walls. Theoretically the lateral pressure exerted by a bank of earth or other material of the same height as the wall is that due to the wedge-shaped mass, *abc* (Fig. 2), included between the vertical back of the wall *ab* and a line *bc* bisecting the angle between the vertical *ab* and *bd*, the slope of repose of the material. This, however, cannot always be entirely relied on in practice, especially in some ground, such as clay, of which the slope of repose is found to vary considerably in different circumstances. An important point in the design of dock and quay walls is the nature of the foundation, as is shown by the instances of failure which could be attributed to its defects. If the foundations are insecure, a wall is liable either to slide bodily forward at the base when the pressure of the filling is applied at the back, or the yielding of the ground under the front toe of the wall causes the top to fall forward. Conditions of the subsoil, which it is difficult, if not impossible, to foresee, have sometimes caused the failure of walls which theoretically were of more than sufficient strength. The experience of some engineers is that a dock wall should be constructed of sufficient strength to support a head of water equal to its height when the dock is empty, but it would appear that such a wall is only required in exceptional cases, and even then would fail if the foundation were not secure. In ordinary dock walls a margin of strength should always be provided to meet any weight which may be placed on the quays at the back, and this, if the foundation is good, should be sufficient for any pressure due to backing. Docks are usually constructed in estuaries and rivers where the circumstances are rarely favourable; the engineer must therefore be guided by practical experience and his own judgment, rather than rely on the ordinary calculations which might be set forth as generally applicable to retaining walls.

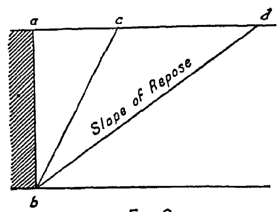



Fig. 2

***Foundations.***

As regards the foundations of walls in soft ground, if the depth of mud or silt is not excessive, and a firm foundation can be obtained beneath it, the wall should be carried down well into the solid ground. The usual course is to enclose the site of the works by a cofferdam so as to exclude the tide, and enable the foundations and other work to be constructed dry, any leakage being kept down by pumping. Where the head of water is not great and the space not limited, effectual dams can be made by embankments. When, however, a considerable head of water has to be dealt with, it becomes necessary to use timber piles driven either in a single continuous row with the joints caulked, or in a double row, with clay puddle between, and well secured by struts at the back. Timber cofferdams admit of much variety of design to suit local circumstances and to meet the varying strains to which they may be subjected. In some instances the cofferdam is partly or wholly formed by a permanent embankment or sea-wall reclaiming ground from the foreshore and enclosing the site of the works; such a method has been adopted at Leith. If the nature of the ground will not admit of a trench being excavated deep enough to afford a firm footing for the wall, this must be obtained by some other method, and the expedient most frequently adopted is to drive timber piles to carry the weight of the wall. The timber chiefly used for this purpose is pitch-pine from the states bordering the Gulf of Mexico; in comparison with the Baltic timbers it is stronger, quite as cheap, and can be obtained in longer lengths. Elm is very tough and durable; so also is beech, which has been largely used, especially when always under water or embedded in the ground. The durability of timber piles depends greatly on their situation; those which are alternately wet and dry do not last so well as those which are wholly in the ground or under water, while some soils have a more injurious effect on timber than others. Many piles have been found in good condition after being as long as 500 years in the ground. If practicable, it is advisable to drive piles until they reach hard ground. Failing this the only satisfactory way of arriving at an approximation of what they will carry is to test the ground by driving one or two piles to what is considered a sufficient depth and loading them with dead weight, from which may be determined the final set for the remainder. It has been conclusively proved that a light hammer with a high fall causes more injury, with less effective work, than a heavy hammer with a short fall. In driving piles in sand a water jet under pressure, in a pipe sunk down so that it delivers the water just below the point of the pile, loosens the sand and greatly facilitates the operation.

Cylinders constructed of brickwork have for a long time been used in India and elsewhere for foundations. At Glasgow, where they formed the foundation of part of the quay walls, they were 12 feet external and 7 ft. 4 in. internal diameter, and were tongued and grooved together (Fig. 3). The ground in which they were sunk consisted chiefly of sand and water-bearing gravel. They were 35 feet in length, and were sunk until their tops were about 2 feet above low-water level; they were then filled with concrete, and upon this foundation the upper wall was constructed. Concrete cylinders were afterwards adopted, built into groups of three, and placed as shown in plan (Fig. 4). They were made in rings 2 ft. 6 in. deep formed alternately of three and four segments so as to break bond when built together, the inside diameters being 5 ft. $9\frac{1}{2}$ in. and the outside 9 ft. $7\frac{1}{2}$ in. Under the bottom ring a cast-iron shoe was secured of the same external size and shape as the ring. This was made in six parts bolted together, and shaped to form a cutting edge. As the rings were built up, the sand and gravel were removed from within the cylinders by means of grabs or excavators. The total height of these cylinders was 28 feet, and when sunk their tops were about 3 feet below the level of low water; the average rate of sinking was about 12 inches an hour,

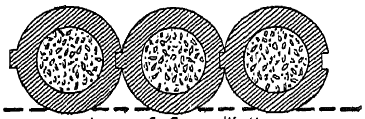



Fig 3

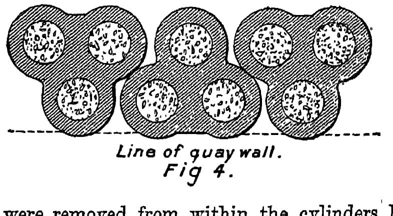



Fig 4.

and cast-iron weights amounting to 300 or 400 tons were generally required to force them down.

At Brest, where the range of spring tides is 20 feet, the foundations of the quay walls were constructed in the deep water without a cofferdam. A bank of rubble was formed up to a level of 15 feet below low water; on this large artificial blocks were placed in two courses reaching to low-water level, the part of the wall above low water being constructed in the ordinary manner by tide work. The blocks, about 100 tons in weight, and constructed of rubble masonry, were built on platforms on a slipway, and when ready for setting were lowered down the slipway sufficiently far to admit of a barge being floated over them; each was then suspended under a barge, and, as the tide rose, was lifted up and taken to the position where it was required to be set, and deposited in its place as the tide fell. In favourable circumstances this method answers well, and with slight modifications has been adopted at other ports.

At Quebec, where the time for constructing harbour works was limited to the summer months, the quay walls were formed of cribwork filled with concrete. The cribs were constructed during the winter, and in the spring were floated into position, where they rested on a foundation of bearing piles; they were then filled with concrete deposited under water. The cribs were in lengths of 40 feet, being 27 feet high, 33 feet wide at base, and 23 feet wide at top.

During the improvements and extensions executed at the port of Antwerp, it was found necessary to build on one side of the river an entirely new line of quay walls in advance of the old line, so as to secure a depth of 26 feet of water at low water and prevent the silting up caused by the irregular and broken line of the old wall. The new quay wall, which was constructed by a special system of movable cofferdams, was built of brickwork faced with stone, and was carried out in lengths of 82 feet. First an iron caisson for compressed air was provided, which was 82 feet long and $29\frac{1}{2}$ feet wide, and which varied in height from $8\frac{1}{2}$ feet to $16\frac{1}{2}$ feet according to the depth required below the bed of the river, the footings of the wall being always $26\frac{1}{2}$ feet below low water. This caisson, after serving for the removal of the soil, was filled with concrete and became an integral part of the foundation. A movable iron cofferdam 40 feet high was fixed by bolts on the top of the caisson and well strutted inside; within this the wall from the top of the foundation to low-water level could be built in the dry and in the open air, the struts being removed and replaced in the ordinary way as the work advanced. Iron tubes provided with air-locks were fixed to the top of the caisson, the wall being built round these tubes so that they could be removed when the caisson had reached the bottom and was filled in. The cofferdam was suspended complete by chains from an iron framework carried on two iron barges, and was raised or lowered by hoisting-gear. The site for the caisson was first prepared by dredging. The caisson with cofferdam attached was then fixed in place by means of the floating barges, and sunk by the weight of the work being carried on above and within it. The narrow spaces between the lengths of wall thus built were filled in afterwards by an arrangement which effectually tied together the whole wall.

*Walls.*

Dock walls are usually now constructed of Portland cement concrete, mixed in proportions varying from 5 to 8 parts of shingle and sand to 1 part of cement, the sand being in the proportion of from $1\frac{1}{2}$ to $2\frac{1}{2}$ parts to 1 part of cement according to the quality required. The interstices of ordinary shingle without sand form about 33 per cent. of its bulk, and they should be completely filled by the cement and sand when mixed. To ensure good work the cement must be of the highest quality, and the other materials must be perfectly clean. Broken stone is sometimes substituted for shingle, and some engineers use large fragments of stone bedded in the mass of the concrete. Care should be taken to make the concrete as compact and solid as possible, in order to prevent the percolation of water, since concrete is liable to damage from sea-water in course of time if this precaution is not observed. The upper portion of the wall, where it is exposed to the rubbing of ships and boats lying alongside, should be faced with masonry or timber fendering. Some quay walls are constructed entirely of timber, the filling at the back being retained by sheet piling up to about low water, and above that level by a paved slope. A slight batter or slope—from 1 in 8 to 1 in 12 is that usually given—to the face of a wall adds to its strength and appearance. Where the range of tide is great, the walls should be vertical or with a very slight batter, since the fall of the tide will otherwise cause the side of the ship to be an inconvenient distance away from the line of the coping.

***Graving docks.***

Later improvements in the design of graving docks consist chiefly in the increased dimensions, the facilities for moving the gates and caissons at their entrances, and the arrangements for pumping out the water. With the increasing size of vessels, it has become necessary to provide larger dry docks in which repairs to such ships may be carried out. In all the most important ports new and extensive graving docks have been constructed. The following are the lengths of some of the largest: Liverpool, 1000 feet; Southampton, 750 feet; Glasgow, 880 feet; Belfast, 850 feet; Barry, 740 feet; Tilbury, 875 feet. Some of the longest graving docks are provided with a caisson or gates, dividing them into two lengths, so that for a short vessel only a part of the dock need be used. The construction of a graving dock requires great care, especially if the ground is of a soft or treacherous nature. If soft ground, such as sand or silt, extends to some depth below the bottom of the dock, and the depth to hard ground is so great as to render the removal of the soft material impracticable, it will be necessary to enclose the site by sheet piling to prevent any movement of the subsoil through scour. This should be done in addition to any piling that may be required to carry the floor and side walls, and is necessary under the entrances of both wet and graving docks; for if water finds its way under the entrance with the pressure due to the head of water on either side of the gates, it will cause a scour, and sooner or later the destruction of the entrance will follow. When the site has been excavated and prepared, and suitable drains have been provided for drawing off any water that may be met with, the foundations for the floor and side walls have to be constructed. For this class of work Portland cement concrete has almost entirely superseded brickwork where suitable materials for concrete can be obtained. The floor of a graving dock is in principle an inverted arch, which has to resist the upward pressure of any water that may penetrate to the under-side, and as such water will also be equally at the back of the walls, they will be subjected to a similar pressure in addition to the lateral pressure due to the filling. This fact should be regarded in putting in the concrete, which should be constructed in sections to the full depth of the floor, with the longitudinal vertical joints radiating as if the surface of the invert were curved (Fig. 5). When the concrete is in contact with rock, the joint should be broken by trenches cut into the surface of the rock, to which the concrete is thus firmly keyed; this is of especial importance if the rock is of a water-bearing nature. The surface of the floor is generally formed of granite masonry bedded on the concrete, deeper stones being placed along the centre to carry the blocks, while the sides are sometimes paved with granite setts, or blue bricks, or, as in the case of a dock at Halifax, N.S., with pitch-pine planking fixed to longitudinals bedded in the concrete. Usually the centre of the floor is kept a few inches higher than the sides, to allow the water to draw off. The blocks on which the keel of the vessel rests when in dock are fixed along the centre of the floor, and are constructed of hard wood, or of cast-iron and wood combined, the parts of

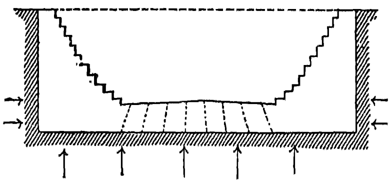


Fig. 5

each block being formed wedge-shaped so as to be easily adjusted to any required height. There is considerable variety in the shape and arrangement of the side walls of graving docks, but they must be strong enough to bear any pressure that may be applied to them as training walls. The faces are constructed in steps, or altars as they are termed (Fig. 5), on which rest the shores which support a vessel in the dock. Steps are constructed in suitable positions for access to the bottom, also slides down which timber and other materials can be lowered. These side walls are usually of concrete faced with stone; in some docks the facing is formed of concrete of extra quality, and in others of blue bricks with copings of stone. The entrances are constructed with side walls and sills to suit the method adopted for closing the dock, gates requiring a different arrangement from that provided for a caisson. Culverts fitted with penstocks are built in the side walls near the entrances, for filling the dock with water. For emptying, centrifugal pumps seem on the whole the most convenient and the least liable to be affected by the passage of small chips of wood, which cannot always be avoided even with the greatest care. When arrangements have to be provided for keeping the entrance clear of mud occasional dredging is generally resorted to. At Liverpool an extensive system of sluicing is adopted, the head of water retained in the dock or closed basin as the tide falls being utilized to produce a strong current which carries off the mud. At Tilbury jets of water under pressure, combined with an arrangement of harrows, are applied at ebb tide to the bottom of the dock and entrance, from an apparatus attached to a floating craft which can be moved to any part required; the mud stirred up by the harrows is set in motion by the jets, and carried away by the ebb tide.

***Timber docks.***

Hitherto most of the dry docks for the United States Government have been constructed of timber, those of masonry having been considered too expensive. In the navy yards of Charlestown, Brooklyn, and Norfolk there are masonry docks, the sills of which are 25 feet below high-water spring tides; in the timber docks at the various yards the sills are from 15 to 22 feet below high water. A report on the relative value of timber and masonry for dry docks by Commodore Endicott, U.S. Navy, chief of the Bureau of Yards and Docks, states that timber docks are temporary structures, and that the wood of which they are built requires extensive renewal at the end of 25 years, practically amounting in some instances to rebuilding; also that accidents have occurred from the partial collapse and bursting of the floor and sides of some of the timber docks. He considers that, in view of the increased depth required in new docks to accommodate vessels of large draught, the risk to their stability will be largely increased, as they will be subjected to more unfavourable conditions, in particular to a much greater hydrostatic pressure, and that freedom from such risk can only be obtained from a masonry structure designed to resist by its own weight the dangerous force to which it is subjected. He recommends that any new docks should be constructed, not of timber, but of masonry and concrete combined; and that instead of being constructed by day labour and by Government employees, they should be carried out by contract, which would be the means of greatly reducing their cost.

***Dock gates.***

Dock gates are constructed of timber or iron. The two doors are exactly similar, each being rather longer than half the width of the entrance, so that when they meet in closing their faces form two sides of a triangle whose base is the straight line drawn from one heel post to the other (Fig. 6). The distance from the apex or meeting-point to the base, which is termed the rise of the gates, is a matter of considerable importance, as affecting the strains on the gates themselves and on the masonry, to which the strains are transmitted at the heel posts; in practice it varies from one-sixth to one-fourth of the width of entrance. The heel post is vertical, and shaped to form a tight joint with the closing face of the

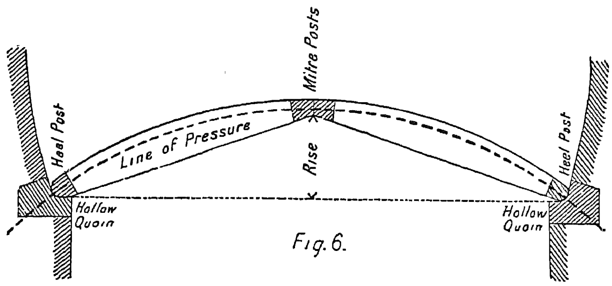



Fig. 6.

hollow quoin; at the bottom is fixed a cast-iron socket which rests upon a cast-iron pivot firmly secured to the masonry of the gate platform, the top being held by an iron strap passing round it and securely anchored to the masonry of the side walls. The main beams of each gate are built into and secured to the heel post at one end and to the mitre post at the other end; the two mitre posts constitute the meeting face of the pair of gates, and should form a tight and even joint from top to bottom. The timber generally used for gates is greenheart, which is durable and not liable in Britain to the attacks of sea-worms. When gates are made of iron the closing faces at sills, mitre posts, and heel posts are formed of timber to ensure close-fitting joints. The gates when open fit back into recesses formed in the side walls. Timber gates are less liable to injury or twisting, and are more easily fitted together than iron gates; on the other hand, the latter can be easily rendered buoyant by the introduction of air chambers, which reduce the strain on the hinges and the weight on the rollers supporting the outer end. These rollers are fixed so that they can be adjusted as required to support the gate, and work on a circular iron way attached to the masonry of the gate platform; they are not necessary for gates where the entrance is less than 60 feet wide. The pressure on a gate is due to the difference in level of water on the inside and outside surfaces; this has to be withstood and conveyed to the side walls by the structure of the gates. The strains in any gate are those of an arch with the load applied in radial lines and equally distributed (Fig. 6). A pair of gates should form part of a circular dam, and should be so designed that the line of pressure approximates to a line forming the arc of a circle passing through the centres of the heel posts and the centre of the meeting face of the mitre posts, to ensure that the gates are subject to compressive stress only. For convenience a pair of gates are usually shaped so that their outside faces when closed form a continuous curve, with the inside faces straight. The subject of strains in dock gates has been most fully dealt with in a paper by Mr A. F. Blandy (*Proc. Inst. C. E.* vol. lviii.), and by Mr J. M. Moncrieff (*ib.* vol. cxvii.), to which the reader is referred for information. For moving dock gates an opening and a closing chain is attached to the outer and inner faces respectively of each gate as low down as can be arranged. The chains are conducted to the back of the side walls through openings, and are worked mostly by hydraulic power. At Barry, Leith, and other ports a more rapid and simple arrangement has been introduced by attaching the piston of a hydraulic engine direct to the back of each gate (Fig. 7). The gate thus closed is held up firm against any undulation of the water outside, and the chains are done away with, together with the necessary guiding sheaves. Instead of gates caissons

are frequently used, and are of two types—floating and sliding. The former, when the entrance is opened, is floated out of its position, while the latter is drawn endways into a chamber constructed at the side of the entrance, being moved over ways with plane sliding surfaces, or on rollers fixed either to the masonry or to the bottom of the caisson. The advantages of caissons are that they save room by shortening the length of the entrance, they dispense with hollow quoins, they facilitate maintenance and repairs, and, by being capable of carrying a road or railway along their top, they do away with the cost and inconvenience of a swing bridge across the entrance. The deck forming the roadway on top of the sliding caisson can be so arranged that it falls automatically as the caisson is drawn into the chamber, and rises again when it is moved out. Caissons are raised and lowered by the aid of air and water chambers, the water being ejected or admitted by pumps. Sliding caissons are constructed of rectangular section, and are drawn backwards and forwards by hauling gear fixed at the inner end of the caisson chamber and worked by steam, compressed air, or hydraulic power, the weight of the caisson on the sliding ways or rollers being adjusted by the amount of water admitted to the water chambers. Floating caissons are in shape somewhat similar to the hull of a ship, with a width at the top varying according to the nature of the road or footway required along it.

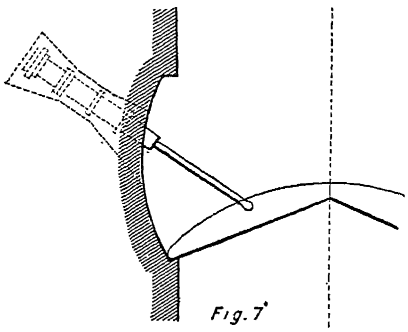


Fig. 7

Floating and pontoon docks are constructed in various forms, but their function is in every case to lift a vessel out of the water and support it by means of their buoyancy. They can only be used in completely sheltered positions. Circumstances, such as a bad foundation, which might render the construction of a solid dock almost if not quite impracticable, would favour the adoption of a floating dock, but each case must be judged on its own merits.

Reference may be made to *Proc. Inst. C. E.*—C. Colson, *Notes on Docks and Dock Construction.*—L. F. Vernon-Harcourt, *Harbours and Docks.*—William Shield, *Principles and Practice of Harbour Construction.* (W. E.)

# DOCKYARDS.

## 1. British.

*Recent Structural Developments.*—The extensions of H.M. dockyards at Portsmouth and Chatham, described in the ninth edition article on Dockyards, marked the most important stage in the history of dockyard construction which had been reached up to the date of their completion and prior to the year 1880. It is proposed to describe briefly in the present article the extent to which H.M. dockyards have developed since that date, with special reference to the great works which were sanctioned by the Naval Works Acts of 1895 and subsequent years.

**Under special legislation.**

The works proposed under these Acts are classified under three heads, viz., (*a*) the enclosure and defence of harbours against torpedo attack; (*b*) adapting naval ports to the present needs of the fleet; (*c*) naval barracks and hospitals. Under the first heading are included the defensive harbours at Portland, Dover, and Gibraltar; under heading (*b*) are included the deepening of harbours and approaches, the dockyard extensions at Gibraltar, Keyham, Simons Bay, and Hong-Kong, with sundry other items. Under heading (*c*) are included the naval barracks at Chatham, Portsmouth, and Keyham; the naval hospitals at Chatham, Haslar, and Haulbowline; the colleges at Keyham and Dartmouth, with other items. The total estimated cost of these works, as stated in the Act of 1899, amounts to upwards of twenty-three and a half millions sterling, and they will form, when completed, the most important additions yet made at any one period to the dockyard and harbour works required to meet the necessities of the fleet. These works will now be briefly described under the headings of their various localities, together with the principal additions to other dockyards carried out between 1880 and 1901.

### (*a*) *Enclosure and Defence of Harbours against Torpedo Attack.*

*Portland.*—The existing harbour of refuge at this station was commenced in 1847 under the direction of the Admiralty, and completed about fifteen years later in the form and extent in which it remained up to the date of the commencement of the additional works now being carried out. The original design consisted of the partial enclosure of an extensive area of water bounded on the south and west by the island of Portland and the adjacent coast, and sheltered thereby from winds from those quarters, and on the east by a breakwater of large dimensions starting from the north-east corner of Portland island. This breakwater consisted of a rubble mound of stone quarried by convict labour at the summit of the island, lowered by a wire-rope incline to the sea-level, and deposited by means of staging in its position in the mound. The breakwater consisted of two portions, an inner arm terminating in a masonry head and fort, and an outer or detached breakwater terminating in a circular fort at its northern extremity, an entrance for shipping being left between the two. The enclosure thus formed afforded a magnificent sheltered roadstead of great extent, with a depth of water of not less than thirty feet over a large proportion of the area.

The developments of naval strategy and the necessity of greater protection from torpedo attack have, however, led to additional works. It will have been observed from the foregoing remarks that the harbour, while protected on the west, south, and east sides, was still open on the north to Weymouth bay and the Channel. It is therefore to the further and complete enclosure of the roadstead on this northern side that the additional works have been directed (Fig. 1). The distance from the circular fort at the extremity of the eastern breakwater above described to the Bincleaves rocks on the western shore of the harbour is about two miles. This opening is now closed by two additional breakwaters, one portion being detached and about 4465 feet in length, the other starting from the Bincleaves shore and about 4642 feet in length. Each breakwater consists of a rubble mound of stone, quarried as before on the summit of the island, lowered by wire-rope incline, shipped into specially designed hopper barges, towed out and deposited on the site of the breakwaters, which have thus been brought up from the sea bottom to above the water-line in depths of water ranging from 30 to 50 feet. Each section of breakwater

is terminated by a masonry head with beacon light, and two entrances, each 700 feet in width, serve for the navigation of shipping in entrance and exit. The defensive harbour thus completely enclosed, partly by natural means, partly by the great artificial works now carried out, covers an area of 2200 acres to the one-fathom line, of which 1500 acres have a depth of not less than 30 feet at low water, and is probably one of the finest artificial harbours in the world. There is no dockyard at Portland, but the watering and coaling appliances for the supply of the fleet are of considerable importance and extent, the latter having lately been greatly improved by the construction of a coaling jetty and camber for the storage of both sea-borne and land-borne coal and its handling by modern hydraulic appliances.

*Dover.*—The Admiralty pier at Dover, so familiar to passengers by this route to or from the Continent, was the first instalment of the scheme for a large harbour of refuge recommended by the Royal Commissions of 1844–45. This pier was commenced in 1847, and practically completed in 1871, having a total length of about 2000 feet. As an engineering structure it has proved successful, as, with the exception of the destruction of the parapet in 1877, no material damage has been caused by the heavy seas to which it has constantly been exposed. The remainder of the scheme was not, however, completed. The Royal Commission of 1881 on the employment of convicts again recommended the construction of a large harbour at Dover, but beyond the erection of a convict prison nothing further was done for some years. In the meanwhile the Dover Harbour Board, with a view to improving the existing condition of the port, commenced the scheme indicated on the plan and entitled the "commercial harbour," consisting of an east pier, which runs parallel to the general direction of the Admiralty pier, and will ultimately enclose in conjunction with the latter a sheltered water area of some 75 acres. This work was commenced in 1893, and is now approaching completion. The enclosed harbour for the accommodation of H.M. navy, for which funds were voted by Parliament in 1895 and subsequent years, is indicated on the plan. It will be seen that the water area enclosed amounts to 610 acres, exclusive of the commercial harbour, of which 322 acres have a depth of not less than 30 feet at low water. The enclosing breakwaters are three in number, the most westerly one being an extension in a south-easterly direction of the existing Admiralty pier for a length of 2000 feet; the southern breakwater is isolated, and is 4200 feet in length, curving round shorewards at its eastern end to accord with the direction of the third breakwater, which forms the eastern boundary of the harbour; the last starts from the shore at a point somewhat east of the convict prison, and runs southerly for a length of 3320 feet.

These three breakwaters, with a united length of rather more than $1\frac{3}{4}$ miles, are each built of massive concrete blocks in the form of a practically vertical wall, founded upon the solid chalk and rising to a quay level of 10 feet above high water Two entrances, one 800 feet and the other 600 feet in width, are provided in the positions shown on the plan. The foreshore at the foot of the cliffs between the Castle jetty and the root of the eastern breakwater is in process of reclamation by means of a massive sea-wall founded upon the chalk. These great works were begun in 1897 (Fig. 2).

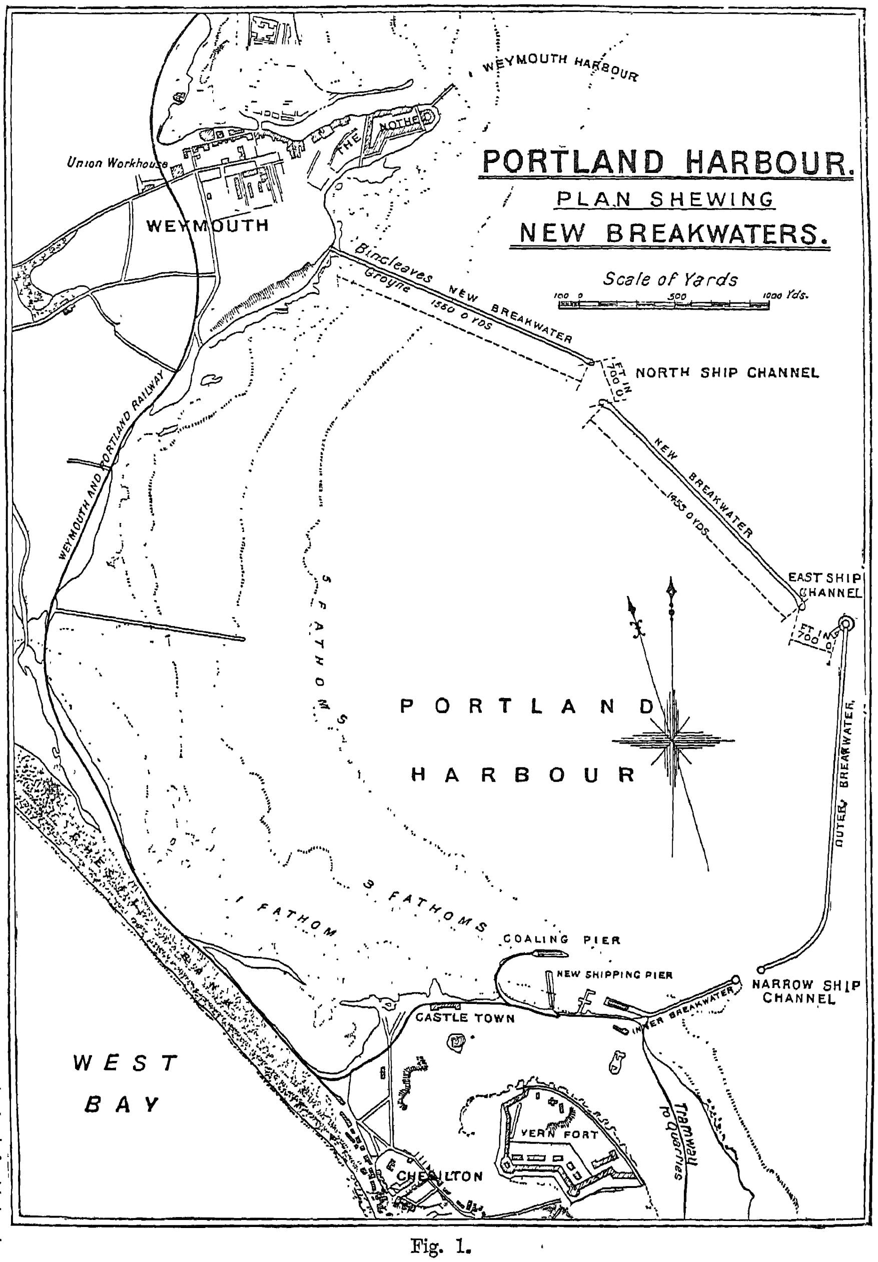



Fig. 1.

*Gibraltar.*—The details of the defensive harbour here are closely connected with the general scheme of dockyard extension, and will be found described under the reference to Gibraltar which follows. The enclosed water area at Gibraltar is less than that at Dover in the proportion of about 440 to 610 acres, but neither harbour is comparable with Portland in area.

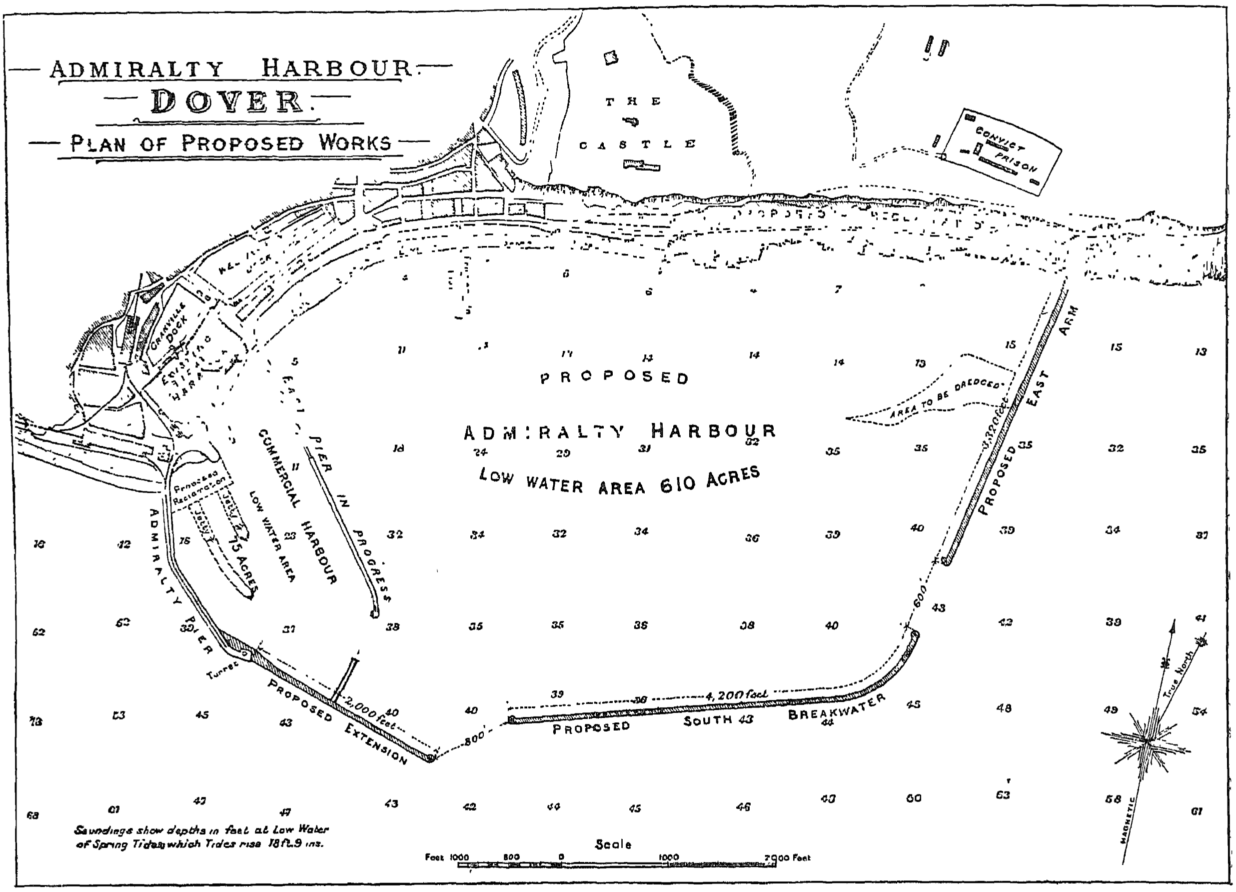

ADMIRALTY HARBOUR
DOVER.
PLAN OF PROPOSED WORKS
THE CASTLE
CONVICT PRISON
GRANVILLE DOCK
EXISTING TIDAL HARBOUR
EAST PIER IN PROGRESS
COMMERCIAL HARBOUR
LOW WATER AREA
Proposed Reclamation
75 ACRES
ADMIRALTY PIER
Turret
PROPOSED EXTENSION
2,000 feet
800'
PROPOSED
ADMIRALTY HARBOUR
LOW WATER AREA 610 ACRES
AREA TO BE DREDGED
3,320 feet
PROPOSED EAST ARM
600'
4,200 feet
PROPOSED SOUTH BREAKWATER
True North
Magnetic
Soundings show depths in feet at Low Water of Spring Tides, which Tides rise 18 ft. 9 ins.
Scale
Feet 1000 500 0 1000 2000 Feet

Fig. 2.

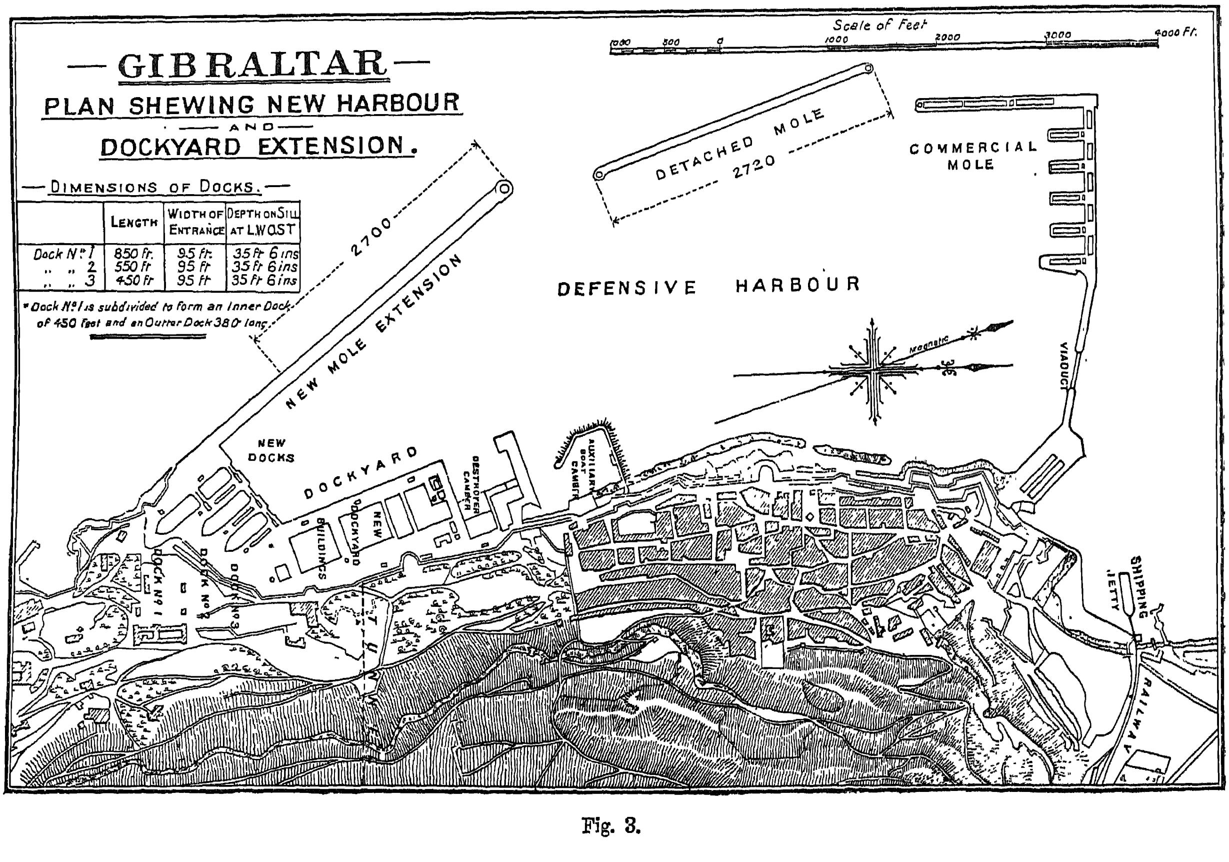

GIBRALTAR
PLAN SHEWING NEW HARBOUR
AND
DOCKYARD EXTENSION.
DIMENSIONS OF DOCKS.
| | Length | Width of Entrance | Depth on Sill at L.W.O.S.T. |
|---|---|---|---|
| Dock No. 1 | 850 ft. | 95 ft. | 35 ft 6 ins |
| " " 2 | 550 ft | 95 ft | 35 ft 6 ins |
| " " 3 | 450 ft | 95 ft | 35 ft 6 ins |
*Dock No. 1 is subdivided to form an Inner Dock of 450 feet and an Outer Dock 380' long.
Scale of Feet
1000 500 0 1000 2000 3000 4000 Ft.
DETACHED MOLE
2720
COMMERCIAL MOLE
2700
NEW MOLE EXTENSION
DEFENSIVE HARBOUR
Magnetic
VIADUCT
NEW DOCKS
DOCKYARD
NEW DOCKYARD BUILDINGS
DESTROYER CAMBER
AUXILIARY BOAT CAMBER
DOCK No. 1
DOCK No. 2
DOCK No. 3
SHIPPING JETTY
RAILWAY

Fig. 3.

### (b) *Adapting Naval Ports to the Present Needs of the Fleet.*

*Gibraltar.*—The history of British naval dockyards is in general one of continuous development, extending over considerable periods of time, and reflecting in the various stages of that history the naval requirements, the engineering skill, and the mechanical resources and appliances of the day. As these have developed and increased, so the older and more obsolete portions and appliances of the yards have been from time to time renewed and readapted to meet modern exigencies; and the result exhibits the constantly increasing effort to meet the demands which modern naval architecture and strategy are as constantly renewing. In the case, however, of the great works at Gibraltar we have the somewhat unique example of the creation of a modern dockyard of the first class, as it were, at a stroke, as the small existing yard will have become entirely absorbed in the new extension works. The absence of any dry dock at Gibraltar had been for some time the occasion of considerable public discussion, and a commission was appointed in 1890 to consider the question. But the recommendations of this commission became greatly amplified in the scheme finally approved by the Admiralty, for which funds were provided in the Naval Works Loan Act of 1895 and subsequent years. This scheme may be said to consist of two principal parts: the construction of a dockyard with ample dry dock accommodation, with the necessary workshops, stores, and offices; and the construction of a great defensive harbour of sufficient extent to shelter a powerful fleet, and yielding largely increased coaling and wharfage accommodation. Combined with the defensive harbour, and forming an integral part thereof, is the new commercial mole, a portion of the cost of which is borne by the colony (Fig. 3).

The necessary space for dockyard purposes is exceedingly limited at the Rock of Gibraltar, and thus, with the exception of the small area of the old yard, the area required has been obtained by artificially reclaiming the land over a considerable sea-space, of which the soundings range from low-water mark to 40 feet in depth. The total area thus created for dockyard purposes is about 64 acres. The material required for this reclamation is obtained chiefly from quarries on the eastern side of the Rock by means of a tunnel pierced for that purpose. The graving docks are three in number, alike in cross section and in depth over the sill, but of unequal lengths, to accommodate battleships and cruisers. Dock No. 1 is 850 feet in length, 95 feet in width at entrance, and has a depth of 35½ feet over the sill at low-water springs. It is divided into two portions by an intermediate sliding caisson, and is capable of docking two ships simultaneously. Dock No. 2 is 550 feet, and Dock No. 3, 450 feet in length, and of similar dimensions in width of entrance and depth over sill. All the docks will have their entrances closed by steel sliding caissons, and are lined throughout with granite and limestone. The most important dockyard buildings are the pumping-engine house, the workshops of the chief constructor's and chief engineer's departments, the naval stores and offices. The pumping-engine house will contain the steam machinery for the emptying of the dry docks, which will be capable of pumping out the contents of the largest dock, amounting at high water to 105,000 tons, and discharging into the sea in five hours. The workshop for the chief constructor's department is an extensive building, 407 feet in length and 322 feet in width. The shops of the chief engineer's department are comprised within a building of similar dimensions. The staff captain's department and other stores are comprised within buildings having a total floor-space of about 300,000 superficial feet. At the northern end of the yard are the administrative offices and a series of slipways for hauling up destroyers, together with a slip for small craft, a wharf for ordnance purposes, and an auxiliary boat camber. The reclaimed area of the dockyard is faced seawards by a wharf wall constructed of interlocked concrete blocks, upon a new system, built in the sea without the aid of a dam, and having an unbroken line for wharfage purposes of about 1600 feet lineal, with a depth of water alongside of 33 feet at low water. Upon this wharf are erected powerful shears and cranes for the use of vessels alongside.

The older appellation of "harbour of refuge" has, from the point of view of the naval strategist, acquired a new and extended meaning, and while the modern defensive harbour may still serve as shelter from bad weather, it further fulfils the not less important function of protection from torpedo attack. The defensive harbour now in course of construction at Gibraltar is formed by the enclosure of a water area of about 440 acres, of which some 250 acres will have a minimum depth of 30 feet at low water. This enclosure is formed by three several works of considerable magnitude: the *New Mole Extension* forming the southerly boundary, the *Commercial Mole* on the north side, and the *Detached Mole* forming the westerly boundary, while two entrances, each 200 yards wide, form the approaches to the harbour from the sea. The *New Mole*, so called in distinction from the Old Mole or Devil's Tongue at the northern end of the town, is supposed to have been commenced during the Spanish occupation in the year 1620. Both New and Old Moles are frequently referred to in Drinkwater's *History of the Siege of Gibraltar*, and the successful assault upon the former by the officers and men of the British fleet forms a leading incident in the capture of Gibraltar by Admiral Sir George Rooke in 1704. Additions to the length of this mole were made at various times, and in 1895 the total length of the artificial mound was about 1400 feet. The extension now in progress will add 2700 feet to this length.

This mole is formed of a rubble mound, with a top width of 102 feet, the stone being obtained from adjacent quarries and deposited in the sea by barges. The harbour side is faced by a continuous wharf wall, having 30 to 35 feet depth of water alongside, and the total length of wharfage available for ships of war for coaling or other purposes will be 3500 feet. The *Detached Mole*, forming the westerly boundary of the harbour, is of a different type of construction. It is a vertical wall formed of massive concrete blocks, the greater number of which are of 32 tons in weight, arranged upon what is known as the sloping block system, and founded upon a rubble mound of stone deposited from barges and levelled for the reception of the blocks by divers. As this breakwater stands isolated, some half a mile from the nearest point on shore, in from 45 to 65 feet depth of water, and has at no time during its construction been connected with the land by any temporary staging, a brief description of the method employed for commencing its constuction will not be without interest. A box-shaped steel caisson, 33 feet wide, 74 feet in length on the top, 101 feet in length at the bottom, and 48½ feet high, fitted with compartments and with ends sloped to the angle of the blockwork, was constructed in this country, shipped to Gibraltar, re-erected, launched, towed to its correct position, and sunk, by the admission of water, on the rubble mound before mentioned. Concrete was then filled in as rapidly as possible until the entire mass, weighing about 9000 tons, had formed, so to speak, an artificial rock or island in the sea, being, in fact, a completed section of the breakwater itself. Upon this foundation were erected two block-setting Titans (see TITAN CRANES), capable of setting 36-ton blocks at a radius of 75 feet, by which means this mole has been rapidly extended north and south to its full length of 2720 feet. The blocks, having been transported from the block-yard by rail and then shipped in barges to the site of the mole, are laid in their sloping position by means of special apparatus designed and patented by the writer.

The *Commercial Mole*, forming the northerly boundary of the harbour, is intended to serve the commercial requirements of the colony, while at the same time it forms an integral portion of the defensive scheme. This mole starts from the neighbourhood of the Waterport wharf, alongside the Old Mole or "Devil's Tongue," an appellation given to this portion of the defences of the fortress during the siege of Gibraltar in 1779–83, on account of the annoyance to the besiegers caused by its flanking fire. The mole consists of a rubble mound projecting in a westerly direction, furnished with five jetties, lying north and south, and terminating in a western arm lying parallel to the jetties. Each jetty and the western arm is faced with a concrete wharf wall, and the total length of wharfage available for mercantile coaling or other purposes amounts to 7000 feet lineal, with a depth of water alongside ranging from 20 to 30 feet. Extensive coal and bonded stores are provided, and an open viaduct is constructed in the connecting arm, leaving a waterway for the purpose of giving circulation to the enclosed waters of the harbour, which is being dredged to secure the depths already referred to.

*Devonport and Keyham.*—Prior to the period dealt with in this article, the works at Keyham described in the ninth edition article on DOCKYARDS had been completed; railway communication with the Cornwall line was established, and a tunnel formed a connexion between the two yards. Keyham yard in 1880 consisted substantially of two basins, the north basin of 9 acres and the south basin of 7 acres in extent; three docks, having floor-lengths of

295, 347, and 413 feet respectively, and extensive dockyard buildings. The most important addition to Devonport yard at this period was the construction of Dock No. 3, having a floor-length of 415 feet, with 34′ 9″ over the sill at high-water springs, and this, with certain dockyard buildings, constitute the principal features in the development of Devonport yard up to the year 1901. Seamen's barracks of considerable architectural importance, with accommodation for 1000 men, together with officers' quarters, drill shed, commandant's residence, &c., were completed on a site to the north of Keyham yard and overlooking the Hamoaze. Such in brief was the extent to which H.M. dockyards at Devonport and Keyham had been developed up to the time when the scheme sanctioned by Parliament under the Naval Works Loan Act of 1895 was first commenced, and the mud flats to the northward of Keyham yard, and immediately in front of the seamen's barracks above referred to, became the active scene of the new works.

These works present three leading features: a tidal basin with entrance from the Hamoaze; a group of three graving docks and entrance lock; and a large enclosed basin, with a coaling depot at the northern end. The tidal basin is in the immediate neighbourhood of the old Keyham north basin, and is 740 feet in length by 590 feet in mean width, with an area of 10 acres and a depth of 32 feet at low water of spring tides. This basin affords access to two graving docks of large dimensions, each dock serving also (when not occupied) as a lock for entrance into the closed basin. One of these docks has a length of 745 feet on floor, with $20\frac{1}{2}$ feet over the sill at low-water springs. The other is 741 feet on floor, with 32 feet over the sill at low-water springs. Each of these docks can be subdivided by means of an intermediate caisson. A third dock, opening out of the closed basin, is 480 feet in length, with $32\frac{1}{2}$ feet over the sill at high water of neap tides, and provision is made for an increase of length when required. An entrance lock, 730 feet in length between caissons, with 32 feet over the sill at low water of spring tides, gives direct access from the Hamoaze to the closed basin, which is 1550 feet in length, 1000 feet in width, and covers an area of $35\frac{1}{2}$ acres, with a depth of $32\frac{1}{2}$ feet at low-water springs. An additional entrance, closed by caissons, but without a lock, communicates with the Hamoaze. A wharf wall forming the eastern boundary of the closed basin will afford a length of wharfage of 800 yards, with 30 feet alongside at low-water springs. The site of these works is an expanse of mud overlying rock at varying depths, which in some places reach 100 feet or more below the level of coping. As the walls of docks, lock, and basins are in every case carried down to the rock, it follows that the process of constructing foundations at such great depths involves engineering operations of considerable magnitude and difficulty.

The docks and basins above described are remarkable for the depths at which their floors and entrances are laid, and this, combined with the tidal rise of $15\frac{1}{2}$ feet, causes the problem of closing and opening the dock and lock entrances to be attended with somewhat more than ordinary difficulty. It is therefore not out of place to describe very briefly the practice in this respect customary in H.M. dockyards. The ordinary lock gate usually found in private docks (though some of the finest modern docks use caissons) is too familiar to need description, but this form of closing an entrance does not afford facilities for carrying a railway line across the dock or lock, and where this is required a swing bridge must be constructed. In the case of H.M. dockyards it frequently happens that railway lines cross the dock entrances, and the weight to be transported by their means, such as heavy guns, boilers, machinery, and the like, would require a swing bridge of great strength and considerable span. It has consequently been found convenient and economical to construct the apparatus for keeping the water out of the dry dock in such a form as to combine the functions of a movable dam and a swing bridge, and this is done by the employment of so-called "caissons." The great majority of dock entrances in H.M. dockyards are closed by caissons, and these are, broadly, of two principal types — the floating or ship caisson and the sliding caisson. The former is sunk into its place in a groove prepared in the dock walls for its reception by means of water supplied by hose into a ballast tank, and raised again by letting the water out. The latter type consists of a rectangular steel or iron box-shaped dam, which is drawn across the entrance by machinery, or withdrawn into a recess provided in the side of the dock entrance when access is required into the dock. Both types can be designed to carry a railway across their upper deck capable of sustaining the heaviest loads ever required. When the caisson is in its place across the entrance and the dock is dry, it has of course to sustain the maximum water pressure which can come upon it at the highest tides. Owing to the causes above mentioned, the caissons at Keyham are of exceptional dimensions, and the mechanical problems to be dealt with in their design are of no ordinary kind. They are, as a rule, sliding caissons, constructed of riveted mild steel, and capable of withstanding a hydraulic pressure amounting in some cases to 3700 tons.

*Simons Bay* (*Cape of Good Hope*).—The existing naval yard at this station covers an area of about 13 acres, exclusive of the victualling establishment and naval hospital, and is provided with a small camber, slipways for torpedo-boats and small vessels, together with various dockyard buildings, storehouses, coal stores, &c., but has no dry dock or deep-water wharf. The new works proposed under the Naval Works Loan Act of 1899, at an estimated cost of two and a half millions sterling, are situated near Blockhouse Point, to the east of the present naval yard. These works consist of a tidal basin of 28 acres in extent, and with a depth of 30 feet at low-water spring tides, enclosed by a breakwater on the eastern and northern sides and a similar projecting arm or pier on the west. The entrance to the basin faces north-westerly, and is 300 feet in width. South of the basin is a large reclaimed area forming the site of the new dockyard. Opening from the basin is a dry dock, 750 feet in length on blocks, with an entrance 95 feet wide and having 30 feet over the sill at low-water spring tides.

This dock can be subdivided by an intermediate caisson in such a manner as to form two docks, respectively 400 feet and 320 feet in length, or 470 feet and 250 feet in length on blocks, as may be required, or the full length of 750 feet can be made available when necessary. The dockyard buildings include extensive shops for the chief engineer's and chief constructor's departments, the pumping-engine house, working sheds, &c., while ample space is reserved for additional docks and buildings. Berthing accommodation is provided in the basin alongside the wharf walls which surround it. The walls available for this purpose have a total length of 2585 feet lineal, are constructed of interlocked concrete block work, with an available depth of water of 30 feet at low water, and are furnished with powerful shear-legs and cranes for the use of vessels alongside. Extensive sheds for the storage of coal are provided. The whole of the dockyard area, together with that of the enclosing breakwater and pier, will be formed by reclamation from the sea; and as the total space thus created amounts to 35 acres, the entire extent of the proposed works, including the tidal basin, will amount to 63 acres in area. The works thus briefly described will, in combination with the existing yard, form an important naval station for the requirements of the fleet in South African waters.

*Hong-Kong*.—The naval yard at this important station consisted of an area of some $4\frac{3}{4}$ acres in extent, but unprovided either with basins, dry docks, or any wharfage suitable for large vessels. The widening range of political affairs in the East, and the increasing requirements of the navy in Chinese waters, had, however, made it obvious that the existing resources of the naval yard were inadequate. The result was an Admiralty scheme of enlargement. The principal features of this scheme are as follows: A tidal basin of $9\frac{1}{4}$ acres in extent is provided, having a depth of 30 feet at low-water springs, and enclosed by wharf walls, giving a total length of wharfage of 2900 feet lineal. A dry dock, opening direct into the roadstead, 550 feet in length on blocks, 95 feet wide at entrance, and with 30 feet over the sill at low-water springs, will accommodate the largest vessel in H.M. navy. Extensive workshops for the chief constructor's and chief engineer's departments, shears, cranes, pumping-engine house, and slipway for

small craft, will also be provided. The site of the extension will be formed by reclamation, and the additional area thus formed, including the basin, will equal $34\frac{1}{2}$ acres. The present yard will thus be increased from $4\frac{3}{4}$ acres to $39\frac{1}{4}$ acres in area, and the extension will mark an important stage in the development of the accommodation required to meet the necessities of the fleet in the East. The existing establishment at Kowloon will be augmented by the construction of coaling jetties, &c.

(*c*) *Naval Barracks, Hospitals, &c.*

The works in progress under this heading are included in the following general remarks on the shore establishments of the navy, which include barracks for the seamen, royal marines, and royal marine artillery, training schools, hospitals, and victualling stores. The policy in recent years with regard to naval barracks has been to provide buildings on shore in place of berthing the men in hulks moored alongside the dockyards; and in pursuance of this policy naval barracks have been provided, or are under construction, in the vicinity of the three great dockyards—Portsmouth, Devonport, and Chatham. At Portsmouth new barracks on the site of the old Anglesey barracks have been commenced, and when completed will provide quarters for 4609 officers and men. At Devonport, as before described, the naval barracks adjacent to the extension works at Keyham were erected to accommodate 1000 officers and men, and the buildings are now being extended so that the numbers may be increased to 2313 officers and men. At Chatham the site of the old convict prison is being utilized for constructing quarters for 3731 officers and men. The royal marines have barracks at Forton, near Gosport; at Stonehouse, near Plymouth; and at Chatham, with a depot at Walmer recently enlarged. The barracks and training establishment of the royal marine artillery are at Eastney, near Portsmouth, and provide accommodation for 1800 officers and men. The above-mentioned buildings include all necessary accessories, such as canteens, drill sheds, sick quarters, and the various buildings required for the accommodation and training of seamen and marines. The training schools on shore include the gunnery establishment at Whale Island in Portsmouth harbour, where an area of 73 acres has been formed by the deposit of excavated material from the dockyard extension works, and a gunnery school, provided for 1100 officers and men, with parade ground, gun drill battery, sick quarters, rifle range, &c. The establishment is about to be enlarged to accommodate an additional number of officers and men under instruction. At Dartmouth H.M.S. *Britannia* has hitherto been used as the training school for naval cadets, but a new naval college is now being erected on the high ground overlooking the site where the *Britannia* is moored. Greenwich Hospital, formerly appropriated to naval pensioners, is now used as a college for the instruction of naval officers in the more advanced branches of their profession, while at Keyham there is a college for engineer students. The largest naval hospital and medical school is at Haslar, near Gosport, covering an area of 88 acres, with beds for 1084 patients. Stonehouse Naval Hospital has 700 beds for the use of seamen and marines of the Devonport district. At Chatham the existing hospital accommodates nearly 250 patients, and a new hospital for 600 beds is under construction. Hospitals or sick quarters are also provided at Great Yarmouth, Dartmouth, Haulbowline, Portland, and South Queensferry. The chief victualling establishments are Deptford for the Thames, Chatham, and Sheerness; the Clarence Yard at Portsmouth; and the Royal William Victualling Yard at Plymouth and Haulbowline. Magazines for warlike stores are established close to the principal dockyards and within easy access by rail or water. At foreign stations Malta has a hospital and victualling yard, Gibraltar has a hospital, and the other chief naval stations in different parts of the world have a shore establishment on a scale adapted to meet their probable requirements.

**Under ordinary navy votes.**

The chief features in the extensions of H.M. dockyards carried out between 1880 and 1901 under the ordinary navy votes, and not already referred to, may now be briefly described.

*Portsmouth.*—The extension works at this dockyard, described in the ninth edition article DOCKYARDS, and completed prior to 1880, formed an important stage in the history of this station, and, together with the works at Chatham carried on at about the same period, marked an epoch of advancement in H.M. yards, following as they did the transformation which had already taken place in naval construction in the substitution of iron for timber and of steam in lieu of sail propulsion. This extension, commenced in 1867, was designed to meet the naval requirements of the day, and no works of equal magnitude have since been carried out at this port. The developments of naval architecture and the increasing length of modern cruisers necessitated, however, additional dry dock accommodation, and in 1896 Docks Nos. 14 and 15 were completed, having a floor length of 557 feet, with 33 ft. 10 in. over the sill at high-water springs. These were the longest docks in the service, with the exception of a double dock at Portsmouth. Other important works carried out since the completion of the extension may be summarized as follows:—The renewal and extension of the jetties on the west front, and, in late years, the construction of jetties at the entrance to the tidal basin and at the north wall; a torpedo range in the harbour; the establishment of a coaling wharf at coaling-point, with hydraulic appliances; the widening of the entrance between Basins 4 and 5; the erection of various buildings, such as torpedo and gun-mounting stores, electrical shops, and the like, with numerous subsidiary works of more or less importance. Extensive dredging of the harbour is in progress for the purpose of increasing the berthing accommodation for the fleet.

*Chatham* dockyard covers an area of 516 acres, including the extension works described in the ninth edition article on DOCKYARDS and completed prior to 1880. No works of equal magnitude or importance have been carried out since that date at this yard, but among the principal additions or improvements which have been made from time to time may be mentioned extensive dredging operations in the Medway for the deepening of the navigable channel and approach to the basins and docks, the provision of a 160-ton crane, the lengthening of Dock No. 5, and the erection of various yard buildings. Additional dry dock accommodation is provided for under the Naval Works Act.

*Pembroke* dockyard has an area of some 79 acres, and is furnished with one dry dock 387 ft. 8 in. in length on blocks, numerous building slips of various lengths, and the usual shops, stores, and other dockyard buildings. The Carr Rocks jetty now under construction will form, when completed, a valuable addition to the resources of the yard in the fitting out and completion of vessels.

*Haulbowline* dockyard was practically completed about the year 1889, and covers an area of 33 acres, while the adjoining victualling yard of 22 acres makes the total area of this naval station 55 acres. The yard includes a closed basin of 9 acres in extent, with entrance from Queenstown harbour, and with 32 ft. 8 in. over the sill at high-water springs. A dry dock at the south end of the basin has a length of 408 feet on blocks, and is

94 feet wide at entrance. The basin is enclosed by wharf walls with a total length of 1700 feet, and furnished with 60-ton shears, cranes, &c. A slipway is provided at the south end of the basin, and the dockyard buildings comprise a pumping-engine house, constructors' shops, furnace house, worksheds, &c.

*Malta* dockyard was but briefly referred to in the ninth edition article, and some further notice is desirable here. The dock and victualling yards occupy together an area of some 100 acres, spread over the shores on both sides of those arms of the grand harbour known as "Dockyard" and "French" creeks, the dockyard being located partly on the former, but principally on the latter creek. In 1880 the graving dock accommodation consisted of one double dock at the extremity of Dockyard creek, known as No. 1 and 2 Docks, with a total length of about 525 feet, and with 25 feet over the sill at average water level, the tidal range at Malta being but slight; and opening into French creek a dry dock of more modern construction, known as No. 3, or the Somerset Dock, 427 feet long on floor, and with 34 feet over the sill. Subsequently to this period the fine range of buildings known as the iron ship repairing shop was erected close to the Somerset Dock, and added greatly to the repairing resources of the yard. Dock No. 4, or the Hamilton Dock, was completed in 1891, having a length on floor of 520 feet, a width of entrance of 94 feet, and with 35 ft. 5 in. depth over the sill at average water level. Associated with this dock was the construction of adjacent deep-water wharf walls, together with the great 160-ton crane. New gun-mounting stores, boiler shop, boat sheds, canteen, coal stores, &c., are among the more recent additions to the yard, and preparations are being made for additional dry dock accommodation

*Halifax* naval yard has an area (including the hospital ground) of about 18 acres. The yard is provided with slipways for small craft, shops, stores, &c., but does not possess a dry dock. A private dock in the immediate vicinity completed in 1889, under a Government subsidy, has a floor length of 560 feet, a width of entrance of 89½ feet, with 30 feet over the sill at high-water springs.

*Bermuda* naval yard is provided with a camber or small enclosed harbour protected with a breakwater. Within the camber is moored an iron floating dock having an inside length of 330 feet. Additional dock accommodation is contemplated.

*Jamaica* naval yard covers an area of about 13 acres, but there is no graving dock.

*Sydney*.—The naval yard at this port is situated on Garden Island, Wooloomooloo Bay, and is provided with a deep-water wharf with shears, an engineer's shop, naval and victualling stores, coal stores and coaling wharf, boat slip, &c. Accommodation for docking H.M. ships is found in the Fitzroy and Sutherland Docks at Cockatoo Island, the former having a length of 474 feet on blocks, with an entrance of 59 feet in width; and the latter a length of 602 feet on blocks, with an 84-feet entrance, having 32 feet over the sill at high-water spring tides.

In addition to the above are naval stations at Ascension, Bombay, Calcutta, Trincomalee, and Esquimalt, together with works in contemplation at Wei-Hai-Wei.

The literature on the subject of H.M. dockyards is not extensive, but the following papers and works may be consulted with advantage:—BERNAYS. "Chatham Dockyard Extension Works," *R. E. Lectures*. Chatham, 1879.—COLSON and MEYER. "Portsmouth Dockyard Extension Works," *Proc. Inst. C. E.*, 1881.—COLSON. "Hamilton Graving Dock, Malta," *Proc. Inst. C. E.*, 1894.—"The Two New Docks at Portsmouth," *Engineer*, vol. lxxxi.—COODE, SON, and MATTHEWS. "Dover Harbour Works," *Brit. Assoc. Mechanical Science Section*. London, 1899.—See also VERNON-HARCOURT. *Harbours and Docks*. London, 1885.—C. COLSON. *Notes on Docks and Dock Construction.* London, 1894. (H. F.)

*Dockyard Administration*.—To a great maritime power like Great Britain the importance of possessing adequate dockyards fitted with every requirement for a fleet is sufficiently obvious. In the dockyard are brought together all the materials of every class and kind required in the construction of ships; and here is provided the labour required for the building of them. In the dockyard the ships receive their provision for offence and defence and their means for navigation, and are fitted in every detail for their service. Depending as the British empire does on the efficiency of its navy to safeguard it from attack and to protect its commerce, it is essential to remember that the navy could not carry on its work successfully if there did not exist an efficient civil service such as is found in British dockyards. In speaking of these establishments, it may be necessary to note that, in addition to the work in the yards of the State, much of that which has been alluded to is carried on in private yards, though the ships built in these last are equipped and brought to completion in the Government establishments. A dockyard may be defined as an enclosure in which are sufficient basins, building slips, dry and wet docks, ammunition, store and coal magazines, coaling wharfs and appliances, and all other things necessary for the life of the ships. It may be noted that a wet dock is a receptacle for a ship which is open to the tide, and a dry dock one specially constructed to receive ships for the repair of the under-water portions of their hulls in the most advantageous conditions.

An ordinary observer, looking at the great mass and variety of stores arriving alongside a ship, and seeing hundreds of men busily engaged in every part of her, may not at once recognize the existence of a system. But closer observation will show that there is a thorough organization, that every man knows his duties, and that every separate party bringing stores or requirements is informed as to exactly what is required to be done with them. The operations go on with celerity, regularity, and order, and it is a matter of astonishment to those who know the vast and varied character of the work how quietly it proceeds and how soon order is evolved from apparent chaos. The dockyards at home and abroad lie within the province of the controller of the navy (the third lord of the Board of Admiralty); and the director of dockyards, whose office, replacing that of surveyor of dockyards, was created in December 1885, is responsible to the controller for the building of ships, boats, &c., in dockyards, and for the maintenance and repair of ships and boats, and of all steam machinery in ships, boats, dockyards, and factories. The director of naval construction, who is also deputy-controller, is responsible, not only for the design of ships, but for their construction, in the sense that he approves great numbers of working drawings of structural parts prepared at the dockyards. But the director of dockyards is the Admiralty official under whose instructions the work goes on, involving the employment and supervision of an army of artisans and labourers. Instructions, therefore, emanate from the Admiralty, but the details lie with the dockyard officials, and in practice there is a considerable decentralization of duties.

The superintendent of a British dockyard is a rear-admiral in the case of Portsmouth, Devonport, and Chatham, and abroad of Malta, but a captain is the superintendent of smaller yards, Sheerness and Pembroke at home, and Gibraltar, Bermuda, Jamaica, Hong-Kong, Sydney, and Ascension abroad; and there are smaller establishments at Halifax, N.S., the Cape of Good Hope,

Trincomalee, and Vancouver; while the Indian Government has dockyards at Bombay and Calcutta.

The chief function of a dockyard is the building and maintaining of ships in efficiency. The constructive work is carried out under the care of the chief constructor of the yard, in accordance with plans sent down from the Admiralty. The calculations for displacement, involving the draught of water forward and aft, have already been made, and, in order to ensure accuracy in the carrying out of the design, an admirable system has been devised for weighing everything that is built into the new ships or that goes on board; and it is astonishing how very closely the actual displacement approximates to that which was intended, particularly when the tendency of weights to increase, in perfecting a ship for commission, is considered. The late Mr Froude, who carried out experiments for many years at Gosport as to the best form for the hulls of ships, was amazed at the great magnitude of the calculations involved in the design of modern vessels. The ship being built to her launching weight, the duty of putting her into the water devolves upon the chief constructor of the yard, and failures in this matter are so extremely rare that it may almost be said they do not occur. As soon as the ship is water-borne the responsibility falls upon the King's harbour master, who has charge of her afloat and of moving ships into the fitting basins. When the ship has been brought alongside the wharf, the responsibility of the chief constructor of the yard is resumed, and the ship is carried forward to completion by the affixing of armour plating, the mounting of guns, often the instalment of engines, boilers, and electrical and hydraulic gear, and the fitting of cabins for officers, mess places for men, and storerooms, and a vast volume of other work unnecessary to be specified. In regard to the complicated details of guns and torpedoes, the captains of the gunnery and torpedo schools have a function of supervision. The captain of the fleet reserve also closely watches the work, because, when the heads of all departments have reported the ship to be ready, she has to be inspected by the commander-in-chief at the port, and then passed into the fleet reserve as ready for sea, and there the captain of the fleet reserve is responsible for her efficiency. Other important officers of a dockyard are the chief engineer; the superintendent civil engineer, who has charge of the work involved in keeping all buildings, docks, basins, caissons, roads, &c., in repair; the naval store officer, who has charge of most of the stores in the dockyard; and the cashier of the yard, whose name sufficiently expresses his duties.

The system of conducting business at the dockyards is analogous to that which prevails at the Admiralty. There is personal communication between the officers responsible for the work, and, as at Whitehall, facilities are afforded for coming to rapid decisions upon matters that are in hand, and the operations are conducted with an ease which contributes much to efficiency. It is the custom for all the principal officers of the dockyard to meet at the superintendent's office at 9.30 A.M. every day, in order that they may be made acquainted with the orders from the Admiralty and may discuss the work of the day, settling the necessary details as they affect the several departments. It thus follows that there is a complete understanding among the principal officers as to the work to be done, and a full recognition of the part which each is to play in its execution. The result is that time is gained by the avoidance of the necessity of passing minutes from department to department—a system which would act prejudicially in many cases.

An efficient police service is a necessity in a dockyard. The force necessary is supplied from the Metropolitan police, and is under the orders of the superintendent of the yard for duties connected with it, and under the commissioner of police for the discipline and disposition of the force. The charges are, of course, paid by the Admiralty, and the system answers well.

(R. V. H.; J. LD.)

### 2. United States.

The shore stations under control of the Navy Department (see Admiralty Administration), and collectively known as naval stations, are under different names according to their nature. Of those called *Navy Yards*, and intended for the general purpose of sources of supply and for repairs of ships, there are within the United States twelve in number. Two of them are on the Pacific coast, situated on Puget Sound, at Bremerton, Washington; and at Mare Island, near San Francisco. The other ten are on the Atlantic coast, and are situated at Kittery, Maine; Boston, Mass.; New London, Conn.; Brooklyn, N.Y.; Philadelphia, Pa.; Washington, D.C.; Portsmouth, Va.; Port Royal, S.C.; Pensacola, Fla.; and Key West, Fla. There are also such naval stations at Havana, Cuba; San Juan, Porto Rico; Honolulu, H.I.; Cavite, P.I.; and Island of Guam, in the Ladrones Islands. A floating dock with a lifting capacity of 15,000 tons is being built for Government use at Algiers, La., near New Orleans.

Besides these, there are important naval stations established for special purposes, but which in some cases are also available for ports of supply and for repairs. These are: the Naval Academy, Annapolis, Md., for the instruction of naval cadets; the training stations at Newport, R.I., and Yerba Buena Island, Cal., for the instruction of apprentices; the proving ground at Indian Head, Md., on the Potomac river, where all Government-built ordnance is tested; the War College at Newport, R.I., for the instruction of officers; the torpedo station at Newport, for the instruction of officers and men in torpedoes, electricity, and submarine diving; the naval observatory at Washington; and the marine post at Sitka, Alaska. Coaling depots have been established at Honolulu, Pago Pago, Samoan Islands, and at Manila, P.I. Numerous others are to be established soon, both at home and abroad.

Naval hospitals are located at the Portsmouth, Boston, New York, Philadelphia, Washington, Norfolk, and Mare Island yards; at Newport, R.I.; Cavite, P.I.; and Yokohama, Japan.

Information regarding the dry docks is given in the table on the following page.

The commandant of a navy yard and station, who is usually a rear-admiral, is its commander-in-chief. His official assistants are called heads of departments. The captain of the yard, who is next in succession to command, has general charge of the water front and the ships moored there, and of the police of the navy yard; it is his duty to keep the commandant informed as to the nature and efficiency of all work in progress. The equipment officer has charge of anchors, chains, rigging, sails, and the electric generating plant. The other heads of departments are the ordnance officer, the naval constructor, the engineering officer, the general storekeeper, the paymaster of the yard, the surgeon, and the civil engineer. The clerks and draughtsmen employed by these officers are appointed under civil service rules, and their employment is continuous so long as funds are available. The foremen are selected by competitive examination, and their number is fixed. In the employment of mechanics and labourers, veterans are given preference, after which follow persons previously employed who have displayed especial efficiency and good conduct. The rates of wages

## AMERICAN NAVY YARD DOCKS.

| Navy Yard. | Portsmouth, N.H. | | Boston, Mass. | | New York, N.Y. | | | League Island, Pa. | | Norfolk, Va. | | Port Royal, S.C. | Pensacola, Fla. | New Orleans, La. | Mare Island, Cal. | | Puget Sound, Wash. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depth of water in channel and harbour M.L.W. | 30 | | 30 | | 30 | | | 28 | | 28 | | 30 | 24 | . . | 28 | | 30 |
| Tides: mean rise and fall | 7.6 | | 10.0 | | 6.2 | | | 4.25 | | 2.7 | | 7.0 | 0.1 | 0.0 | 4.6 | | 8.1 |
| Length: wharf room | 5500 | | 4200 | | 10,600 | | | 12,500 | | 3700 | | 800 | 3200 | ... | 4000 | | 1200 |
| Facilities: making extensive repairs | Good | | Very good | | Excellent | | | Good | | Excellent | | Fair | Poor | None | Very good | | Fair |
| Facilities: obtaining material and supplies | Good | | Excellent | | Excellent | | | Excellent | | Very good | | Fair | Poor | Very good | Very good | | Poor |
| Number of docks | 2 | | 2 | | 3 | | | 2 | | 2 | | 1 | 1 | 1 | 2 | | 1 |
| *Description of docks*:— | 1 | 2 | 1 | 2 | 1 | 2 | 3 | 1 | 2 | 1 | 2 | 1 | 1 | 1 | 1 | 2 | 1 |
| Type | Wood, floating | Concrete and stone | Stone | Concrete and stone | Stone | Timber | Timber | Timber repaired with masonry | Concrete and stone | Stone | Timber repaired with masonry | Timber | Wood, floating | Steel, floating | Stone | Concrete and stone | Timber with masonry |
| Date of completion | 1851 | Building | 1833 | Building | 1851 | 1890 | 1897 | 1891 | Building | 1834 | 1889 | 1895 | 1898 | Building | 1886 | Building | 1897 |
| Condition at present | Fair | New | Excellent | New | Excellent | Good | Fair | Fair | New | Excellent | Very good | Good | Good | New | Excellent | New | Very good |
| Length: On coping | 350 0 | 750.0 | 397.6 | 750.0 | 369.2 | 480.0 | 670 0 | 500.0 | 750.0 | 331.8 | 500.0 | 495.0 | 234.7 | 345.0 | 513.0 | 750.0 | 650.0 |
| Length: On floor | 344.9 | 725.0 | 368.2 | 729 0 | 338.2 | 439 9 | 626.7 | 459.9 | 723.0 | 302.8 | 459.9 | 459.0 | 234.7 | 525 0 | 459.0 | 723.0 | 618.5 |
| Width: Body at coping | 90.7 | 130.0 | 86.12 | 114.0 | 98.0 | 130.3 | 151.0 | 133 0 | 134.0 | 86.2 | 130.3 | 126.0 | 67.2 | 108.1 | 122.2 | 134.0 | 130.1 |
| Width: Entrance at coping | 90 7 | 101.8 | 61.0 | 101.7 | 66.0 | 90.0 | 105.2 | 89.9 | 102.6 | 60 0 | 85.0 | 97.0 | 67.2 | 100.0 | 80 6 | 101.9 | 92.7 |
| Width: Body on floor | 56.7 | 80.0 | 30.0 | 72.0 | 30.0 | 50.0 | 64.3 | 50.0 | 80.0 | 30.0 | 50.0 | 54.0 | 57.7 | 84.25 | 30.0 | 80.0 | 67.1 |
| Width: Entrance on sill | 56.7 | Bottom 69 flat, with sides rad. 10 | Inverted arch rad. 4.8 | Bottom 72 flat, with sides rad. 10 | Rad. bottom 69.6, 15.5 sides | 72.0 | 70.0 | 53.0 | Bottom flat, with sides rad. 10 | Inverted arch rad. 60 | 52.9 | 66.0 | 57.7 | 90.25 | Bottom 30.1 flat, with sides rad. 24 | Bottom 73.5 flat, with sides rad. 10 | Bottom 46.1 flat, with sides rad. 20.6 |
| Water over sill | 22.0 | 30.0 | 25.0 | 30.0 | 25.0 | 25.6 | 29.0 | 25.4 | 30.0 | 25.1 | 25.5 | 26.0 | 17.0 | 28.0 | 27.4 | 30.0 | 30.0 |
| Travelling crane around dock | No | No | No | No | Yes | Yes | Yes | Yes | No | Yes | Yes | No | No | No | Yes | No | No |

are determined semi-annually by a board of officers, who ascertain the wages paid by private establishments in the vicinity of the navy yard. Eight hours constitute the legal work day. When emergencies necessitate longer hours the workmen are paid at the ordinary rate plus 50 per cent.

The nature and extent of work to be performed upon naval vessels is determined by the Secretary of the Navy; the commandant then issues the necessary orders. The material required is obtained by a system of requisitions, which provide for the purchase from the lowest bidder after open competition. Heads of departments initiate the purchase of materials which are peculiar to their own work; ordinary commercial articles, however, are usually carried in a special stock called the "Naval Supply Fund," which may be drawn upon by any head of department. All materials are inspected, both as to quantity and quality, by a board of inspectors consisting of three officers.

(W. T. S.)

### 3. Other Dockyards.

*France.*—The French coast is divided into five naval arrondissements, which have their headquarters at the five naval ports, of which Cherbourg, Brest, and Toulon are the most important, Lorient and Rochefort being of lesser degree. All are building and fitting-out yards. Each arrondissement is divided into sous-arrondissements, having their centres in the great commercial ports, but this arrangement is purely for the embodiment of the men of the Inscription Maritime, and has nothing to do with the dockyards as naval arsenals. In each arrondissement the vice-admiral, who is naval prefect, is the immediate representative of the Minister of Marine, and has full direction and command of the arsenal, which is his headquarters. He is thus commander-in-chief, as also governor-designate for time of war, but his authority does not extend to ships belonging to organized squadrons or divisions. The naval prefect is assisted by a rear-admiral as chief of the staff (except at Lorient and Rochefort, where the office is filled by a captain), and a certain number of officers, the special functions of the chief of the staff having relation principally to the efficiency and *personnel* of the fleet, while the "major-general," who is usually a rear-admiral, is concerned chiefly with the *matériel*. There are also directors of stores, of naval construction, of the medical service, and of the submarine defences (which are concerned with torpedoes, mines, and torpedo-boats), as well as of naval ordnance and works. The prefect directs the operations of the arsenal, and is responsible for its efficiency and for that of the ships which are there in reserve. In regard to the constitution and maintenance of the naval forces, the administration of the arsenals is divided into three principal departments, the first concerned with naval construction, the second with ordnance, including gun-mountings and small-arms, and the third with the so-called submarine defences, dealing with all torpedo *matériel*.

*Cherbourg*, at the head of the Cotentin Peninsula, is a dockyard and harbour chosen on geographical grounds and possessing no natural advantages. It owes its existence in the first place to Louis XIV., and Vauban as the engineer, but the construction of the great breakwater, which encloses the harbour on the north, was a work of very great difficulty; it, after being damaged and washed away several times, was recommenced in 1832 and completed. It is over 4000 yards long, is well protected by forts, and has two entrances, the eastern passage having been narrowed to 500 yards by a second breakwater carried out from the Batterie des Grêves to the Ile Pelée, while the western entrance is about 1000 yards wide, and lies between the main breakwater and a mole run out from the Fort de Querqueville. The arsenal covers an area of about 54 acres. It consists of an entrance port and of two large basins, all cut out of the solid rock, and there are eight dry docks, of which the principal are capable of admitting the largest vessels. The arsenal is very completely fitted, and there are extensive stores, magazines, barracks, and engineering shops. The small battleship *Henri IV.* has been built there, with several modern armoured cruisers, and Cherbourg has become the principal arsenal for the building of submarine boats.

The harbour and arsenal of *Brest* are approached through the Goulet, which is divided into two deep channels by the Fillettes and the Mengam Reef, beyond which a great expanse of water is reached, stretching eastward to Landevenec and having the arsenal of Brest on the north. The arsenal lies in a rocky valley open to the harbour, into which the little river Penfeld flows, the two sides of the channel being united by a splendid revolving bridge, which gives a headway at high tides of 72 feet. The water space has an average width of 110 yards in the port, with a maximum of about 170 yards and a minimum of 75 yards. Near the entrance is the great basin excavated in 1683 and enlarged in 1864. Beyond are the stores and magazines, the old prison, the rope-works, the saw-yard, and the building slips, while on the Recouvrance or western side, beyond the bridge, are the gun-shops, the *salle d'armes*, machine-shops, basins and slips, as well as coaling and other establishments. The arsenal possesses a dry dock for destroyers and gunboats, two for cruisers and small battleships, and two for the largest classes of ships. A reconstruction has been begun which will give two additional large docks, of which one can be used for two vessels owing to the provision of a dividing dock-gate. Another dock of large size is to be constructed in the commercial port. At the entrance to the arsenal, and actually in the harbour of Brest, a jetty has been constructed, forming what is called the *rade-abri*. The works there are to be extended, and magazines and engineering shops are to be built on land won from the harbour. In regard to building facilities, it may be said that Brest has five slips for the construction of vessels ranging from 150 tons to 13,000 tons. The sinuosities of the valley in which the arsenal lies render it somewhat incommodious, but the protective harbour mentioned above will considerably increase the facilities. The arsenal and the harbour, as well as its approaches, are protected by a great number of forts and batteries furnished with modern heavy and quick-firing guns.

The harbour of *Lorient* is formed by the junction of the Blavet and Scorff, and is 3½ miles long, the naval arsenal being on the Scorff, and chiefly on its right bank. Lorient is a port of construction, but large ships built there are usually fitted at Brest. The largest battleships, such as the *Bouvet*, *Brennus*, and *St Louis*, as well as first-class armoured cruisers, have been constructed at the port. There are two dry docks, and the port is well equipped, but the harbour is shallow, and will not accommodate a large squadron, the usual anchorage being to the north of the Ile Groix.

*Rochefort*, the head of the fourth arrondissement, dates from the time of Louis XIV., and is formed by the river Charente, the waters of which are being deepened to facilitate the approach for larger vessels. The largest ships built at the port do not exceed 8000 tons. There are two dry docks, three building slips, and a torpedo basin.

*Toulon* is the most important of the French dockyards, and is the headquarters of the Mediterranean fleet. The arsenal, which was created by Louis XIV., Vauban being the engineer of the works, lies on the north side of the Petite Rade. This is approached from the Grande Rade by passages at the north and south ends of a long breakwater which extends from the direction of Le Mourillon towards the Cépet Peninsula. The arsenal has been greatly enlarged, and at the present time the water space within the moles amounts to about 150 acres, while the quays approach 4 miles in length. Outside in the Petite Rade is a splendid protected anchorage for a great fleet, the whole being commanded by many forts and batteries. There are four great basins approached from the Petite Rade—the Vieille Darse, to the east, on the side of Le Mourillon; the Darse Vauban, next to it; and the Darse de Castigneau and the Darse Missiessy, farther to the west. In the Darse Vauban are three dry docks, two of them 246 feet long, with a depth of water on the sill of about 20 feet; while the third is 283 feet long, with a depth of over 24 feet. Three other dry docks are in the Darse de Castigneau, of which one is in two sections. The largest of the docks is 385 feet long, and the depth of water on the sill in all these docks averages 30 feet. In the Darse Missiessy are two dry docks, 426 feet long, with a depth on the sill of over 32 feet. There are several building slips, and the yard is supplied with a gun foundry and wharf, fitting shops, boiler works, victualling and other establishments, rolling mills, magazines, and everything that can be required to make it the efficient base of a great fleet. Le Mourillon is a subsidiary yard at Toulon, devoted chiefly to ship-building, and possessing large facilities, including five covered slips.

*Corsica*, which has naval harbours at Ajaccio and other places, is a dependency of the arsenal at Toulon. Porto Vecchio is intended to be made a centre of the mobile defence of the island, with every facility for the repairing of torpedo-boats; Bonifacio to be

improved as a secondary station; Bastia to be provided with a floating dock; and minor establishments to be formed at Calvi and the Ile Rousse.

Docking facilities are being increased in *Algeria*, and the naval station is being united with that of Tunis. *Bizerta*, the Tunisian port, has been made a naval base by the deepening and fortifying of the canal which is the approach to the inner lake, upon which naval establishments are being constructed for the refitting, coaling, and provisioning of the fleet. There are arsenals also at Saigon and Hai-phong, and an establishment at Diego Suarez, which is being extended.

The subsidiary establishments in France are the gun foundry at *Ruelle;* the steel and iron works at *Guérigny*, where anchors, chains, and armour-plate are made; and the works at *Indret*, on an island in the lower Loire, where machinery is constructed. There are many private shipbuilding establishments in the country, the most important being the Forges et Chantiers de la Méditerranée at *La Seyne*, on the lesser roadstead at Toulon, where very many French and foreign warships of the largest classes have been built. The same company has a building yard at *Graville*, near Havre. Other establishments are the Ateliers et Chantiers de la Loire, at *Saint Nazaire;* the Normand Yard, at *Havre;* and the Chantiers de la Gironde, near *Bordeaux*.

*Germany*.—With the expansion of the German navy considerable additions have been made to the two principal dockyards. These are Wilhelmshaven, the naval headquarters on the North Sea, and Kiel, the headquarters on the Baltic, Danzig being an establishment of lesser importance, and Kiao-chow an undeveloped base in the Shan-tung peninsula, China. The chief official at each home dockyard is the superintendent (Oberwerftdirektor), who is a rear-admiral or senior captain directly responsible to the Naval Secretary of State. Under the superintendent's orders are the chief of the "Ausrüstung" department, or captain of the fleet reserve, the directors of ordnance, torpedoes, navigation, naval construction, engineering, and harbour works, with some other officers. The chiefs of the constructive and engineering departments are responsible for the building of ships and machinery, and for the maintenance of the hulls and machinery of existing vessels; while the works department has charge of all work on the quays, docks, &c., in the dockyard and port. A great advance has been made in increasing the efficiency and capabilities of the imperial dockyards by introducing a system of continuous work in the building of new ships and effecting alterations in others, and German material is exclusively used.

*Wilhelmshaven*, on the Jade, is an artificial port, and has been constructed entirely since the year 1857, when extensive works were undertaken to protect the port from the inroads of the North Sea. The old port is on the western side, where, communicating with the sea by the fitting basin, is a building harbour with three dry docks and two building slips. Here two other large dry docks are now being constructed at a total cost of 12 million marks, partly contributed by the North German Lloyd in consideration of the navy forgoing the right to precedence over all vessels of the mercantile marine in regard to the use of the company's dock at Bremerhaven. This renunciation only applies to times of peace. The new docks will admit the largest men-of-war, even if lying deep in the water through the flooding of compartments, and will be provided with very powerful pumping apparatus, which will empty them in 2½ hours. After the war with France a second building period was entered upon at Wilhelmshaven, and works, including another harbour entrance, were continued until 1886. A new mole is now being built on the east side, where a third entrance to the harbour is projected, as well as the construction of a great basin and other works. There are at the present time two large building slips at the yard, a floating dock, and the five dry docks, built and building, alluded to above. The machine-shops, ordnance, and other stores and magazines are very extensive.

The North Sea station is now in direct communication with the arsenal at *Kiel*, on the Baltic, by way of the Kaiser Wilhelm Canal from Brunsbüttel, on the Elbe, to Holtenau, on Kiel Bay. Kiel is an extremely important naval station on the eastern side of the Schleswig-Holstein neck and on one of the finest harbours in the world, and possesses a fully equipped arsenal equal to all the requirements of the Baltic command. Kiel itself has greatly grown since the war of 1864 gave it to the Prussians. The arsenal is provided with a complete establishment for the building, fitting, and provisioning of a great fleet; and the docking facilities are being increased by the building of two great dry docks analogous to those at Wilhelmshaven. There are at the present time four building and patent slips, four dry docks, and two floating docks. A new harbour for torpedo craft is being constructed in Wick Bay, south of the mouth of the Kaiser Wilhelm Canal. No account of Kiel would be complete without a reference to the Germania Yard, which is now an establishment of the Krupp firm, and is capable of constructing vessels of the largest class. There are ten building slips in this yard, ready or projected, four having lately been built and roofed in, so that work can go on in all weathers. The Howaldt works at Kiel are also of great importance, and have large building facilities, which are being added to, with a floating dock for ships of 11,000 tons.

*Danzig* is a yard of lesser importance, but very completely equipped for the building of small armour-clads and cruisers. Here are two building slips and one dry dock. The Schichau Shipbuilding Works at Elbing (where torpedo craft are built) have also an important establishment at Danzig, and vessels of the largest class have been built there. The Vulkan Yard at Bredow, near Stettin, the Weser Company at Bremen, and the establishment of Blohm & Voss at Hamburg, are other important private establishments which have built many vessels for the German navy as well as for foreign states.

*Russia*.—In Russia the naval ports are of two classes. The most important are Cronstadt, St Petersburg, and Nicolaieff. Of lesser importance are Reval, Sveaborg, Sebastopol, Batum, Baku, and Vladivostok. The last-named port does not lose importance through the acquisition of Port Arthur, which, however, is rapidly becoming the chief Russian naval base in the Pacific. The administration of the larger ports, except St Petersburg, which is under special regulations, is in the hands of vice-admirals, who are commanders-in-chief, while the smaller ports are under the direction of rear-admirals. All are directly under the Minister of Marine, except that the Black Sea ports and Astrabad, on the Caspian, are subordinate to the commander-in-chief at Nicolaieff. Latterly Sebastopol has grown in importance, and will ultimately become a purely naval harbour, the commercial harbour being removed to Feodosia. The Russian Government proposes also to remodel the harbour works at St Petersburg and Cronstadt, and it is stated that the latter will become a naval port only. The Emperor Alexander III. Port at Libau, on the Baltic, in a region less liable to be icebound in the winter, is approaching completion. Considerable progress has been made in building ice-breaking vessels, by which it is hoped to maintain open passages to the ports during the winter months. A small port is being formed on the White Sea, which may ultimately be connected with the Gulf of Finland by a canal through the lake region.

There are two Government dockyards in the city of St Petersburg, both under the supervision of the port admiral. The most important of these is the new Admiralty Yard in the centre of the city, where both building and repairing work goes forward. There are three building slips in the yard, of which two, for the construction of the largest battleships, are new and of stone. The slips are housed in, so that the building work can go on in all weathers. At this yard there is also a very large experimental basin, some 400 feet in length, for trials with models of vessels. The yard is well provided with appliances, and there are two large machine-shops. The Galerny Island Yard is a little lower down the river, and is an important building establishment entirely devoted to construction. There are two building slips for large vessels, besides numerous workshops, storehouses, and other buildings, and a very fine moulding loft about 500 feet long and nearly 100 feet broad. The battleships *Alexander II.*, *Gangut*, *Poltava*, *Petropavlovsk*, *Sevastopol*, and *Orel* have been built at the Galerny Yard.

The Baltic Yard is near the mouth of the Neva, and was originally known as the Baltic Shipbuilding and Engineering Works, but it was taken over by the Ministry of Marine, which owned most of the shares, in 1894. Since that time the establishment has been enlarged, and a new stone building slip, 520 in length, completely housed in, has been finished, and numerous buildings have been erected. Here the *Rurik*, *Rossia*, *Gromoboi*, and other powerful cruisers were built. The Baltic works are now directed by a constructor of the imperial navy, but the work is not entirely confined to warship building.

The dockyard at *Cronstadt* is the principal arsenal for supplying

the Baltic fleet with stores and ammunition, and is largely used for repairs, there being four dry docks—the Alexandrovsky, 584 feet long and 85 feet wide; the Constantinovsky, 490 feet long and 73 feet wide; the Nikolaievsky; and the Petrovsky. There are numerous workshops, storehouses, magazines, and steam factories, with a depôt for torpedoes and a torpedo workshop. The workmen employed at St Petersburg number about 3500, at the Baltic Yard about 7250, and at Cronstadt about 3830. There are no strictly private yards for the building of large vessels in Russia, with the exception of the Black Sea Company at Nicolaieff. Messrs Creighton build torpedo-boats at Abo in Finland, and the Admiralty has steel works at Ijora, where some torpedo-boats have been built; and other ordnance and steel works are at Obukhoff and Putiloff. The new port at Libau includes an outer port, a naval port, and a commercial harbour. In the first named is a large basin for ships completing, surrounded by storehouses, workshops, and other buildings, as well as another large basin with dry docks and workshops for repair, the two being connected by a canal. The works in the naval port were approaching completion in 1901.

At *Vladivostok* a fine new dry dock has been opened, which is 550 feet long and 90 feet wide. The facilities of *Port Arthur* are being considerably developed, and the completion of the railway adds greatly to the importance of the port.

*Italy.*—The principal Italian state dockyards are Spezia, Naples, and Venice, the first named being by far the most important. It covers an area, including the water spaces, of 629 acres, and there are five dry docks, three of them being 433 feet long and 105 feet wide, and two of them 361 feet long and 98 feet 6 inches wide. The dockyard is very completely equipped with machinery of the best British, German, and Italian makes. At Spezia several of the finest Italian ships have been built. The number of hands employed in the yard averages 4000. Spezia has two building slips, and for smaller vessels there are two in the neighbouring establishment of San Bartolommeo (which is the headquarters for submarine mining), and one at San Vito, where is a Government gun factory.

The dockyard at *Naples* covers an area of about 18 acres, but at Castellammare the establishment is a little larger. There are four building slips at the last-named establishment, and a fine dry dock is at Naples.

At *Venice* are two fine dry docks, 361 feet long, and two building slips, and the yard is well equipped for turning out iron and steel forgings. A large dry dock has been built at Taranto. There is a small naval establishment at Maddalena Island on the Strait of Bonifacio. The Italian Government has no gun or torpedo factories, nearly all the ordnance coming from the Armstrong factory at Pozzuoli, near Naples, and the torpedoes from the Schwarzkopf factory at Venice, while armour-plates are produced at the important works at Terni. Machinery is supplied by the firms of Ansaldo, Odero, Orlando, Guppy & Hawthorn, and Pattison. The three establishments first named have important shipbuilding yards, and have constructed vessels for the Italian and foreign navies. The Orlando Yard at Leghorn is Government property, but is leased by the firm, and possesses five building slips.

*Austria-Hungary.*—The naval arsenal is on the well-protected harbour of Pola, in Istria, which is the headquarters of the national navy, and includes establishments of all kinds for the maintenance of the fleet. There are large building and docking facilities, and a number of warships have been built there. There is a construction yard also at Trieste. A new coaling and torpedo station is at Teodo, large magazines and stores are at Vallelunga, and the mining establishment is at Ficella. The shipbuilding branch of the navy is under the direction of a chief constructor (Oberster-Ingenieur), assisted by seven constructors, of whom two are of the first class. The engineering and ordnance branches are similarly organized.

*Spain.*—The Spanish dockyards are of considerable antiquity, but of diminishing importance. There is an establishment at Ferrol, another at Cartagena, and a third at Cadiz. They are well equipped in all necessary respects, but are not provided with continuous work. A recent arrangement is the specialization of the yards, Ferrol being designed for larger, and Cartagena for smaller, building work. The ordnance establishment is at Carraca.

*Japan.*—The principal Japanese dockyard, which was established by the Shogunate in 1866, is Yokosuka. French naval constructors and engineers were employed, and several wooden ships were built there. The Japanese took the administration into their own hands in 1875, and have built a number of vessels of small displacement in the yard. The limit of size has been about 5000 tons, but it is intended to enlarge the establishment so that vessels of the first class may ultimately be built there. There is a first-class modern dry dock which will take the largest battleship. About 4000 hands are employed. Shipbuilding would be undertaken to a larger extent but for the fact that nearly all material has to come from abroad. All the important vessels of the Japanese navy have been built in Great Britain, France, Germany, and the United States. Japan has dockyards of lesser importance at Kuré and Sassebo, and a fourth is being established at Maisuru, on the north-west coast of the main island. (J. LD.)

**Dodgson, Charles Lutwidge** ("LEWIS CARROLL") (1832–1898), English mathematician and author.—The literary life of "Lewis Carroll" is familiar to every one, but the private life of Charles Lutwidge Dodgson was retired and practically uneventful. The son of the Rev. Charles Dodgson, vicar of Daresbury, he was born in that village on 27th January 1832. After four years' schooling at Rugby, he matriculated at Christ Church, Oxford, in May 1850; and from 1852 till 1870 held a studentship there. He took his degree in 1854, and the following year was appointed mathematical lecturer at Christ Church, a post he continued to fill till 1881. In 1861 he was ordained. His earliest publications, beginning with *A Syllabus of Plane Algebraical Geometry* (1860) and *The Formulæ of Plane Trigonometry* (1861), were exclusively mathematical; but late in the year 1865 he published, under the pseudonym of "Lewis Carroll," *Alice's Adventures in Wonderland*, a work that was the outcome of his keen sympathy with the imagination of children and their sense of fun. Its success was immediate, and the name of "Lewis Carroll" has ever since been a household word. It was followed (in the "Lewis Carroll" series) by *Phantasmagoria*, in 1869; *Through the Looking-Glass*, in 1871; *The Hunting of the Snark*, 1876; *Rhyme and Reason*, 1883; *A Tangled Tale*, 1885; and *Sylvie and Bruno*, in two parts, 1889 and 1893. A number of anonymous skits on Oxford topics, that appeared between 1865 and 1874, were due to his pen. While "Lewis Carroll" was delighting children of all ages, C. L. Dodgson periodically published mathematical works, such as *An Elementary Treatise on Determinants* (1867), *Euclid, Book V., proved Algebraically* (1874), *Curiosa Mathematica* (1888); and throughout this dual existence Mr Dodgson pertinaciously refused to acquiesce in being publicly identified with "Lewis Carroll." Though the fact of his authorship of the "Alice" books was an open secret, he invariably stated, when occasion called for such a pronouncement, that "Mr Dodgson neither claimed nor acknowledged any connexion with the books not published under his name." He died at Guildford, 14th January 1898. (R. F. S.)

**Dodona.**—The ruins at Dramisos, near Tsacharovista, in Epirus, consisting of a theatre, the walls of a town, and some other buildings, had been conjectured to be those of Dodona by Wordsworth in 1832, but the conjecture was changed into ascertained fact by the excavations of M. Carapanos. In 1875 he made some preliminary investigations; soon after, an extensive discovery of antiquities was made by peasants, digging without authority; and after this M. Carapanos made a systematic excavation of the whole site. The topographical and

architectural results are disappointing, and show either that the site always retained its primitive simplicity, or else that whatever buildings once existed have been very completely destroyed. As M. Carapanos states that he has turned over the whole surface to a considerable depth, he can hardly have failed to bring to light whatever is left.

To the south of the hill, on which are the walls of the town, and to the east of the theatre, is a plateau about 200 yards long and 50 yards wide. Towards the eastern end of this terrace are the scanty remains of a building which can hardly be anything but the temple of Zeus; it appears to have consisted of pronaos, naos or cella, and opisthodomus, and some of the lower drums of the internal columns of the cella were still resting on their foundations. No trace of any external colonnade was found. The temple was about 130 feet by 80 feet. It had been converted into a Christian church, and hardly anything of its architecture seems to have survived. In it and around it were found the most interesting products of excavation—statuettes and decorative bronzes, many of them bearing dedications to Zeus Naïos and Dione, and inscriptions, including many small tablets of lead which contained the questions put to the oracle. Farther to the west, on the same terrace, were two rectangular buildings, which M. Carapanos conjectures to have been connected with the oracle, but which show no distinguishing features.

Below the terrace was a precinct, surrounded by walls and flanked with porticoes and other buildings; it is over 100 yards in length and breadth, and of irregular shape. One of the buildings on the south-western side contained a pedestal or altar, and is identified by M. Carapanos as a temple of Aphrodite, on the insufficient evidence of a single dedicated object; it does not seem to have any of the characteristics of a temple. In front of the porticoes are rows of pedestals, which once bore statues and other dedications. At the southern corner of the precinct is a kind of gate or propylæum, flanked with two towers, between which are placed two coarse limestone drums. If these are *in situ* and belong to the original gateway, it must have been of a very rough character; it is very improbable that they carried, as M. Carapanos suggests, the statuette and bronze bowl by which divinations were carried on.

The chief interest of the excavation centres in the smaller antiquities discovered, which are now placed in M. Carapanos's collection in Athens. Among the dedications, the most interesting historically are a set of weapons dedicated by King Pyrrhus from the spoils of the Romans, including characteristic specimens of the pilum. The leaden tablets of the oracle contain no certain example of a response, though there are many questions, varying from matters of public policy or private enterprise to inquiries after stolen goods.

See *Dodone et ses Ruines*, par Constantin Carapanos. Paris, 1878. For the oracle inscriptions, see E. S. Roberts in *Journal of Hellenic Studies*, vol. i. p. 228. (E. Gr.)

**Dolby.** See Sainton.

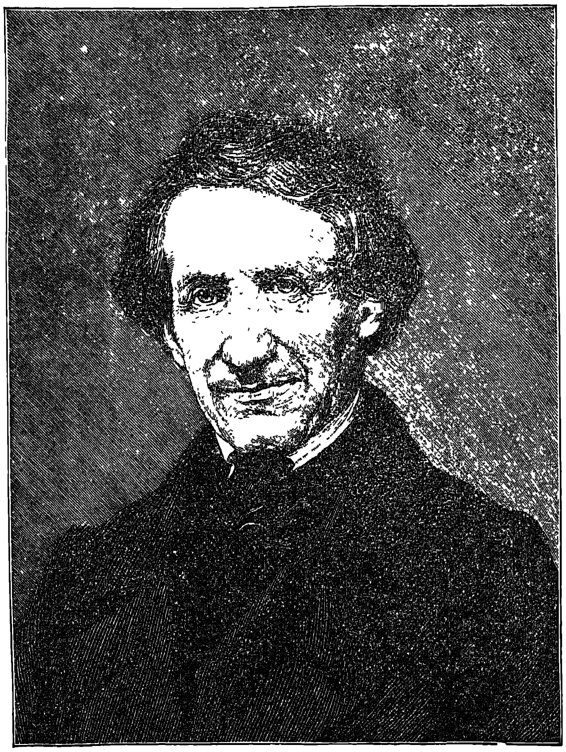
**Dolgelley,** a market-town, railway station, and county town of Merionethshire, Wales, 68 miles south-east by south of Holyhead. There are a parish church and various chapels. There is a free grammar school (1665). The old "Parliament House" has been demolished. Area of urban district, 175 acres. Population (1881), 2455; (1901), 2437. Area of civil parish, 25,375 acres. Population (1881), 3962; (1891), 3785.

**Döllinger, Johann Joseph Ignaz von** (1799–1891), German theologian and Church historian, was born at Bamberg, Bavaria, on 28th February 1799. He came of an intellectual stock, his grandfather and father having both been physicians of eminence and professors of one or other of the branches of medical science. His father was also a man of general literary culture, and celebrated for his power of imparting instruction, though he is said to have been somewhat rough and overbearing in character. The mother of the young Döllinger, too, was a member of a family not undistinguished in intellectual power. The early education of their son was carried out under his father's supervision; and though the stories which have become widely current about the proficiency of Dollinger at an early age in Greek and Latin were denied by the celebrated theologian himself, we may be sure that he was not permitted to be backward in his studies. The elder Döllinger, shortly after his son's birth, was removed to a professorship at Wurzburg. There he came into friendly relations with the well-known philosopher Schelling, a circumstance which doubtless left its stamp for life upon his son.

Young Döllinger mastered the French language very early, and soon conceived an enthusiastic admiration for Napoleon, which lasted until, at about seventeen years of age, he fell in with an account of the treatment of Pope Pius VII. by that great conqueror. At this period he left the gymnasium at Würzburg, to which he had early been sent, and began to study natural philosophy at the university in that city. In 1817 he commenced the study of mental philosophy and philology. He thus laid a basis of sound general knowledge before he pursued the study to which he ultimately devoted himself. This study was theology, which he decided to take up in 1818, because he believed it to lie beneath every other science which could be named. The teaching of theology in Roman Catholic Germany was then passing through a transition stage. But at that moment ecclesiastical history continued to be very ill taught, and young Döllinger resolved to carry on the study of it independently—a resolution which in all probability materially affected his career.

In 1820 he became acquainted with Huber, another fact which, as will be seen, largely influenced his own life as well as that of his friend. On 5th April 1822 he was ordained priest, after studying awhile at Bamberg, and in 1823—at a very early age—he became professor of Ecclesiastical History and Canon Law at Aschaffenburg. Here began his career as author. He then took his doctor's degree, and in 1826 became professor of Theology at Munich, where he spent the rest of his life. About this time Döllinger brought upon himself the animadversion of Heine, who was then editor of a Munich paper. He described the professor's face as the "gloomiest" in the whole procession of ecclesiastics which took place on Good Friday. All shades of Christianity, it is to be remembered, came under the lash of that unsparing satirist. It has sometimes been stated that in his earlier years Döllinger was a pronounced Ultramontane. This does not appear to have been altogether the case; for, very early in his professorial career at Munich, the Jesuits attacked his teaching of ecclesiastical history, and the celebrated Möhler, who afterwards became his friend, on being appealed to, pronounced on the whole in his favour. He also entered into relations with the well-known French Liberal Catholic Lamennais, whose views on the reconciliation of the Roman Catholic Church with the principles of modern society had aroused much suspicion in Ultramontane circles. In 1832 Lamennais, with his friends Lacordaire and Montalembert, visited Germany, and obtained considerable sympathy in their attempts to bring about a modification of the Roman

Catholic attitude to modern problems. Dollinger seems to have regarded favourably the removal, by the Bavarian Government, in 1841, of Professor Kaiser from his chair, because he had taught the infallibility of the Pope. On the other hand, he published a treatise in 1838 against mixed marriages, and in 1843 wrote strongly in favour of requiring Protestant soldiers to kneel at the consecration of the Host when compelled officially to be present at Mass. Moreover, in his work on the "Reformation" (1846–1848) he is very severe on the Protestant leaders, and he also accepts, in his earlier works, the Ultramontane view then current on the practical condition of the Church of England, a view which in later days he found reason to change. Meanwhile he had visited England, where he was well received; and he afterwards travelled in Holland, Belgium, and France, acquainting himself with the condition and prospects of the Roman Catholic Church in those countries. In 1842 he entered into correspondence with the leaders of the Tractarian movement in England, and some interesting letters have been preserved which were exchanged between him and Dr Pusey, Mr Gladstone, and Mr Scott (afterwards Mr Hope Scott). When the last-named joined the Church of Rome he was warmly congratulated by Dollinger on the step he had taken. He, however, much regretted the gradual and very natural trend of his new English allies towards extreme Ultramontane views, of which Archdeacon, afterwards Cardinal, Manning ultimately became an enthusiastic advocate. In 1845 Döllinger was made representative of his University in the Second Chamber of the Bavarian Legislature. In 1847, in consequence of the fall from power in Bavaria of the Abel Ministry, with which he had been in close relations, he was removed from his professorship at Munich, but in 1849 he was invited to occupy the chair of Ecclesiastical History. In 1848, when nearly every throne in Europe was shaken by the spread of revolutionary sentiments throughout the European continent, he was elected delegate to the National German Assembly at Frankfort,—a sufficient proof that at this time he was regarded as no mere narrow and technical theologian, but as a man of wide and independent views. It has been said that his change of relations to the Papacy dated from the Italian war in 1859, but no sufficient reason has been given for this statement. It is far more probable that, like Grosseteste, he had imbibed in early youth an enthusiastic sentiment of attachment to the Papacy as the only centre of authority, and the only guarantee for public order in the Church, but that his experience of the actual working of the Papal system had to a certain extent convinced him how little correspondence there was between his ideal and the reality. He may also have been unfavourably impressed with the promulgation by Pius IX. in 1854 of the dogma of the Immaculate Conception of the Blessed Virgin. But, whatever may have been his reasons, he ultimately became the leader of those who were energetically opposed to any addition to, or more stringent definition of, the powers the Papacy had possessed for centuries. By the year 1863 his position had evidently undergone a change. In that year he invited a number of theologians, amounting to one hundred, to discuss the question which Lamennais and Lacordaire had previously and prematurely raised in France, namely, the attitude that should be assumed by the Roman Catholic Church towards modern ideas. His *The Church and the Churches* (Munich, 1861) dealt to a certain extent with the same question. But his address to the assembled divines in 1863 was, as Professor Woker says (*Internationale Theologische Zeitschrift*, July 1899, p. 459), "practically a declaration of war against the Ultramontane party." He had spoken boldly in favour of freedom for the Church in the Frankfort National Assembly in 1848, but he had found the authorities of his Church claiming a freedom of a very different kind from that for which he had contended. The freedom he claimed for the Church was freedom to manage her affairs without the interference of the State; the adherents of the Papacy desired freedom in order to put a stop to the dissemination of modern ideas. The famous *Syllabus*, recently put forth by Pius IX., had declared war against modern science and progress, and had reproduced the mediæval claims of the Church in a most uncompromising form. The addresses delivered in the Assembly of Divines in 1863 were a declaration in the opposite direction. The Pope for a moment seemed to hesitate, but there could be little doubt what course he would ultimately pursue, and after four days' debate the Assembly was closed at his command. It was in connexion with this question that Döllinger published his *Past and Present of Catholic Theology* and his *Universities Past and Present* (Munich, 1867).



JOHANN JOSEPH IGNAZ VON DÖLLINGER.
*(From a photograph by F. Bruckmann, Münich.)*

We now approach the critical period of Dollinger's life. It was about this time that some of the leading theologians of the Roman Catholic Church, conceiving that the best way of meeting present perils was to emphasize, as well as to define more clearly, the authority of the Pope, advised him to make his personal infallibility a dogma of the Church, and urged strenuously on him the necessity of calling a Council for that purpose. There was considerable opposition in various quarters. Many bishops and divines considered the proposed definition a false one. Others, though accepting it as the truth, declared its promulgation to be inopportune. But the headquarters of the opposition was Germany, and its leader was Döllinger, whose high reputation and vast stores of learning placed him far above any other member of the band of theological experts who now gathered around him. Among them were his intimate friends Friedrich and Huber, in Bavaria. In the rest of Germany he found many supporters, chiefly professors in the Catholic faculty of theology at Bonn: among these were the famous canonist von Schulte, the

learned Reusch, the afterwards celebrated ecclesiastical historian Langen, as well as Reinkens, afterwards bishop of the Old Catholic Church in Germany, Knoodt, and other distinguished scholars. In Switzerland, Professor Herzog, who became Old (or, as it is sometimes called, Christ-) Catholic Bishop in Switzerland, and other learned men supported the movement. Early in 1869 the famous *Letters of Janus* (which were at once translated into English) began to appear. They were written by Dollinger in conjunction with Huber and Friedrich, afterwards professors at Munich. In these the tendency of the *Syllabus* towards obscurantism and Papal despotism, and its incompatibility with modern thought, were clearly pointed out; and the evidence against Papal Infallibility, resting, as the "Letters" asserted, on the Forged Decretals, and accepted without controversy in an age of ignorance, was ably marshalled for the guidance of the Council. When, on 8th December 1869, it had actually assembled, the world was kept informed of what was going on in the *Letters of Quirinus*, written by Döllinger and Huber while the debates of the Council were proceeding. Some of these letters appeared in the German newspapers. An English translation was published by Rivington. Augustin Theiner, the librarian at the Vatican, then in disgrace with the Pope for his outspoken Liberalism, kept his German friends well informed of the course of the discussions. The proceedings of the Council were frequently very stormy, and the opponents of the dogma of Infallibility complained that they were not unfrequently interrupted, and that endeavours were made to put them down by clamour. The dogma was at length carried by a considerable majority of the bishops present, and the rest one by one submitted, Bishops Hefele, of Rottenburg, and Strossmayer, from Croatia, being the last who held out. Döllinger, however, was not to be silenced. He headed a protest by forty-four professors in the University of Munich, and gathered together a Congress at Nuremberg, which met in August 1870 and issued a declaration adverse to the Vatican decrees. An immense ferment took place. In Bavaria, where Döllinger's influence was greatest, the strongest determination to resist the resolutions of the Council prevailed. But the authority of the Council was held by the Archbishop of Munich to be paramount, and he called upon Döllinger to submit. Instead of submitting, Döllinger, on 28th March 1871, addressed a memorable letter to the archbishop, refusing to subscribe the decrees. They were, he said, opposed to Holy Scripture, to the traditions of the Church for the first thousand years, to historical evidence, to the decrees of the General Councils, and to the existing relations of the Roman Catholic Church to the State in every country in the world. "As a Christian, as a theologian, as an historian, and as a citizen," he added, "I cannot accept this doctrine." The reply of the Archbishop of Munich was the proclamation of an excommunication against the disobedient professor. This roused opposition afresh. He was almost unanimously elected rector-magnificus of the University of Munich, and Oxford, Edinburgh, and Marburg Universities conferred upon him the honorary degree of doctor of laws, and Vienna that of philosophy. The Bavarian clergy invited Bishop Loos, the bishop of a Church in Holland which for more than 150 years had existed independent of the Papacy, and had adopted the name of "Old Catholic," to hold confirmations in Bavaria. The offer was accepted, and the bishop was received with triumphal arches and other demonstrations of joy. The three Dutch Old Catholic bishops declared themselves ready to consecrate a bishop, if it were desired. The momentous question was discussed at a meeting of the opponents of the Vatican decrees, and it was resolved to elect a bishop and ask the Dutch bishops to consecrate him. Dollinger, however, voted against the proposition, and withdrew from any further steps towards the promotion of the movement. This was the critical moment in the history of the resistance to the decrees. Had Döllinger, with his immense reputation as a scholar, as a divine, and as a man, allowed himself to be consecrated bishop of the Anti-Vaticanist Church, it is impossible to say how wide the schism would have been. But he declined to initiate a schism. His refusal lost Bavaria to the movement; and the number of Bavarian sympathizers was still further reduced when the seceders, in 1878, allowed their priests to marry, a decision which Döllinger, as was known, sincerely regretted. The Old Catholic Communion, however, was formally constituted, with Reinkens at its head as bishop, and it still continues to exist. Dollinger's attitude to the new community was not very clearly defined, nor indeed very consistent. He did not refuse to meet the Old Catholic leaders in the various Conferences which were held between 1871 and 1875, and was always ready to give his advice, when asked, to the infant community. He remained on the most friendly terms with its members. His addresses on the Reunion of the Churches, delivered at the Bonn Conference of 1872, show that he was by no means hostile to the newly formed communion, in whose interests these Conferences were held. It may be difficult to reconcile the two declarations made by him at different times: "I do not wish to join a schismatic society; I am isolated," and "As for myself, I consider that I belong by conviction to the Old Catholic community." The latter declaration was made some years after the former, in a letter to Pastor Widmann. The nearest approach to a reconciliation of the two statements would appear to be that while, at his advanced age, he did not wish to assume the responsibility of being head of a new denomination, formed in circumstances of exceptional difficulty, he was unwilling to condemn those who were ready to hazard the new departure. "By conviction" he belonged to the Old Catholics, but practically he took no active part in their proceedings. Yet at least he was ready to meet the leaders of the Old Catholic Church, to address them, and to discuss difficult problems with them. In 1874, and again in 1875, he presided over the Reunion Conferences held at Bonn and attended by leading ecclesiastics from the British Isles and from the Oriental Church, among whom where Bishop Christopher Wordsworth of Lincoln; Bishop Harold Browne of Ely; Lord Plunket, archbishop of Dublin; Lycurgus, archbishop of Syros and Tenos; Canon Liddon; Professor Ossinine of St Petersburg, and other eminent divines. At the latter of these two Conferences, when Döllinger was seventy-six years of age, he delivered a series of marvellous addresses in German and English, in which he discussed the state of theology on the Continent, the Reunion question, and the religious condition of the various countries of Europe in which the Roman Catholic Church held sway. Not the least of his achievements on this occasion was the successful attempt, made with extraordinary tact, ability, knowledge, and perseverance, to induce the Orientals, Anglicans, and Old Catholics present to accept a formula of concord, drawn from the writings of the leading theologians of the Greek Church, on the long-vexed question of the Procession of the Holy Spirit. This result having been attained, he passed the rest of his days in retirement, emerging sometimes from his retreat to give addresses on theological questions, and also writing, in conjunction with his friend Reusch, his last book, *Geschichte der Moralstreitigkeiten in der Römisch-Katholischen Kirche seit dem sechzehnten Jahrhundert, mit Beiträgen zur Geschichte und Charak-*

*teristik des Jesuitenordens* (Nordlingen, 1889), in which he deals with the moral theology of St Alphonso de Liguori. He died in Munich, on the 14th January 1890, at the age of ninety-one. In his latest moments he refused the sacraments at the hands of a Roman Catholic priest, and the last offices were performed by his faithful and attached friend Professor Friedrich.

In addition to the works referred to in the foregoing sketch, we may mention *The Eucharist in the First Three Centuries* (Mainz, 1826), a *Church History* (Ratisbon, 1836–1838), *Hippolytus and Callistus* (Ratisbon, 1854), *First Age of Christianity* (1860). His *Lectures on the Reunion of the Churches* and on *The Vatican Decrees* have also been published. Both these last have been translated into English. (J. J. L*.)

**Dolnja-Tuzla,** capital of the district of Tuzla in the province of Bosnia, Austria-Hungary, beautifully situated in a mountainous district on the right bank of the Julla, at the terminus of a branch railway line from Doboj, from which it is 38½ miles south-east. From a very ancient date it has had an important connexion with the salt industry, being known by the Romans as *Ad Salinas*, while in the Middle Ages it was known as Sou or Sow, the capital of the salt district. It is the seat of an Orthodox bishop. A high school (*obergymnasium*) was opened in 1898. Of late, attempts have been made to develop the salt industry. There are coal-mines in the neighbourhood, and there is also a trade in corn, cattle, swine, and horses. An ammonia soda factory has been opened near the town. The population is 10,227, all Mahommedans, including a permanent colony of gypsies.

**Dominica,** the largest island in the colony of the Leeward Islands, of which it forms one of the five presidencies. The temperature ranges from 78° to 86° in the hot season (from August to October), and from 72° to 84° during the cooler months. In spite of the heavy rainfall (varying in different parts of the island from 50 to 162 inches per annum) the atmosphere is dry, the rain sinking into the porous soil very rapidly. The climate, though hot on the low ground, is decidedly healthy for the tropics, and no case of yellow fever has occurred since 1850. In 1871 the census return gave 27,178 inhabitants; that of 1891 gave 26,841 (335 white, 6806 coloured, and 19,700 black). In 1900 the population was estimated at 30,000. The value of the imports for 1874 was £56,714; for 1899, £66,433; while for 1874 exports were £67,720; and for 1899, £64,070. The principal exports in 1899 were limes and lime-juice, cacao, and sugar. Other products are coffee, cocoanuts, nutmegs, cloves, cinnamon, and other spices, oranges, bananas, pineapples, and almost all tropical fruits. The tonnage of the vessels entered and cleared during 1898 was (steam, 447,324; sailing, 9674) 456,998, of which 451,136 was British and 5862 foreign. The revenue for 1874 was £15,022; for 1898, £24,570. The expenditure for 1874 was £17,456; for 1898, £24,648. The manufactures of the island include sugar, lime-juice, and bay-oil; there are many peasant proprietors and metayers. In religion, Roman Catholics predominate. Education in the primary schools is free and by law compulsory. The Cambridge Local Examinations are held in the colony. The French patois, a result of French occupation from time to time, is the predominant language of the peasant class, but English is understood by many, and its general use is increasing. In 1898 the local legislature, in consideration of pecuniary assistance from Great Britain, passed an Act abrogating the semi-elective constitution and providing for a Legislative Council of 12 members,—6 official and 6 unofficial,—all nominated by the Governor.

**Don, Province of the** (Russian, *Donskaya Oblast*), a province of S.E. Russia. The governments of Voronezh, Kharkoff, and Ekaterinoslav lie to the west, the Sea of Azov to the south-west, the Caucasian provinces Kubañ and Stavropol to the south, Astrakhan and Saratov to the east. Area, 63,532 square miles. Population (1897), 2,575,818. It almost entirely belongs to the domain of the South Russian prairies, having the character of higher, ravinated plains in the north (Donetskiy Kryazh), west, and south-west, while in the south-east, towards the Manych, they belong to the type of the dry Aral-Caspian steppes (Zadonsk Steppe), dotted with salt lakes. The geological formation consists of Carboniferous sandstones, clay slates and limestones containing anthracite and coal; Cretaceous marls, chalk, sandstone, and green sands—chalk cliffs accompanying the Don for 200 miles of its course; and Miocene limestones and clays. Coal is extracted in the south-west, also some chalk, slate, limestone, and salt. The surface, especially west of the Don, is fertile black earth, interrupted here and there, and especially in the Zadonsk Steppe, with clay impregnated with salt. The province is watered by the Don and its tributaries, of which the Donets, Chir, and Mius are on the left bank, Khoper and Medvyeditsa on the right. The Don is navigable for more than 650 miles below Voronezh, attaining, after its junction with the Sosna, a width of 250 to 300 yards, and 600 yards in its lower course. Before entering the Sea of Azov it sends it a long navigable branch, the Aksai, and in its delta it divides into some thirty minor branches (*ghirla*). The Don is a very important artery of navigation for S.E. Russia; and as it approaches very near to the Volga at Kalach, which is connected by a 40-miles railway with Tsaritsyn on the Volga, goods shipped down or up the latter (corn, naphtha, timber, &c., 450,000 tons every year) are transported to the Don in order to be shipped to Rostov and Taganrog for export or to be sent up the river to Central Russia; at the same time goods imported to the last-named ports are brought to Kalach and transported to the Volga to be sent up this river. Moreover, in its upper parts the Don is connected by a canal with the Oka, tributary of the Volga. Nearly 550,000 tons of various goods are shipped every year in the basin of the Don, the chief ports being Rostov, Taganrog on the Sea of Azov, Kalach, and Uryupina. The climate is continental and dry, the average temperatures being:—year 43° Fahr., January 13°, July 72°, at Uryupina (50° 48′ N.; alt. 92 ft.); and year 48° Fahr., January 21°, July 73°, at Taganrog. The yearly amount of rain is only 13·4 and 17·5 inches respectively. Forests cover only 2 per cent. of the area.

Nearly one-half of the population (966,869, of whom 483,174 were men and 483,695 women, out of a total population which was 2,078,878 in 1891) belong to the Cossacks. The great bulk of the population belong to the Greek Orthodox Church; there were, moreover, in 1891, 123,039 Nonconformists, 43,714 other Christians, 15,154 Jews, 2478 Mussulmans, and 29,550 Lamaite Kalmyks, who also belonged to the Cossack *Voisko*. The Cossacks own 23,485,640 acres of land and have a reserve of 6,210,000 acres, more than half of which is rented. Provincial self-government was introduced in 1879, but withdrawn three years later. The province is well provided with schools, especially on the Cossack territory.

Agriculture is the main occupation, but the crops vary very much from year to year on account of want of rain (from 3,524,000 to 8,420,000 quarters). Vine-growing on a large scale and tobacco culture are carried on in the south. Cattle-breeding is important, there being 532,688 horses (some very fine breeds), 1,889,600 horned cattle, and 3,093,600 sheep. Rich fisheries at the mouth of the Don. Nearly 13,000 persons are engaged in coal-mining, 580,000 tons of anthracite and 700,000 tons of coal being extracted yearly. The yearly production of all factories attains £2,261,000, the chief of them being ironworks, and tobacco factories. The exports are considerable, consisting chiefly of corn, cattle, horses, sheep, wine, fish, and hides.

The province is under the Ministry of War, and is divided into nine districts: Donets (chief town Kamenskaya, 23,576 inh.), First Don (Konstantinovskaya, 8808 inh.), Second Don (Nizhne-Chirskaya, 15,196 inh.), Rostov (chief town Rostov-on-the-Don,

119,889 inh.), Salsky (Velikoknyazheskaya village), Taganrog (chief town same name, 51,965 inh.), Ust-Medvyeditsa (chief town same name, 14,520 inh.), Khoper (Uryupinskaya, 9612 inh.), Cherkassky (chief town Novocherkassk, capital of province, 52,005 inh.). Many of the Cossack villages (*stanitsas*) are very populous. (P. A. K.)

**Don Benito,** a town of Spain in the province of Badajoz, 62 miles east of Badajoz by rail. Population in 1897, 15,863. It is a prosperous, busy place, with an active trade in wheat, wine, oil, and fruit. There are brandy distilleries, flour-mills, and soap, linen, jute, and cloth factories. Public buildings include a theatre and two casinos.

**Doncaster,** a municipal and quarter sessions borough and market-town in the Doncaster parliamentary division of Yorkshire, England, on the Don, 156 miles north-east of London by rail. Besides a Wesleyan school, there have been erected Primitive Methodist, Presbyterian, Baptist, Congregational, and Wesleyan chapels; also Roman Catholic and other churches. A free library and school of science and art, public baths, gas-works, electricity works, corn exchange, markets, slaughter-houses, and cold stores have been built; and the water-works constructed at Thrybergh in 1880 (£170,000) have been augmented to more than twice their capacity of supply by a joint scheme undertaken in partnership with Sheffield and Rotherham; electric trams running from the borough into adjoining suburbs are in course of construction; the old opera-house has been taken down and a new one erected near the railway station, and the Yorkshire institution for deaf mutes enlarged. The racecourse accommodation has been extended by the formation of the Sandall mile course and the erection of additional permanent stands. The Great Northern Railway Company's locomotive and carriage works employ between 5000 and 6000 hands. Area, 1695 acres. Population (1881), 21,139; (1901), 28,928.

**Donchery,** an ancient town and railway station, in the arrondissement of Sedan, department of Ardennes, France, 3 miles west of Sedan, on the Meuse. A sanguinary battle between the French and Bavarians was fought here on the left bank of the Meuse, 31st August 1870, and two days later, at the Château de Bellevue, Napoleon surrendered his sword to the king of Prussia; and terms of capitulation for Sedan were agreed on. Population (1901), 1915.

**Donegal,** a maritime county of Ireland, province of Ulster.

*Area and Population.*—The area of the administrative county in 1900 was 1,190,268 acres, of which 220,864 were tillage, 422,862 pasture, 995 fallow, 5890 plantation, 102,465 turf-bog, 28,614 marsh, 346,289 barren mountain, and 62,289 water, roads, fences, &c. The new administrative county under the Local Government (Ireland) Act, 1898, is identical with the old judicial county. The population in 1881 was 206,035, and in 1891, 185,635, of whom 91,478 were males and 94,157 females, divided as follows among the different religions:—Roman Catholics, 154,893; Protestant Episcopalians, 21,884; Presbyterians, 18,055; Methodists, 2006; and other denominations, 797. The decrease of population between 1881 and 1891 was 9·90 per cent. The average number of persons to an acre was ·16. Of the total population, 180,844 inhabited the rural districts, being an average of 181 persons to each square mile under crops and pasture. The population in 1901 was 173,625 (Roman Catholics, 134,999; Protestant Episcopalians, 19,907; Presbyterians, 16,221; Methodists, 1795; others, 703), being a decrease of 6·5 per cent. The following table gives the degree of education in 1891:—

| | Males. | Females. | Total. | Percentage. | | |
|---|---|---|---|---|---|---|
| | | | | R. C. | Pr. Ep. | Presb. |
| Read and write | 47,464 | 45,304 | 92,768 | 48·8 | 73·6 | 81·3 |
| Read only | 10,486 | 11,981 | 22,467 | 13·9 | 12·8 | 11·0 |
| Illiterate | 24,175 | 27,838 | 52,013 | 37·3 | 13·6 | 7·7 |

In 1881 the percentage of illiterates among Roman Catholics was 47·8. In 1891 there were 7 superior schools with 154 pupils (27 Roman Catholics and 127 Protestants), and 424 primary schools with 20,747 pupils (14,648 Roman Catholics and 6099 Protestants). The number of pupils on the rolls of the national schools on 30th September 1899 was 30,016, of whom 23,183 were Roman Catholics and 6833 Protestants. The following table gives the number of births, deaths, and marriages in various years:—

| Year. | Births. | Deaths. | Marriages. |
|---|---|---|---|
| 1881 | 4519 | 2802 | 682 |
| 1891 | 3900 | 2982 | 674 |
| 1899 | 3785 | 2512 | 712 |

In 1899 the birth-rate per 1000 was 20·4, and the death-rate 13·5; the rate of illegitimacy was 1·8 per cent. of the total births. The total number of emigrants who left the county between 1st May 1851 and 31st December 1899 was 121,429, of whom 64,848 were males and 56,581 females. The chief towns in the county are Ballyshannon, Letterkenny, and Donegal.

*Administration.*—The county is divided into four parliamentary divisions, north, south, east, and west, the number of registered electors in 1900 being respectively 8095, 8370, 7950, and 9475. The ratable value in 1900 was £304,121. By the Local Government (Ireland) Act, 1898, the fiscal and administrative duties of the grand jury and (to a less extent) of other bodies were transferred to a county council, urban and rural district councils were established, and under that Act the county now comprises 2 urban and 10 rural sanitary districts.

*Agriculture.*—The following tables give the acreage under crops, including meadow and clover, and the amount of live-stock in 1881, 1891, 1895, and 1900:—

| Year. | Wheat. | Oats. | Barley, Rye, and Beans. | Potatoes. | Turnips. | Other Green Crops. | Flax. | Meadow and Clover. | Total. |
|---|---|---|---|---|---|---|---|---|---|
| 1881 | 671 | 93,989 | 3189 | 48,666 | 14,797 | 4343 | 11,844 | 53,989 | 231,488 |
| 1891 | 468 | 90,627 | 2820 | 43,340 | 18,778 | 4375 | 5,093 | 66,055 | 231,556 |
| 1895 | 219 | 87,725 | 2460 | 42,446 | 19,267 | 4223 | 7,645 | 68,350 | 232,235 |
| 1900 | 283 | 82,568 | 1721 | 39,725 | 18,552 | 4071 | 6,816 | 67,128 | 220,864 |

In 1899 the total value of the cereal and other crops was estimated by the Registrar-General at £1,569,253. The number of acres under pasture in 1881 was 380,510; in 1891, 410,259; and in 1900, 422,862.

| Year. | Horses and Mules. | Asses. | Cattle. | Sheep. | Pigs. | Goats. | Poultry. |
|---|---|---|---|---|---|---|---|
| 1881 | 23,762 | 2500 | 178,286 | 202,885 | 35,968 | 3702 | 706,797 |
| 1891 | 23,224 | 2265 | 164,844 | 147,894 | 22,885 | 3118 | 675,700 |
| 1895 | 23,939 | 2116 | 180,954 | 183,212 | 34,514 | 2855 | 762,652 |
| 1900 | 22,511 | 3096 | 186,324 | 194,707 | 27,471 | 2916 | 867,492 |

The number of milch cows in 1891 was 65,264, and in 1900, 66,335. It is estimated that the total value of cattle, sheep, and pigs in 1899 was £2,709,468. In 1900 the number of holdings not exceeding 1 acre was 1573; between 1 and 5, 2882; between 5 and 15, 10,399; between 15 and 30, 8432; between 30 and 50, 4037; between 50 and 100, 3161; between 100 and 200, 1026; between 200 and 500, 344; above 500, 97—total, 31,951. The number of loans issued (the number of loans being the same as the number of tenants) under the Land Purchase Acts, 1885, 1891, and 1896, up to 31st March 1900, was 1207, amounting to £334,948. The number of loans for agricultural improvements sanctioned under sect. 31 of the Land Act, 1881, between 1882 and 1900, was 280, and the amount issued was £17,943. The total amount issued on loan for all classes of works under the Land Improvement Acts, from the commencement of operations in 1847 to 31st March 1900, was £190,129.

*Fisheries.*—In the deep-sea and coast fishery districts of Killybegs, Gweedore, and Rathmullen the number of vessels registered in 1899 was 678, employing 2929 men and boys. The number of persons employed in the salmon-fishery districts of Ballyshannon and Letterkenny in the same year was 988. (W. H. Po.)

**Doobaunt,** a river of Mackenzie and Keewatin districts, Canada. It rises in Wholdiah Lake, in 104° 20′ W. long. and 60° 15′ N. lat., and flows northward to its confluence with the Thelew river, and thence eastward to Chesterfield Inlet, an arm of Hudson Bay. It passes through several lake-expansions, including Doobaunt Lake,

ILLUSTRATIONS FOR DANTE'S *INFERNO.* BY GUSTAVE DORÉ.

with an area of 1700 square miles and an altitude of 500 feet above the sea; Aberdeen, altitude, 130 feet; and Baker, 30 feet above the sea. Discovered in 1770 by Samuel Hearne, the Doobaunt was explored by J. B. Tyrrell in 1893, and the Thelew by David Hanbury in 1899.

**Dorchester,** a municipal borough, market-town, and county town in the southern parliamentary division (since 1885) of Dorsetshire, England, on the Frome, 120 miles south-west by west from London by rail. Recent erections are the Dorset County Museum, an isolation hospital, and a statue to the Dorsetshire poet, William Barnes (1889). The borough gardens were bought and laid out by the corporation in 1896. Area, 1653 acres. Population (1881), 7567; (1901), 9458.

**Dordogne,** a department in the south-west of France, watered by the Dordogne.

Area, 3561 square miles, distributed among 47 cantons and 585 communes. From 492,205 in 1886 the population decreased to 448,545 in 1901. Births in 1899, 9377, of which 361 illegitimate; deaths, 9831; marriages, 3777. There were, in 1896, 1220 schools, with 62,000 pupils, and 15 per cent. of the population was illiterate. The area under cultivation in 1896 comprised 1,887,952 acres, of which 1,104,600 acres are arable land, 494,229 acres are woodland, and 54,365 acres vineyards. The wheat crop of 1899 amounted to the value of £1,980,300; maize returned £173,800; potatoes, £630,500; mangold-wurzel, £155,000; the natural pastures, £604,000. Hemp, yielding in 1899 altogether a value of £3940, and tobacco £85,800, are also cultivated with success. The produce of the vines in 1899 amounted to the value of £680,000; of chestnuts, £92,000; of walnuts, £83,000. The live-stock in 1898 comprised 16,290 horses, 21,650 asses, 201,900 cattle, 399,000 sheep, 175,750 pigs, and 9150 goats. The mining industry turned out in 1898 2500 metric tons of lignite, 1200 tons of peat, and 1300 tons of iron. Building stone is quarried in abundance, and the metallurgic industry yielded in 1896 £32,000 worth of iron. With the exception of paper manufacture, the other industries are in a backward state. The capital town, Périgueux, has a population of 31,400.

**Dordrecht** or **Dordt,** one of the oldest towns in the province of South Holland, Netherlands, 10 miles south-east of Rotterdam, on the main line between that town and Antwerp, at the junction of the Old and New Maas (Noord), the Merwede, and the waterway to Zeeland. As Tiel was deprived of a portion of its trade by Dordrecht, so the trade of Dordrecht has in part been diverted to Rotterdam. The shipping trade of the town, however, still remains very considerable, 2600 ships passing weekly. The trade is mainly in wood (imported from Germany, Scandinavia, and America), salt, oil-seeds, wine, grain, and petroleum. The town has numerous engineering works, sawmills, distilleries, stained-glass works, and shipbuilding yards. The Gothic Greek church was successfully restored in 1882, the theatre of the *Musis Sacrum* enlarged in 1885, and a new theatre erected in 1889. Population (1900), 34,386.

**Doré, Louis Auguste Gustave** (1832–1883), French artist, the son of a civil engineer, was born at Strassburg on 6th January 1832. In 1848 he came to Paris and secured a three years' engagement on the *Journal pour Rire*. His facility as a draughtsman was extraordinary, and among the books he illustrated in rapid succession were Balzac's *Contes Drolatiques* (1855), Dante's *Inferno* (1861), *Don Quixote* (1863), *The Bible* (1866), *Paradise Lost* (1866), and the works of Rabelais (1873). He painted also many large and ambitious compositions of a religious or historical character, and made some success as a sculptor, his statue of Alexandre Dumas in Paris being perhaps his best-known work in this line. He died 25th January 1883.

**Dorking,** a market-town in the Reigate parliamentary division of Surrey, England, on the Mole, 26 miles south of London by rail. Recent erections are the Roman Catholic church (rebuilt), a drill hall, and a literary institute. Area of urban district, 1347 acres. Population (1881), 6328; (1901), 7670. Area of old civil parish, now comprising both Dorking and Dorking Rural, 10,028 acres. Population (1881), 9577; (1901), 11,410.

**Dornbirn,** a township in the district of Feldkirch, Vorarlberg (Austria), on the Vorarlberg line of the Austrian State Railway. A busy industrial centre, the regulated Dornbirner Ach furnishing motive-power for several factories. The industries include the manufacture of machinery, hardware and metal goods, jewellery, cotton spinning, weaving, and printing, and a model dairy farm. Population (1890), 10,678; (1900), 13,052.

**Dorner, Isaac August** (1809–1884), German Lutheran theologian, was born at Neuhausen-ob-Eck, in Würtemberg, 20th June 1809. He studied at Tübingen, and then returned to his native village and assisted his father in the pastorate of the parish. He afterwards visited Holland and England, in order to investigate the condition of Protestantism in those countries. He was made professor of Theology at Tübingen in 1838, at Kiel in 1839, at Königsberg in 1840, of the Protestant Faculty of Theology at Bonn in 1847. Thence he removed to Berlin. Though a student at Tübingen, he did not embrace the well-known views on theology and early Church history which originated at that university. In his famous *History of the Doctrine of the Person of Christ*, in which he investigated with remarkable skill and clearness the teaching of the leading divines of the first five centuries, he has left an indelible record of his ability and research. He was a voluminous writer, and among his most important works are a *History of Protestant Theology* (1867), and his *System of Christian Doctrine* (1879–81), and *System of Christian Morals* (1888). He also contributed to Herzog's well-known *Encylopädie für Protestantische Theologie*. For many years he assisted in editing the *Jahrbücher für Deutsche Theologie*. He died at Wiesbaden, 8th July 1884. (J. J. L*.)

**Dornoch,** a royal and parliamentary burgh (Wick group) and the county town of Sutherlandshire, Scotland, on the Dornoch Firth, 7 miles south-south-east of the Mound station on the Highland Railway. A light railway between the Mound and Dornoch is being constructed. The tower of the cathedral, built by Bishop Gilbert de Moravia (1222–45), remains; the main body was rebuilt in 1837, and is used as the parish church. On the site of the Bishop's Palace, of which the tower is still standing, are the county buildings. There are well-known golf links and a public library. Population (1881), 497; (1901), 624.

**Dorohoi,** a town in Rumania, and chief town of the district bearing the same name, about 80 miles north-west of Jassy, on the river Shiska, tributary of the Pruth. It has an extensive transit trade in the products of Northern Europe. The Church of St Nicholas, built by Stephen the Great in the 15th century, is remarkable. The annual fair held on 12th June is important. Population, of which between 50 and 60 per cent. are Jews (1900), 12,701.

**Dorpat.** See YURIEV.

**Dorsetshire,** a south-eastern county of England, bounded S. and S.W. by the English Channel, W. by Devon, N.W. by Somerset, N.E. by Wilts, and E. by Hampshire.

*Area and Population.*—The area of the ancient and administra-

tive county, as given in the census returns, is 632,272 acres, or 988 square miles. The population in 1881 was 190,969, and in 1891 was 194,517, of whom 94,735 were males and 99,782 females, the number of persons per square mile being 197, and of acres to a person 3·25. Since 1891 the area of the administrative county has undergone certain changes. In 1895 the parishes of Goathill, Poyntington, Sandford-Orcas, Seaborough, and Trent were transferred from Somerset to Dorset, and the parish of Wambrook from Dorset to Somerset, and in 1896 the parishes of Chardstock and Hawkchurch were transferred from Dorset to Devon. The area of the registration county is 616,403 acres, with a population in 1891 of 188,995, of whom 69,216 were urban, and 119,779 rural. Within this area the increase of population between 1881 and 1891 was 2·17 per cent. Between 1881 and 1891 the excess of births over deaths was 22,388, but the increase in resident population was only 4023. In 1901 the population was 202,962. The following table gives the numbers of marriages, births, and deaths, with the number of illegitimate births, in 1880, 1890, and 1898:—

| Year. | Marriages. | Births. | Deaths. | Illegitimate Births. | |
|---|---|---|---|---|---|
| | | | | Males. | Females. |
| 1880 | 1214 | 5508 | 3122 | 134 | 128 |
| 1890 | 1332 | 4786 | 2970 | 100 | 107 |
| 1898 | 1371 | 4852 | 2973 | 101 | 89 |

The number of marriages in 1899 was 1319, of births 4807, and of deaths 3144.

The following table shows the marriage, birth, and death rates per 1000 of the population, with the percentage of illegitimate births, for a series of years:—

| | 1870-79. | 1880. | 1880-89. | 1890. | 1888-97. | 1898. |
|---|---|---|---|---|---|---|
| Marriage-rate | 13·7 | 13·1 | 13·4 | 14·1 | 13·9 | 14·3 |
| Birth-rate | 29·5 | 29·6 | 28·1 | 25·4 | 26·4 | 25·4 |
| Death-rate | 17·8 | 16·8 | 16·3 | 15·7 | 15·7 | 15·5 |
| Percentage of illegitimacy | 5·2 | 4·8 | 4·8 | 4·3 | 4·5 | 3·9 |

Both the birth-rate and the death-rate are much below the average for England. In 1891 there were in the county 771 natives of Scotland, 1240 natives of Ireland, and 396 foreigners.

*Constitution and Government.*—The ancient county is divided into four parliamentary divisions, but has no parliamentary borough. The administrative county contains thirteen towns and urban districts: Blandford Forum (3649), Branksome (8095), Bridport (5710), Dorchester (9458), Lyme Regis (2095), Poole (19,461), Portland (15,262), Shaftesbury (2027), Sherborne (5753), Swanage (3384), Wareham (2003), Weymouth and Melcombe Regis (19,831), Wimborne Minster (3696). Dorsetshire is in the western circuit, and assizes are held at Dorchester. The boroughs of Bridport, Dorchester, Lyme Regis, Poole, and Weymouth and Melcombe Regis have separate commissions of the peace, and the borough of Poole has in addition a separate court of quarter sessions. The ancient county, which is almost entirely in the diocese of Salisbury, contains 254 entire ecclesiastical parishes or districts and parts of five others.

*Education.*—The number of elementary schools in the county on 31st August 1899 was 278, of which only 25 were board, and 253 were voluntary schools, the latter including 234 National Church of England schools, 3 Wesleyan, 7 Roman Catholic, and 9 "British and other." The average attendance at board schools was 3301, and at voluntary schools 24,855. The total school board receipts for the year ended 29th September 1899 were over £10,035. The income under the Agricultural Rates Act was over £632.

*Agriculture.*—About three-fourths of the area of the county is under cultivation, and of this nearly five-eighths is in permanent pasture, while there is, in addition, about 26,000 acres in hill pasturage. Nearly 38,000 acres are under woods. Of the green crops, wheat, barley, and oats occupy an almost equal acreage; but turnips are grown on nearly three-fourths of the acreage under green crops. The following table gives the main divisions of the cultivated area at intervals of five years from 1880:—

| Year. | Total Area under Cultivation. | Corn Crops. | Green Crops. | Clover. | Permanent Pasture. | Fallow. |
|---|---|---|---|---|---|---|
| 1880 | 485,857 | 105,113 | 58,054 | 52,239 | 262,427 | 7766 |
| 1885 | 491,123 | 97,206 | 59,104 | 52,157 | 277,503 | 5026 |
| 1890 | 493,321 | 91,851 | 53,889 | 51,556 | 291,818 | 3903 |
| 1895 | 487,296 | 82,299 | 50,728 | 49,711 | 299,600 | 4503 |
| 1900 | 481,430 | 83,137 | 49,227 | 48,933 | 299,312 | 2678 |

The following table gives particulars regarding the principal live-stock during the same years:—

| Year. | Total Horses. | Total Cattle. | Cows or Heifers in Milk or in Calf. | Sheep. | Pigs. |
|---|---|---|---|---|---|
| 1880 | 16,192 | 76,049 | 47,791 | 463,864 | 37,857 |
| 1885 | 15,794 | 91,202 | 54,675 | 460,371 | 47,790 |
| 1890 | 15,970 | 89,017 | 53,834 | 418,945 | 63,556 |
| 1895 | 16,425 | 83,071 | 52,192 | 370,947 | 66,211 |
| 1900 | 15,588 | 87,904 | 53,620 | 360,491 | 50,930 |

*Industries and Trade.*—According to the annual report for 1898 of the chief inspector of factories and workshops (1900), the total number of persons employed in factories and workshops in 1897 was 7994, as compared with 7950 in 1896. Non-textile factories employed 3820, of whom 1080 were employed in the manufacture of machines, appliances, conveyances, or tools. Paper is manufactured, and ships and yachts are built at Poole. Of the 3347 persons employed in workshops, 1182 were employed in the clothing industries. The number of persons employed in mines and quarries in 1899 was 2038. Limestone and potter's and other clay are dug in increasing quantities, and the famous Purbeck marble and Portland freestone are more and more in demand. The amount of limestone dug in 1898 was 519,214 tons, and of clay 148,184 tons. There are no returns regarding the Portland stone.

There are numerous fishing stations along the coast. The fishing is generally prosecuted within 3 miles of the shore. There are some oyster beds near Poole. The total fish landed in 1899 amounted to 11,305 cwt., valued at £8143.

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**Dortmund,** a town of Prussia, province of Westphalia, 50 miles east by north from Düsseldorf. Since the abolition of the walls in 1872 and the conversion of their site into promenades, the town has rapidly assumed a modern appearance. The 13th-century town-hall, with the adjacent Bread House, was thoroughly restored in 1899; the basement of the former contains the municipal antiquarian museum. The post office (1895), synagogue (1898), Roman Catholic church of Our Lady, the provincial law courts, the municipal infirmary, the monuments of the war of 1870–71 (1881) and Bismarck (1899), and the Emperor William Park, with a bronze statue of the Emperor William I. (1894) by Schilling, and a bronze statue of the Emperor Frederick III. (1898), deserve mention. But the real interest of Dortmund centres in her industries—iron, coal, beer, and bricks. Whereas in 1860 the output of the Dortmund coal-field was under 4½ million tons (valued at £1,362,300), in 1870 it had increased to over 11⅓ millions (£3,353,450), in 1880 to close upon 22½ million tons (£5,147,700), in 1890 to approximately 35½ million tons (£14,122,100), and in 1897 to 48½ million tons.[1] During the same period, *i.e.*, from 1860 to 1897, the number of workmen employed in the coal-mines increased from 28,460 to 185,640. The chief products of the iron furnaces, forges, foundries, and other works are mining plant, wire-ropes, implements and machinery, safes, and sewing machines. One firm alone employs nearly 8000 workmen. In addition to the above there are several flour and saw mills. In connexion with the Dortmund-Ems Canal a space of 360 acres has been set apart at Dortmund for docks, and in 1899 four basins, each 43 acres in area and 8⅙ feet minimum depth, were already constructed. Population (1885), 78,435; (1890), 89,663; (1895), 111,232; (1900), 142,418.

[1] See *Coal Industry of the Rhenish Westphalian Provinces,* by T. R. Mulvany (1898), Dipl. and Cons. Reps., Misc. Series, No. 454.

**Dost Mahommed Khan** (1793–1863), founder of the dynasty of the Barakzai in Afghanistan, was born in 1793. His elder brother, the chief of the Barakzai, Fati Khan, took an important part in raising Mahmud to the sovereignty of Afghanistan in 1800 and in restoring him to the throne in 1809. That ruler repaid his services by causing him to be assassinated in 1818, and thus incurred the enmity of his tribe. After a bloody conflict Mahmud was deprived of all his possessions but Herat, the rest of his dominions being divided among Fati Khan's brothers. Of these Dost Mahommed received for his share Ghazni, to which in 1826 he added Kabul, the richest of the Afghan provinces. From the commencement of his reign he found himself involved in disputes with Ranjit Singh, the Sikh ruler, who used the dethroned Saduzai prince, Shuja-ul-Mulk, as his instrument. In 1834 Shuja made a last attempt to recover his kingdom. He was defeated by Dost Mahommed under the walls of Kandahar, but Ranjit Singh seized the opportunity to annex Peshawar. The recovery of this fortress became the Afghan Amir's great concern. Rejecting overtures from Russia, he endeavoured to form an alliance with England, and welcomed Alexander Burnes to Kabul in 1837. Burnes, however, was unable to prevail on the Governor-General, Lord Auckland, to respond to the Amir's advances. Dost Mahommed was enjoined to abandon the attempt to recover Peshawar, and to place his foreign policy under British guidance. In return he was only promised protection from Ranjit Singh, of whom he had no fear. He replied by renewing his relations with Russia, and in 1838 Lord Auckland set the British troops in motion against him. In March 1839 the British force under Sir Willoughby Cotton advanced through the Bolan Pass, and on the 26th April it reached Kandahar. Shah Shuja was proclaimed Amir, and entered Kabul on 7th August, while Dost Mahommed sought refuge in the wilds of the Hindu Kush. Closely followed by the British, Dost was driven to extremities, and on 4th November 1840 surrendered as a prisoner. He remained in captivity during the British occupation, during the disastrous retreat of the army of occupation in January 1842, and until the recapture of Kabul in the autumn of 1842. He was then set at liberty, in consequence of the resolve of the British Government to abandon the attempt to intervene in the internal politics of Afghanistan. On his return from Hindustan Dost Mahommed was received in triumph at Kabul, and set himself to re-establish his authority on a firm basis. From 1846 he renewed his policy of hostility to the British and allied himself with the Sikhs; but after the defeat of his allies at Gujarat on 21st February 1849 he abandoned his designs and led his troops back into Afghanistan. In 1850 he conquered Balkh, and in 1854 he acquired control over the southern Afghan tribes by the capture of Kandahar. On 30th March 1855 Dost Mahommed reversed his former policy by concluding an offensive and defensive alliance with the British Government. In 1857 he declared war on Persia in conjunction with the British, and in July a treaty was concluded by which the province of Herat was placed under a Barakzai prince. During the Indian Mutiny Dost Mahommed punctiliously refrained from assisting the insurgents. His later years were disturbed by troubles at Herat and in Bokhara. These he composed for a time, but in 1862 a Persian army, acting in concert with Ahmed Khan, advanced against Kandahar. The old Amir called the British to his aid, and, putting himself at the head of his warriors, drove the enemy from his frontiers. On 26th May 1863 he captured Herat, but on 9th June he died suddenly in the midst of victory, after playing a great rôle in the history of Central Asia for forty years. He named as his successor his son, Shir Ali Khan. (E. I. C.)

**Dostoievsky, Feodor Mikhailovitch** (1821–1881), Russian author, born at Moscow, 30th October 1821, was the second son of a retired military surgeon of a decayed noble family. He was educated at Moscow and at the military engineering academy at St Petersburg, which he left in 1843 with the grade of sub-lieutenant. Next year his father died, and he resigned his commission in order to devote himself to literature—thus commencing a long struggle with ill-health and penury. In addition to the old Russian masters Gogol and Pushkin, Balzac and George Sand supplied him with literary ideals. He knew little of Dickens, but his first story is thoroughly Dickensian in character. The hero is a Russian "Tom Pinch," who entertains a pathetic, humble adoration for a fair young girl, a solitary waif like himself. Characteristically, the Russian story ends in "tender gloom." The girl marries a middle-aged man of property; the hero dies of a broken heart, and his funeral is described in lamentable detail. The germ of all Dostoievsky's imaginative work may be discovered here. The story was submitted in manuscript to the Russian critic, Bielinski, and excited his astonishment by its power over the emotions. It appeared in the course of 1846 in the *Recueil de Saint-Petersbourg*, under the title of "Poor People." An English version, *Poor Folk*, with an introduction by Mr George Moore, appeared in 1894. The successful author became a regular contributor of short tales to the *Annals of the Country*, a monthly periodical conducted by Kraevsky; but he was wretchedly paid, and his work, though revealing extraordinary power and intensity, commonly lacks both finish and proportion. Poverty and physical suffering robbed him of the joy of life and filled him with bitter thoughts and morbid imaginings. During 1847 he became an enthusiastic member of the revolutionary reunions of the political agitator, Petrachevski. Many of the students and younger members did little more than discuss the theories of Fourier and other economists at these gatherings. Exaggerated reports were eventually carried to the police, and on 23rd April 1849 Dostoievsky and his brother, with thirty other suspected personages, were arrested. After a short examination by the secret police they were lodged in the fortress of St Peter and St Paul at St Petersburg, in which confinement Feodor wrote his story *A Little Hero*. On 22nd December 1849 the accused were all condemned to death and conveyed in vans to a large scaffold in the Simonovsky Place. As the soldiers were preparing to carry out the sentence, the prisoners were informed that their penalty was commuted to exile in Siberia. The novelist's sentence was four years in Siberia and enforced military service in the ranks for life. On Christmas Eve 1849 he commenced the long journey to Omsk, and remained in Siberia, "like a man buried alive, nailed down in his coffin," for four terrible years. His Siberian experiences are graphically narrated in a volume to which he gave the name of *Recollections of a Dead-House* (1858). It was known in an English translation as *Buried Alive in Siberia* (1881; another version, 1888). His release only subjected him to fresh indignities as a common soldier at Semipalatnisk; but in 1858, through the intercession of an old school-fellow, General Todleben, he was made an under-officer; and in 1859, upon the accession of Alexander II., he was finally recalled from exile. In 1858 he had married a widow, Madame Isaieff, but she died at St Petersburg in 1867 after a somewhat stormy married life.

After herding for years with the worst criminals,

Dostoievsky obtained an exceptional insight into the dark and seamy side of Russian life. He formed new conceptions of human life, of the balance of good and evil in man, and of the Russian character. Psychological studies have seldom, if ever, found a more intense form of expression than that embodied by Dostoievsky in his novel called *Crime and Punishment.* The hero Raskolnikoff is a poor student, who is led on to commit a murder partly by self-conceit, partly by the contemplation of the abject misery around him. Unsurpassed in poignancy in the whole of modern literature is the sensation of compassion evoked by the scene between the self-tormented Raskolnikoff and the humble street-walker, Sonia, whom he loves, and from whom, having confessed his crime, he derives the idea of expiation. Raskolnikoff finally gives himself up to the police and is exiled to Siberia, whither Sonia follows him. The book gave currency to a number of ideas, not in any sense new, but specially characteristic of Dostoievsky: the theory, for instance, that in every life, however fallen and degraded, there are ecstatic moments of self-devotion; the doctrine of purification by suffering, and by suffering alone; and the ideal of a Russian people forming a social state at some future period bound together by no obligation save mutual love and the magic of kindness. In this visionary prospect, as well as in his objection to the use of physical force, Dostoievsky anticipated in a remarkable manner some of the conspicuous tenets of his great successor Tolstoi. The book electrified the reading public in Russia upon its appearance in 1866, and its fame was confirmed when it appeared in Paris in 1867. To his remarkable faculty of awakening reverberations of melancholy and compassion, as shown in his early work, Dostoievsky had added, by the admission of all, a rare mastery over the emotions of terror and pity. But such mastery was not long to remain unimpaired. *Crime and Punishment* was written when he was at the zenith of his power. His remaining works exhibit frequently a marvellous tragic and analytic power, but they are unequal, and deficient in measure and in balance. The chief of them are: *The Injured and the Insulted, The Demons* (1867), *The Idiot* (1869), *The Adult* (1875), *The Brothers Karamzov* (1881).

From 1865, when he settled in St Petersburg, Dostoievsky was absorbed in a succession of journalistic enterprises, in the Slavophil interest, and suffered severe pecuniary losses. He had to leave Russia, in order to escape his creditors, and to seek refuge in Germany and Italy. He was further harassed by troubles with his wife, and his work was interrupted by epileptic fits and other physical ailments. It was under such conditions as these that his most enduring works were created. He managed finally to return to Russia early in the 'seventies, and was for some time director of the *Russian World.* From 1876 he published a kind of review, entitled *Carnet d'un Ecrivain,* to the pages of which he committed many strange autobiographical facts and reflections. The last eight years of his life were spent in comparative prosperity at St Petersburg, where he died on 9th February 1881.

His life had been irremediably seared by his Siberian experiences. He looked prematurely old; his face bore an expression of accumulated sorrow; in disposition he had become distrustful, taciturn, contemptuous—his favourite theme the superiority of the Russian peasant over every other class; as an artist, though uncultured, he had ever been subtle and sympathetic, but latterly he was tortured by tragic visions and morbidly preoccupied by exceptional and perverted types. M. de Vogüé, in his admirable *Ecrivains Russes,* has worked out with some success a parallel between the later years of Dostoievsky and those of Jean Jacques Rousseau. Siberia effectually convinced the novelist of the impotence of Nihilism in such a country as Russia; but though he was assailed by ardent Liberals for the reactionary trend of his later writings, Dostoievsky became, towards the end of his life, an extremely popular figure, and his funeral, on 12th February 1881, was the occasion of one of the most remarkable demonstrations of public feeling ever witnessed in the Russian capital. The death of the Russian novelist was not mentioned in the London press; it is only since 1885, when *Crime and Punishment* first appeared in English, that his name has become at all familiar in England, mainly through French translations. A complete edition of his novels was issued at St Petersburg in fourteen volumes, 1882–83. Two critical studies by Tchij and Zelinsky appeared at Moscow in 1885, and a German life by Hoffmann at Vienna in 1899. (T. SE.)

**Douai,** chief town of arrondissement, department of Nord, France, 20 miles south of Lille, junction on railway from Paris to Lille. The manufacture of glass, oil, sugar, and paper, wool-spinning, leather-currying, and bell-founding, have all become important industries. The town library now contains 80,000 volumes and 1800 manuscripts.—Dorignies, 1½ mile north of the town, is an important industrial suburb; Sin-le-Noble, Dechy, and Sambres, though distinct municipalities, are practically suburban. The port traffic of Douai and Dorignies in 1898 amounted to 427,677 tons. Population (1881), 20,608; (1901), 33,918.

**Doubs,** a department in the east of France, bordering on Switzerland. It is traversed by the Jura mountains and watered by the Doubs.

Area, 2052 square miles. The population decreased from 310,963 in 1886 to 296,957 in 1901. Births in 1899, 7222, of which 590 were illegitimate; deaths, 6706; marriages, 2186. There were in 1896 1024 schools, with 51,000 pupils; 1 per cent. of the population was illiterate. The area under cultivation in 1896 comprised 1,097,186 acres, of which only 360,785 acres were arable and 12,355 acres in vines. Forest, on the other hand, covers an extensive area, occupying with the natural grass lands nearly 741,000 acres. The wheat crop yielded in 1899 a value of only £420,000, but the produce of the green crop and grass lands amounted in 1899 to the value of £902,000, the natural pastures alone yielding the value of £603,000. The live-stock in 1899 included 19,990 horses, 121,330 cattle, 47,750 sheep, 45,580 pigs, and 6700 goats. Doubs has no coal, but it turned out, in 1896, 6200 metric tons of iron and 20,000 tons of rock-salt. It produced, in 1898, 19,000 metric tons of wrought-iron and steel, of the value of £170,000. Among the other industries watch-making takes the first rank, having its centres at Besançon and Montbéliard, while distillation holds the second place, producing a yearly average of 687,800 gallons. Besançon, the capital, has 55,250 inhabitants.

**Douglas,** a town and railway station on the east coast of the Isle of Man, England, 75 miles by steamer north-west of Liverpool. The steamship communication with this popular watering-place has been greatly improved during the last twenty-five years, in particular the service connecting it with Liverpool, Barrow, Fleetwood, Dublin, and the Clyde. Many improvements have also been made in the town itself, which has displaced Castletown as the legal capital of the island. A magnificent parade sweeps around the bay; new wide streets have been cleared in the old town and constructed in the new; municipal buildings, a free library, a second theatre, and three music-halls with capacious dancing saloons have been erected; an electric tramway has been laid down to all parts of the island; cable and horse trams encircle the town; and a sporting summer golf course has been constructed at Howstrake, in addition to the winter course behind the town. Many of the public undertakings, such as the water-works, abattoirs, markets, and cemetery, are under municipal control. Douglas is in the parish of Onchan, and in 1881 had a population of 15,725; in

1901, 19,126, with a suburban population just outside the borough of 3100.

**Douglass, Frederick** (1817–1895), American orator, was born in Tuckahoe, Talbot county, Md., and died in Anacostia, D.C., 20th February 1895. His mother was a slave and his father a white man. He learned to read and write, and was allowed to hire his own time and work in a shipyard. In 1838 he escaped from slavery, and soon settled in New Bedford, Mass. A speech made by him in 1841 resulted in his being offered the agency of the Massachusetts Anti-Slavery Society. From that time his oratorical powers rapidly developed, and he aroused much interest in the cause of emancipation. In 1845 he made a lecturing tour through the British Isles, where he remained until 1847. For many years after 1847 he conducted an anti-slavery weekly journal at Rochester, N.Y. He encouraged, but did not actually participate in, John Brown's invasion of Harper's Ferry. In 1870 he became editor of the *New National Era* in Washington, D.C. When, in 1871, President Grant appointed a commission to report on the question of annexing Santo Domingo to the United States, Douglass became its assistant-secretary. In 1872 he was presidential elector at large for the State of New York. From 1876 to 1881 he was marshal of the District of Columbia, after which time he was its recorder of deeds for five years. From 1889 to 1891 he was United States minister to Hayti. The experiences of his life were described in an autobiography.

**Doukhobors, The.**—"Doukhobors" is a name given by the Russian Orthodox clergy to a community of nonconformist peasants. The word etymologically signifies "spirit-fighters," being originally intended by the priesthood to convey that they fight against the Spirit of God; but the Doukhobors themselves accepted the term as signifying that they fight, not against, but for and with the Spirit. Of late, however, they have decided to give up this name and call themselves "Christians of the Universal Brotherhood." This religious community was first heard of in the middle of the 18th century. By the end of that century or the beginning of the 19th their doctrine had become so clearly defined, and the number of their members had so greatly increased, that the Russian Government and Church, considering this sect to be peculiarly obnoxious, started an energetic campaign against it. The foundation of the Doukhobors' teaching consists in the belief that the Spirit of God is present in the soul of man, and directs him by its word within him. They understand the coming of Christ in the flesh, his works, teaching, and sufferings, in a spiritual sense. The object of the sufferings of Christ, in their view, was to give an example of suffering for truth. Christ continues to suffer in us even now when we do not live in accordance with the behests and spirit of his teaching. The whole teaching of the Doukhobors is penetrated with the Gospel spirit of love. Worshipping God in the spirit, they affirm that the outward Church and all that is performed in it and concerns it has no importance for them. The Church is where two or three are gathered together, *i.e.*, united in the name of Christ. They pray inwardly at all times; on fixed days they assemble for prayer-meetings, at which they greet each other fraternally with low bows, thereby acknowledging every man as a bearer of the Divine Spirit. Their teaching is founded on tradition, which is called among them the "Book of Life," because it lives in their memory and hearts. It consists of sacred songs or chants, partly composed independently, partly formed out of the contents of the Bible, which, however, has evidently been gathered by them orally, as until quite lately they were almost entirely illiterate and did not possess any written book. They found alike their mutual relations and their relations to other people—and not only to people, but to all living creatures—exclusively on love, and therefore they hold all people equal and brethren. They extend this idea of equality also to the Government authorities, obedience to whom they do not consider binding upon them in those cases when the demands of these authorities are in conflict with their conscience; while in all that does not infringe what they regard as the will of God they willingly fulfil the desire of the authorities. They consider killing, violence, and in general all relations to living beings not based on love as opposed to their conscience and to the will of God. They are industrious and abstemious in their lives, and when living up to the standard of their faith they present one of the nearest approaches to the realization of the Christian ideal which has ever been attained.

Such, in their most general character, are the beliefs for which the Doukhobors have long endured cruel persecution. Under Nicholas I., in the years 1840 and 1850, the Doukhobors, who on religious grounds refused to participate in military service, were all banished from the government of Tauris—whither they had been previously transported from various parts of Russia by Alexander I.—to Transcaucasia, near the Turkish frontier. But neither the severe climate nor the neighbourhood of wild and warlike hillmen shook their faith, and in the course of half a century, in one of the most unhealthy and unfertile localities in the Caucasus, they transformed this wilderness into flourishing colonies, and continued to live a Christian and laborious life, making friends instead of fighting with the hillmen. But the wealth to which they attained in the Caucasus weakened for a time their moral fervour, and little by little they began to depart somewhat from the requirements of their belief. As soon, however, as events happened among them which disturbed their outward tranquillity, the religious spirit which had guided their fathers immediately revived within them. In 1887, in the reign of the Tsar Alexander III., universal military service was introduced in the Caucasus; and even those for whom, as in the case of the Doukhobors, it had formerly been replaced with banishment, were called upon to serve. This measure took the Doukhobors unawares, and at first they outwardly submitted to it. About the same time, by the decision of certain Government officials, the right to the possession of the public property of the Doukhobors (valued at about £50,000) passed from the community to one of their members, who had formed out of the more demoralized Doukhobors a group of his own personal adherents, which was henceforth called the "Small Party." Soon afterwards several of the most respected representatives of the community were banished to the government of Archangel. This series of calamities was accepted by the Doukhobors as a punishment from God, and a spiritual awakening of a most energetic character ensued. The majority (about 12,000 in number) resolved to revive in practice the traditions left them by their fathers, which they had departed from during the period of opulence. They again renounced tobacco, wine, meat, and every kind of excess, many of them dividing up all their property in order to supply the needs of those who were in want, and they collected a new public fund. They also renounced all participation in acts of violence, and therefore refused military service. In confirmation of their sincerity, in the summer of 1895 the Doukhobors of the "Great Party," as they were called in distinction from the "Small Party," burnt all the arms which they, like other inhabitants of the Caucasus, had taken up for their protection from wild animals, and those who were in

the army refused to continue service. At the commencement of the reign of the Tsar Nicholas II., in 1895, the Doukhobors became the victims of a series of persecutions, Cossack soldiers plundering, insulting, beating, and maltreating both men and women in every way. More than four hundred families of Doukhobors who were living in the province of Tiflis were ruined and banished to Georgian villages. Of 4000 thus exiled, more than 1000 died in the course of the first two years from exhaustion and disease; and more would have perished had not information reached Count Leo Tolstoy and his friends, and through them the Society of Friends in England. Funds were immediately raised by sympathizers for alleviating the sufferings of the starving victims. At the same time an appeal, written by Tolstoy and some of his friends, requesting the help of public opinion in favour of the oppressed Doukhobors, was circulated in St Petersburg and sent to the Emperor and higher Government officials. The Doukhobors themselves asked for permission to leave Russia, and the Society of Friends petitioned the Emperor to the same effect. In March 1898 the desired permission was granted, and the first party of Doukhobors, 1126 in number, were able in the summer of 1898 to sail from Batum for Cyprus, which was originally chosen for their settlement because at that time funds were not sufficient for transferring them to any other British territory. But as contributions accumulated, it was found possible to send a number of Doukhobor emigrants to Canada, whither they arrived in two parties, numbering above 4000, in January 1899. They were joined in the spring of the same year by the Cyprus party, and another party of about 2000 arrived from the Caucasus. In all about 7500 Doukhobor immigrants arrived in Canada. The Canadian Government did their best to facilitate the immigration, and allotted land to the Doukhobors in the provinces of Assiniboia near Yorkton and of Saskatchewan near Thunder Hill and Prince Albert. They were very cordially received by the population of the Canadian port towns. In April 1901, in the Canadian House of Commons, the Minister of Justice made a statement about them in which he said that "not a single offence had been committed by the Doukhobors; they were law-abiding, and if good conduct was a recommendation, they were good immigrants. . . . The large tracts of land demanded population, and if they were not given to crime, the conclusion was that they would make good citizens." About eighteen months after they arrived in Canada the Doukhobors sent the Society of Friends a collective letter in which they sincerely thanked the English and American Friends for all the generous help of every kind they had received at their hands, but begged the Quakers to cease sending them any more pecuniary support, as they were now able to stand on their own feet, and therefore felt it right that any further help should be directed to others who were more in need of it.

See also *Christian Martyrdom in Russia*, by V. Tchertkoff. The Free Age Press, Christchurch, Hants. (V. T.)

**Doulton, Sir Henry** (1820–1897), English inventor and manufacturer of pottery, born in Vauxhall 25th July 1820, was from the age of fifteen actively employed in the pottery works of his father, John Doulton, at Lambeth. One of the first results of his many experiments was the production of good enamel glazes. In 1846 he initiated in Lambeth the pipe works, in which he superintended the manufacture of the drainage and sanitary appliances which have helped to make the firm of Doulton famous. In 1870 the manufacture of "Art pottery" was begun at Lambeth, and in 1877 works were opened at Burslem, where almost every variety of china and porcelain, as well as artistic earthenware, has been produced. Works have since been opened at Rowley Regis, Smethwick, St Helens, Paisley, and Paris. After the Paris Exhibition of 1878, Henry Doulton was made a Chevalier of the Legion of Honour. In 1872 the "Art department" was instituted in the Doulton works, giving employment to both male and female artists, amongst whom such workers as George Tinworth and the Misses Barlow have obtained a reputation outside their immediate sphere. In 1887 Mr Doulton received the honour of knighthood, and a few years later was awarded the Albert Medal by the Society of Arts. He married in 1849 the daughter of Mr J. L. Kennaby; she died in 1888. Sir Henry Doulton took an active interest, as Almoner, in St Thomas's Hospital. He died in London 18th November 1897. (R. F. S.)

**Douro** (in Spanish, *Duero*; Portuguese, *Douro*), a river of the Iberian peninsula. It rises in the Sierra d'Urbion (between the Sierra de la Demanda and the Sierra de Moncayo), describes a wide curve eastwards past Soria, then flows on the whole west right across the Spanish tableland, passing on the way Valladolid and Zamora; then from Paradela to Barca d'Alva it flows south-west and forms the frontier between Spain and Portugal. It crosses Portugal in an east to west direction in a narrow and tortuous bed, and enters the Atlantic 3 miles below Oporto. In Spain it receives from the right the rivers Pisuerga, Valderaduey, and Esla, and from the left several small streams which drain the Sierra Guadarrama; and in Portugal the Agueda, Côa, and Paiva from the left, and the Sabor, Túa, and Tamega from the right. The lower stream is beset with numerous rapids, called *pontos*, and is subject to swift and violent inundations. On this account navigation is attended with difficulties and risks between its mouth and Barca d'Alva; but a railway, running for the most part along the right bank, traverses the Portuguese portion of the river. The mouth of the river is partly blocked by a rocky bar, but has recently been improved. Its total length is about 420 miles, of which 140 are in Portugal. Its waters abound in fish, especially trout, shad, and lampreys.

**Douro,** a former province of Portugal, corresponding to the present districts of Oporto, Aveiro, and Coimbra (*qq.vv.*). Area, 3506 square miles. Population (1900), 1,237,374, giving 353 inhabitants to the square mile.

**Douwes-Dekker, Edward.** See DEKKER, EDWARD DOUWES.

**Dover,** the principal Cinque Port, municipal and parliamentary borough of Kent, England, terminal station of the South-Eastern and Chatham and Dover Railway, 76 miles by rail east-south-east of London. The municipal borough, till 1895 coextensive with the parliamentary, was then extended to include parts of parishes previously in the rural district of Dover. In 1885 the parliamentary representation was reduced to one member. In 1888 the gates of Wellington dock were widened 10 feet to admit the new Channel steamers; new coal stores were erected on the Northampton quay; the shipway was lengthened 40 feet, and widened for the reception of vessels up to 800 tons. In 1891 it was resolved to construct a new commercial harbour, estimated to cost about £700,000 and to be finished by the end of 1901. Begun in 1893, the works include (1) an open iron viaduct, 1260 feet long, joining the east pier; (2) the extension of the east pier, of solid masonry, to a length of 1920 feet; (3) two jetties, 1100 and 500 feet long respectively; (4) reclamation of 5 acres of land, between the Admiralty pier and the mouth of the present harbour, as a water station; (5) an extension of the Admiralty pier. The harbour thus formed will have a

water area of 75 acres, with a depth within the mouth of over 40 feet at low water. A great national harbour, estimated to occupy ten years in building and to cost £3,500,000, commenced in 1899, will comprise (1) an extension of the Admiralty pier east-south-east for a distance of 2000 feet, over 90 feet from base of wall to top of parapet; (2) an east arm, projecting 3300 feet into the sea; (3) a sea-wall, 3850 feet long, from the Castle jetty to the base of the east arm; (4) reclamation of the foreshore between the back of the wall and the base of the cliff; (5) a breakwater 4300 feet long, $\frac{3}{4}$ mile from the shore, from the south extremity of the east arm, south-west and west by south to a point 800 feet from the Admiralty pier extension, with entrance at each end of about 7 fathoms at low water. The Admiralty harbour will cover at low water an area of 610 acres, accommodating twenty of the largest ships and any number of armed cruisers, torpedo and dispatch boats, at any time needing its shelter. Coaling berths will extend 1800 feet along the inner side of the east arm. To strengthen its defences, the construction of three powerful forts was begun in 1899. Three pits have been sunk to work the coal discovered by boring. The water-works, which are the property of the corporation, are situated on Castle Hill, and have given a constant supply since 1870. The rainfall at this point, 200 feet above sea-level, was 24·34 inches in 1899 and 31·34 inches in 1900. The sewage outfall, constructed in 1885 at a cost of £7500, discharges into the sea, to the west of the Admiralty pier, at a distance of 1225 feet from the shore. There is a promenade pier (1893), costing £24,000; electric lighting, begun in 1894; electric tramways, with a length of $3\frac{1}{4}$ miles; and a public park (1883), of $22\frac{1}{2}$ acres. Besides the mail and packet service, Dover does a trade in shipbuilding, timber, rope and sail making, and ships' stores. Shipping at port in 1888, 46 vessels of 3478 tons; in 1898, 66 of 5066 tons. Entered in 1888, 2923 vessels of 720,337 tons; cleared, 2895 of 716,544 tons. Entered in 1898, 3718 vessels of 1,015,609 tons; cleared, 3675 of 1,006,951 tons. Imports of foreign and colonial merchandise in 1888, valued £6,333,468; exports of produce of the United Kingdom, £1,128,104. In 1898, imports valued £9,451,780; exports, £1,564,225. Area of parliamentary borough, 1317 acres. Population (1881), 30,270; (1901), 33,300. Area of municipal borough as now extended, $1779\frac{1}{2}$ acres. Population (1891), 33,503; (1901), 41,782.

**Dover,** capital of the state and of Kent county, Delaware, U.S.A., on the Philadelphia, Wilmington, and Baltimore Railroad, at an altitude of 40 feet. It is the site of the state college for coloured students, opened in 1892. Population (1880), 2811; (1890), 3061; (1900), 3329, of whom 123 were foreign-born and 772 negroes.

**Dover,** capital of Strafford county, New Hampshire, U.S.A., in 43° 14′ N. lat. and 70° 54′ W. long., on Cocheco river, 12 miles from its mouth, at the lower falls, and at the head of navigation. Its street plan is irregular, few of the streets are paved, and its water supply, derived from Cocheco river, is obtained by gravity. It is at the intersection of two branches of the Boston and Maine Railway, and these, with the river, give it considerable commerce. Its manufactures consist mainly of cotton and woollen goods. Population (1880), 11,687; (1890), 12,790; (1900), 13,207, of whom 3298 were foreign-born.

**Dover,** a town of Morris county, New Jersey, U.S.A., on the Rockaway river, at an altitude of 570 feet. It is on the Morris Canal, and on the Central of New Jersey and the Delaware, Lackawanna, and Western Railways. It contains iron furnaces, rolling mills, and steel works. Population (1880), 2958; (1900), 5938, of whom 947 were foreign-born and 53 negroes.

**Dower,** or the life interest of the widow in a third part of her husband's lands, is governed in the United Kingdom, so far as women married after 1st January 1834 are concerned, by the Dower Act, 1834, and under it only attaches on the husband's death to the lands which he actually possessed for an estate of inheritance at the time of his death. The wife is now entitled to dower out of equitable estates, but joint estates are still exempt. By the Act the wife's dower is placed completely under her husband's control. It does not attach to any land actually disposed of by him in his lifetime or by his will, nor to any land from which he has declared by deed his wife shall not be entitled to dower. He may also defeat her right, either as to any particular land or to all his lands, by a declaration in his will; while it is subject to all the deceased husband's debts and contracts, and to any partial estates which he may have created during his life or by his will. A widow tenant in dower may make leases for twenty-one years under the Settled Estates Act, 1878. Free-bench is an analogous right in regard to copyhold land; it does not fall within the Dower Act, 1834, and varies with the custom of each manor. At common law, and prior to the Act of 1834, dower was of a very different nature. The wife's right attached, while the husband was still living, to any land whereof he was solely seised in possession (excluding equitable and joint estates) for an estate of inheritance at any time during the continuance of the marriage, provided that any child the wife might have had could have been heir to the same, even though no child was actually born. When once this right had attached, it adhered to the lands, notwithstanding any sale or devise the husband might make; nor was it liable for his debts. In this way dower proved an obstacle to the free alienation of land, for it was necessary for a husband wishing to make a valid conveyance to obtain the consent of his wife releasing her right to dower. This release was only effected by a fine, the wife being separately examined. Often, by reason of the expense involved, the wife's concurrence was not obtained, and thus the title of the purchaser was defective during the wife's lifetime. The acceptance of a jointure by the wife before marriage was, however, destructive of dower; if after marriage, she was put to her election between it and dower. By the ingenuity of the old conveyancers, devices, known as "uses to bar dower" (the effect of which was that the purchaser never had at any time an estate of inheritance in possession), were found to prevent dower attaching to newly purchased lands, and so to enable the owner to give a clear title, without the need of the wife's concurrence, in the event of his wishing, in his turn, to convey the land. All this has, however, been swept away by the Dower Act, 1834, and a purchaser of land need not now trouble himself to inquire whether the dower of the wife of the vendor has been barred, or to insist on her concurrence in a fine. (H. S. S.)

**Down,** a maritime county of Ireland, province of Ulster, bounded on the N. by Belfast Lough and Antrim, on the E. and S. by the Irish Sea, and on the W. by Armagh. The area of the judicial county in 1900 was 612,093 acres, of which 255,745 were tillage, 262,237 pasture, 763 fallow, 13,573 plantation, 1688 turf bog, 4129 marsh, 41,495 barren mountain, and 32,463 water, roads, fences, &c. The new administrative county under the Local Government (Ireland) Act, 1898, includes the portion of the town of Newry formerly situated in Armagh, but does not include the portion of Lisburn and the portion of Belfast formerly situated in Down. The population in 1881 was 272,107; in 1891, 267,059, of whom 126,268 were males and 140,791 females, divided

as follows among the different religions:—Presbyterians, 106,346; Roman Catholics, 73,410; Protestant Episcopalians, 65,239; Methodists, 7742; and other denominations, 14,322. The population in 1901 was 289,335 (Roman Catholics, 76,535; Protestant Episcopalians, 71,568; Presbyterians, 114,182; Methodists, 10,543; others, 16,507), being an increase of 7·3 per cent.; but these figures include part of the county borough of Belfast.

The following table gives the number of births, deaths, and marriages in various years:—

| Year. | Births. | Deaths. | Marriages. |
|---|---|---|---|
| 1881 | 5671 | 4257 | 1062 |
| 1891 | 7005 | 5419 | 1376 |
| 1899 | 7752 | 5366 | 1464 |

The chief towns in the county are Newtownards, Banbridge, Downpatrick, and Holywood.

*Education.*—The following table gives the degree of education in 1891:—

| | Males. | Females. | Total. | Percentage. | | |
|---|---|---|---|---|---|---|
| | | | | R. C. | Pr.Ep. | Presb. |
| Read and write . | 72,239 | 77,570 | 149,809 | 62·6 | 73·4 | 82·3 |
| Read only . . | 10,750 | 17,442 | 28,192 | 15·8 | 16·0 | 12·1 |
| Illiterate . . | 10,650 | 12,487 | 23,137 | 21·6 | 10 6 | 5·6 |

The percentage of illiterates among Roman Catholics in 1881 was 26·5. In 1891 there were 15 superior schools with 621 pupils (Roman Catholics 191 and Protestants 430), and 460 primary schools with 32,461 pupils (Roman Catholics 8690 and Protestants 23,771). The number of pupils on the rolls of the national schools on 30th September 1899 was 50,220, of whom 11,595 were Roman Catholics and 38,625 Protestants.

*Administration.*—The county is divided into four parliamentary divisions, north, south, east, west, the number of registered electors in 1900 being respectively 9886, 8944, 8489, and 8815. The borough of Newry returns one member. The ratable value in 1900 was £794,836. By the Local Government (Ireland) Act 1898, the fiscal and administrative duties of the grand jury and (to a less extent) of other bodies were transferred to a county council, urban and rural district councils were established, and under that Act the county now comprises 7 urban and 8 rural sanitary districts.

*Agriculture.*—The following tables show the acreage under crops, including meadow and clover, and the amount of live-stock in 1881, 1891, 1895, and 1900. The figures for 1900 are for the new administrative county.

| Year. | Wheat. | Oats. | Barley, Beans, &c. | Potatoes. | Turnips. | Other Green Crops. | Flax. | Meadow and Clover. | Total. |
|---|---|---|---|---|---|---|---|---|---|
| 1881 | 22,365 | 106,094 | 1715 | 51,668 | 16,813 | 4754 | 28,089 | 70,035 | 301,533 |
| 1891 | 13,277 | 101,060 | 967 | 48,305 | 17,957 | 4666 | 12,968 | 73,367 | 272,567 |
| 1895 | 7,225 | 100,090 | 851 | 46,053 | 20,017 | 3835 | 16,634 | 78,957 | 273,662 |
| 1900 | 9,531 | 95,218 | 1372 | 43,014 | 20,101 | 4114 | 7,738 | 74,395 | 255,745 |

For 1899 the total value of the cereal and other crops was estimated by the Registrar-General at £1,755,140. The number of acres under pasture in 1881 was 217,543; in 1891, 242,700, and in 1900, 262,237.

| Year. | Horses and Mules. | Asses. | Cattle. | Sheep. | Pigs. | Goats. | Poultry. |
|---|---|---|---|---|---|---|---|
| 1881 | 31,465 | 1382 | 129,447 | 56,745 | 34,272 | 10,911 | 636,802 |
| 1891 | 32,171 | 1302 | 150,481 | 101,931 | 51,703 | 13,791 | 719,682 |
| 1895 | 35,142 | 1359 | 151,261 | 92,791 | 45,651 | 12,838 | 822,123 |
| 1900 | 33,700 | 1454 | 159,745 | 122,166 | 42,153 | 11,186 | 1,049,373 |

The number of milch cows in 1891 was 53,743, and in 1900 54,087. It is estimated that the total value of cattle, sheep, and pigs in 1899 was £2,242,131. In 1900 the number of holdings not exceeding 1 acre was 6306, between 1 and 5, 3775, between 5 and 15, 8904, between 15 and 30, 6505, between 30 and 50, 3181, between 50 and 100, 1756, between 100 and 200, 333, between 200 and 500, 87, and above 500, 23—total, 30,870. The number of loans issued (the number of loans being the same as the number of tenants) under the Land Purchase Acts, 1885, 1891, and 1896, up to 31st March 1900, was 1314, amounting to £497,045. The number of loans sanctioned for agricultural improvements under sect. 31 of the Land Act, 1881, between 1882 and 1900 was 102, and the amount issued £8887. The total amount issued on loan for all classes of works under the Land Improvement Acts from the commencement of operations to 31st March 1900 was £99,765.

*Fisheries.*—In 1899, 375 vessels, employing 1120 hands, were registered in the deep sea and coast fishery districts of Donaghadee, Strangford, and Newcastle. In the same year 15,519 cwt. of herring were caught in the Ardglass fisheries. (W. H. Po.)

**Downpatrick,** a market-town and county town of Down, Ireland, on Strangford Lough, 18 miles south-east of Belfast by rail. It ceased to be a parliamentary borough in 1885. It is governed by town commissioners, but under the powers conferred by the Local Government (Ireland) Act, 1898, can apply to be constituted an urban sanitary district. The County Down Railway connects the town with Belfast and (among other places) with Newtownards and Newcastle, a favourite watering-place. In 1883 an assembly hall was erected at the expense of Lord Dunleath, and a new lunatic asylum has been opened near the town. Population (1881), 3901; (1901), 2992.

**Doyle, Sir Francis Hastings Charles,** Bart. (1810–1888), English man of letters, was born at Nunappleton, Yorkshire, 22nd August 1810, and was educated at Eton and Oxford, where he took a first-class in classics in 1831, and became a Fellow of All Souls'. He read for the Bar, but was chiefly interested in literature and society. Among his intimate friends was Mr Gladstone, whose "best man" he was; but in later life their political opinions widely differed. In 1841 he published *Miscellaneous Verses*, (1844) *Two Destinies*, (1852) *The Duke's Funeral*, (1866) *Return of the Guards and other Poems*; and from 1867 to 1877 he was professor of poetry at Oxford. In 1869 some of the lectures he delivered were published in book form. In 1886 he published his *Reminiscences*, full of records of the interesting people he had known. Sir Francis Doyle succeeded his father (chairman of the Board of Excise) as second baronet in 1839, and married in 1844. From 1846 he held various important offices in the Customs. He died 8th June 1888. A cultivated and agreeable man and writer, Doyle's poetry is memorable for certain isolated and spirited pieces, which became popular because of their thoroughly English celebration of manly deeds. The best known are his ballads on the "Birkenhead" disaster and on "The Private of the Buffs."

**Doyle, Richard** (1824–1883), English artist, son of John Doyle, the caricaturist known as "H. B." (1797–1868), was born in London in 1824. His father's "Political Sketches" took the town by storm in the days of Lord Grey and Lord Melbourne. The son was an extremely precocious artist, and in his "Home for the Holidays," done when he was twelve, and his "Comic English Histories," drawn four years later, he showed extraordinary gifts of humour and fancy. He had no art training outside his father's studio. In 1843 he joined the staff of *Punch*, drawing cartoons and a vast number of illustrations, but he retired in 1850, in consequence of the attitude adopted by that paper towards what was known as "the papal aggression," and especially towards the pope himself. In 1854 he published his "Continental Tour of Brown, Jones, and Robinson." His illustrations to three of the *Christmas Books* of Charles Dickens, and to *The Newcomes* by Thackeray, are reckoned among his principal achievements; and his fanciful pictures of elves and fairies have always been general favourites. He died on 11th December 1883. His most popular drawing is his cover of *Punch*.

**Dozy, Reinhart Pieter Anne** (1820–1883), Dutch Arabic scholar of French (Huguenot) origin, was born at Leyden in February 1820. The Dozys, like so

many other contemporary French families, emigrated to the Low Countries after the revocation of the Edict of Nantes, but some of the former appear to have settled in Holland as early as 1647. Dozy studied at the University of Leyden, obtained the degree of doctor in 1844, was appointed an extraordinary professor of history in 1850, and professor in 1857. The first results of his extensive studies in Oriental literature, Arabic language and history, manifested themselves in 1847, when he published Al-Marrakushi's *History of the Almohades* (Leyden, 2nd ed., 1881), which, together with his *Scriptorum Arabum loci de Abbaditis* (Leyden, 1846–63, 3 vols.), his editions of Ibn-Adhari's *History of Africa and Spain* (Leyden, 1848–52, 3 vols.), of Ibn-Badrun's *Historical Commentary on the Poem of Ibn-Abdun* (Leyden, 1848), and his *Dictionnaire detaillé des noms des vêtements chez les Arabes* (Amsterdam, 1845)—a work crowned by the Dutch Institute—stamped Dozy as one of the most learned and critical Arabic scholars of his day. But his real fame as a historian mainly rests on his great work *Histoire des Mussulmans d'Espagne, jusqu'à la Conquête de l'Andalousie par les Almoravides*, 711–1110 (Leyden, 1861; 2nd ed., *ibid.*, 1881; a graphically written account of Moorish dominion in Spain, which shed new light on many obscure points, and has remained the standard work on the subject. Dozy's *Recherches sur l'Histoire et la Littérature de l'Espagne pendant le Moyen Age* (Leyden, 2 vols., 1849; 2nd and 3rd ed., completely recast, 1860 and 1881) form a needful and wonderfully trenchant supplement to his *Histoire des Mussulmans*, in which he mercilessly exposes the many tricks and falsehoods of the monks in their chronicles, and effectively demolishes a good part of the Cid legends. As an Arabic scholar Dozy stands well-nigh unsurpassed in his *Supplément aux Dictionnaires Arabes* (Leyden, 1877–81, 2 vols.), a work full of research and learning, a storehouse of Arabic lore. To the same class belongs his *Glossaire des mots espagnols et portugais, dérivés de l'Arabe*, edited with Dr W. H. Engelmann of Leipzig (Leyden, 1866; 2nd ed., 1868), and a similar list of Dutch words derived from the Arabic. Dozy also edited Al Makkari's *Analectes sur l'Histoire et la Littérature des Arabes d'Espagne* (Leyden, 1855–61, 2 vols.), and, in conjunction with his friend and worthy successor, Professor De Goeje, at Leyden, Edrisi's *Description de l'Afrique et de l'Espagne* (1866), also the *Calendrier de Cordoue de l'année* 961; *texte arabe et ancienne traduction latine* (Leyden, 1874). *Het Islamisme* (*Islamism;* Haarlem, 1863; 2nd ed., 1880; French translation) is a popular exposition of Mahommedanism, of a more controversial character; and *De Israelieten te Mekka* (*The Israelites at Mecca*, Haarlem, 1864, became the subject of a rather heated discussion in Jewish circles. Dozy died at Leyden, May 1883. (H. Ti.)

**Drachmann, Holger** (1846–——), Danish poet and dramatist, the son of a well-known physician of Copenhagen, Dr A. G. Drachmann, whose family was of German extraction, was born in Copenhagen on the 9th October 1846. Owing to the early death of his mother, who was a Dane, the child was left much to his own devices. He soon developed a fondness for semi-poetical performances, and loved to organize among his companions heroic games, in which he himself took such parts as those of Tordenskjold and Niels Juul. His studies were belated, and he did not enter the university until 1865, leaving it in 1866 to become a student in the Academy of Fine Arts. From 1866 to 1870 he was learning, under Professor Sörensen, to become a marine painter, and not without success. But about the latter date he came under the influence of Georg Brandes, and, without abandoning art, he began to give himself more and more to literary ideas. He travelled very extensively in England, Scotland, France, Spain, and Italy, and his literary career began by his sending letters about his journeys to the Danish newspapers. After returning home, he settled for some time in the island of Bornholm, painting seascapes. He now issued his earliest volume of *Poems*, 1872, and joined the group of young Radical writers who gathered under the banner of Brandes. Drachmann was unsettled, and still doubted whether his real strength lay in the pencil or in the pen. By this time he had enjoyed a surprising experience of life, especially among sailors, fishermen, students, and artists, and the issues of the Franco-German War and the French Commune had persuaded him that a new and glorious era was at hand. His volume of lyrics, *Muffled Melodies*, 1875, proved that Drachmann was a poet with a real vocation, and he began to produce books in prose and verse with great rapidity. *Young Blood*, 1876, is his solitary attempt at a realistic novel of to-day. But in 1877 he returned to his true field in his magnificent *Songs of the Sea*, and he won the passionate admiration of his countrymen by his prose work, with interludes in verse, called *Over the Frontier There*, a series of impressions made on Drachmann by a visit to the scenes of the war with Germany. During the succeeding years he was a great traveller, visiting most of the principal countries of the world, but particularly familiarizing himself, by protracted voyages, with the sea and with the life of man in maritime places. In 1879 he published *Tendrils and Roses*, amatory lyrics of a very high order of melody, in which he showed a great advance in technical art. To the same period belongs *On the Faith and Honour of a Sailor*, a volume of short stories in prose. It was about this time that Drachmann broke with Brandes and the Radicals, and set himself at the head of a sort of "Nationalist" or popular-Conservative party in Denmark. He continued to celebrate the life of the fishermen and sailors in books, whether in prose or verse, which were the most popular of their day. *Paul and Virginia* and *Lars Kruse* (both 1879); *East of the Sun and Moon*, 1880; *Chrysalis and Butterfly*, 1882; and *Strandby Folk*, 1883, were among these. In 1882 Drachmann published his fine translation, or paraphrase, of Byron's *Don Juan*. He now gave his attention to dramatic composition, and in 1885 his romantic play called *Once upon a Time* enjoyed an enormous success on the boards of the Royal Theatre, Copenhagen. He pursued this profitable course, and his tragedies of *Völund Smed* and *Brav-Karl* have made him the most popular playwright of Denmark. He published a volume of exquisitely fantastic *Melodramas* in rhymed verse, a collection which contains some of Drachmann's most perfect work. It is impossible to give the titles of all the poet's publications, which are extremely numerous. In 1899 he enjoyed a great success through Scandinavia by his romantic play called *Gurre*, and in 1900 he brought out a prose story called *Dædalus* and a brilliant lyrical drama, *Hallfred Vandraadeskjald*. In the winter of 1900 Drachmann visited England, and was entertained at dinner by fifty English authors. A man of lofty stature and commanding appearance, he looks like a poet and a Viking. He is unquestionably the greatest writer that Denmark produced in the last quarter of the 19th century.

**Dragasani**, a town in Rumania, of 4398 inhabitants, on the right bank of the river Olt. It was the scene in 1821 of a bloody battle between the Turks and the troops of Ypsilanti, in which the latter were completely defeated. The vines of the neighbouring hills produce the best white wines in the country.

**Drama.**—The last quarter of the 19th century witnessed a very distinct progress in the theatrical life of the world at large. It is at present too early to unify this movement by tracing it to any one cause or set of causes, political, economic, or psychological. Yet the fact is clear that the new theatrical literature of England, France, Germany, and even of Italy and America, represents a break with tradition rather than a continuance of it.

*English drama.*

In England the whole mechanism of theatrical life had undergone a radical change in the middle decades of the century. At the root of this change lay the immense growth of population and the enormously increased facilities of communication between London and the provinces. Similar causes came into operation, of course, in France, Germany, and Austria, but were much less distinctly felt, because the numerous and important subventioned theatres of these countries remained more or less unaffected by economic influences. Free trade in theatricals (subject only to certain licensing regulations and to a court censorship of new plays) was established in England by an Act of 1843, which abolished the long moribund monopoly of the "legitimate drama" claimed by the "Patent Theatres" of Drury Lane and Covent Garden. The drama was thus formally subjected to the operation of the law of supply and demand, like any other article of commerce, and managers were left, unaided and unhampered by any subvention or privilege, to cater to the tastes of a huge and growing community. Theatres very soon multiplied, competition grew ever keener, and the long run, with its accompaniments of ostentatious decoration and lavish advertisement, became the one object of managerial effort. This process of evolution may be said to have begun in the second quarter of the 19th century and completed itself in the 3rd. The system which obtains to-day, almost unforeseen in 1825, was in full operation in 1875. The repertory theatre, with its constant changes of programme, maintained on the Continent partly by subventions, partly by the mere force of artistic tradition, had become in England a faint and far-off memory. There was not a single theatre in London at which plays, old and new, were not selected and mounted solely with a view to their continuous performance for as many nights as possible, anything short of fifty nights constituting an ignominious and probably ruinous failure. It was found, too, that those theatres were most successful which were devoted exclusively to exploiting the talent of an individual actor. Thus when the fourth quarter of the century opened the long "run" and the actor-manager were in firm possession of the field.

The outlook was in many ways far from encouraging. It was not quite so black, indeed, as it had been in the late 'fifties and early 'sixties, when the "legitimate" enterprises of Phelps at Sadler's Wells and Charles Kean at the Princess's had failed to hold their ground, and when modern comedy and drama were represented almost exclusively by adaptations from the French. There had been a slight stirring of originality in the series of comedies produced by T. W. Robertson (1829–1871) at the Prince of Wales's Theatre, Tottenham Street, where, under the management of Mr and Mrs Bancroft,[1] a new school of mounting and acting, minutely faithful (in theory at any rate) to everyday reality, had come into existence. But the hopes of a revival of English comedy seemed to have died with Robertson's death. One of his followers, James Albery (1832–1889), possessed both imagination and wit, but had not the strength of character to do justice to his talent, and sank into a mere adaptor. In the plays of another disciple, H. J. Byron (1836–1884), the Robertsonian or "cup-and-saucer" school declined upon sheer inanity. Of the numerous plays signed by Tom Taylor (1817–1880) some were original in substance, but all were cast in the machine-made French mould. Wilkie Collins (1824–1889), in dramatizing some of his novels, produced somewhat crude anticipations of the modern "problem play." The literary talent of Mr W. S. Gilbert (*b.* 1836) displayed itself in a group of comedies both in verse and prose; but Mr Gilbert saw life from too peculiar an angle to represent it otherwise than fantastically. The Robertsonian impulse seemed to have died utterly away, leaving behind it only five or six very insubstantial comedies and a subdued, unrhetorical method in acting. This method the Bancrofts proceeded to apply, during the 'seventies, to revivals of stage classics, such as *The School for Scandal*, *Money*, and *Masks and Faces*, and to adaptations from the French of Sardou.

While the modern drama appeared to have relapsed into a comatose condition, poetic and romantic drama was giving some signs of life. At the Lyceum in 1871 Henry Irving (*b.* 1838) had leapt into fame by means of his performance of Mathias in *The Bells*, an adaptation from the French of Erckmann-Chatrian. He followed this up by an admirably picturesque performance of *Charles I.* in a play of that name by W. G. Wills (1828–1893), a writer of some talent, which ran to waste for lack of an adequate sense of either dramatic or literary form. In the autumn of 1874 the great success of Mr Irving's Hamlet was hailed as the prelude to a revival of tragic acting. As a matter of fact, it was the prelude to a long series of remarkable achievements in romantic drama and melodrama. Mr Irving's lack of physical and vocal resources prevented him from scaling the heights of tragedy, and his Othello, Macbeth, and Lear could not be ranked among his successes; but he was admirable in such parts as Richard III., Shylock, Iago, and Wolsey, while in melodramatic parts, such as Louis XI. and the hero and villain of *The Lyons Mail*, he was unsurpassed. Mephistopheles in a version of *Faust* (1885), perhaps the greatest popular success of his career, added nothing to his reputation for artistic intelligence; but on the other hand his Becket in Tennyson's play of that name (1893) was one of his most masterly efforts. His management of the Lyceum (1878–1899) did so much to raise the status of the actor and to restore the prestige of poetic drama, that the knighthood conferred upon him in 1895 was felt to be no more than an appropriate recognition of his services. But unfortunately his managerial career had scarcely any significance for the living English drama. He seldom experimented with a new play, and, of the few which he did produce, only *The Cup* and *Becket* by Lord Tennyson have the remotest chance of being remembered.

To trace the history of the English drama, then, we must go back to the Prince of Wales's Theatre. Even while it seemed that French comedy of the school of Scribe was resuming its baneful predominance, the seeds of a new order of things were slowly germinating. *Diplomacy*, an adaptation of Sardou's *Dora*, produced in 1878, brought together on the Prince of Wales's stage Mr and Mrs Bancroft, Mr and Mrs. Kendal, Mr John Clayton, and Mr Arthur Cecil—in other words, the future managers of the Haymarket, the St James's, and the Court Theatres, which were destined to see the first real stirrings of a literary revival. Mr and Mrs Kendal, who, in conjunction with Mr John Hare, managed the St James's Theatre

[1] Sir Squire Bancroft, who was knighted in 1897, was born on 14th May 1841, and made his début at Birmingham in 1861. In 1865 he joined the company with which Miss Marie Wilton (whom he afterwards married) opened the Prince of Wales's Theatre, in Tottenham Court Road, London; and he became co-manager with his wife in 1868. They moved to the Haymarket in 1880, and formally retired from the stage in 1885, but at rare intervals afterwards occasionally reappeared.

from 1879 to 1888, produced Mr A. W. Pinero's first play of any consequence, *The Money-Spinner* (1881), and afterwards *The Squire* (1882) and *The Hobby Horse* (1887). Mr and Mrs Bancroft, who, after entirely rebuilding the Haymarket Theatre, managed it from 1880 till their retirement in 1885, produced in 1883 Mr Pinero's *Lords and Commons;* and Messrs Clayton and Cecil produced at the Court Theatre between 1885 and 1887 his three brilliant farces *The Magistrate*, *The Schoolmistress*, and *Dandy Dick*, which, with the sentimental comedy, *Sweet Lavender*, produced at Terry's Theatre in 1888, assured his position as an original and fertile dramatic humorist of no small literary power. It is to be noted, however, that Mr Pinero was almost the only original playwright represented under the Bancroft, Hare-Kendal, and Clayton-Cecil managements, which relied for the rest upon adaptations and revivals. Adaptations of French vaudevilles were the staple productions of Mr Charles Wyndham's management at the Criterion from its beginning in 1876 until 1893, when he first produced an original play of any importance. When Mr Beerbohm Tree went into management at the Haymarket in 1887, he still relied largely on plays of foreign origin. Mr George Alexander's first managerial ventures (Avenue Theatre, 1890) were two adaptations from the French. Until well on in the 'eighties, indeed, adaptation from the French was held the normal occupation of the British playwright, and original composition a mere episode. Robertson, Byron, Albery, Gilbert, Tom Taylor, Charles Reade, Herman Merivale, G. W. Godfrey, all produced numerous adaptations; Mr Sydney Grundy was for twenty years occupied almost exclusively in this class of work; Mr Pinero himself has adapted more than one French play. To this day the managers have not quite unlearnt the habit of regarding Paris as the natural fountainhead of English drama. The 'eighties, then, may on the whole be regarded as showing a very gradual decline in the predominance of France on the English stage, and an equally slow revival of originality, so far as comedy and drama were concerned, manifesting itself mainly in the plays of Mr Pinero.

The reaction against French influence, however, was no less apparent in the domain of melodrama and operetta than in that of comedy and drama. Until well on in the 'seventies, D'Ennery and his disciples, adapted and imitated by Boucicault and others, ruled the melodramatic stage. The reaction asserted itself in two quarters—in the East End at the Grecian Theatre, and in the West End at the Princess's. In *The World*, produced at Drury Lane in 1880, Paul Meritt (*d.* 1895) and Henry Pettitt (*d.* 1893) brought to the West End the "Grecian" type of popular drama; and at Drury Lane it has survived in the elaborately spectacular form imparted to it by Sir Augustus Harris, who managed that theatre from 1879 till his death in 1896. The production of Mr G. R. Sims's *Lights o' London* at the Princess's in 1881, under Mr Wilson Barrett's management, also marked a new departure; and the two streams of melodrama flowed together in a long series of popular plays at the Adelphi Theatre, from about 1882 to almost the end of the century. The "Adelphi" as opposed to the "Drury Lane" type of drama has recently died out in the West End, apparently because a host of suburban theatres drew away its audiences. Of all these English melodramas, only one, *The Silver King*, by Mr H. A. Jones (Princess's, 1882) could for a moment compare in invention or technical skill with the French dramas they supplanted. The fact remains, however, that even on this lowest level of dramatic art the current of the time set decisively towards home-made pictures of English life, however crude and puerile.

For twenty-five years, from 1865 to 1890, the English stage was overrun with French operettas of the school of Offenbach. Hastily adapted by slovenly hacks, their librettos (often witty in the original) became incredible farragos of metreless doggrel and punning ineptitude. The great majority of them are now so utterly forgotten that one scarcely realizes, until one looks into the records, how in their heyday they swarmed on every hand. The reaction began in 1875 with the performance at the Royalty Theatre of *Trial by Jury*, by Mr W. S. Gilbert and Mr (afterwards Sir) Arthur Sullivan (1842–1900). This was the prelude to that brilliant series of witty and melodious extravaganzas which began with *The Sorcerer* at the Opera Comique Theatre in 1877, but has been mainly associated with the Savoy Theatre, opened by Mr D'Oyly Carte (*d.* 1901) in 1881. Little by little the Gilbert and Sullivan operettas (of which the most famous, perhaps, were *H.M.S. Pinafore*, 1878, *Patience*, 1881, and *The Mikado*, 1885) undermined the popularity of the French opera-bouffes, and at the same time that of the indigenous "burlesques" which, graceful enough in the hands of their inventor J. R. Planché (1796–1880), had become mere incoherent jumbles of buffoonery, devoid alike of dramatic ingenuity and of literary form. When, early in the 'nineties, the collaboration between Mr Gilbert and Sir Arthur Sullivan became intermittent, and the vogue of the Savoy somewhat declined, a new class of extravaganza arose, under the designation of "musical comedy" or "musical farce." It first took form in a piece called *In Town*, by Messrs "Adrian Ross" and Osmond Carr (Prince of Wales's Theatre, 1892), and rapidly became very popular. In these plays the scene and costumes are almost always modern, though sometimes exotic, and the prose dialogue, setting forth an attenuated and entirely negligible plot, is frequently interrupted by musical numbers. The lyrics are often very clever pieces of rhyming, totally different from the inane doggrel of the old opera-bouffes and burlesques. In other respects there is little to be said for the literary or intellectual quality of "musical farce"; but being an entirely English (or Anglo-American) product, it falls into line with the other indications we have noted of the general decline—one might almost say extinction—of French influence on the English stage.

To what causes are we to trace this gradual disuse of adaptation? In the domain of modern comedy and drama, to two causes acting simultaneously: the decline in France of the method of Scribe, which produced "well-made," exportable plays, more or less suited to any climate and environment; and the rise in England of a generation of playwrights more original, thoughtful, and able than their predecessors. It is not at all to be taken for granted that the falling off in the supply of exportable plays meant a decline in the absolute merit of French drama. That point is discussed in the section *French Drama* below. The historian of the future may very possibly regard the movement in France, no less than the movement in England, as a step in advance, and may even see in the two movements co-ordinate manifestations of one tendency. Be this as it may, the fact is certain that as the playwrights of the Second Empire gradually died off and were succeeded by the authors of the "new comedy," plays which would bear transplantation became ever fewer and farther between. It is worthy of note that (a few mere buffooneries apart) most of the adaptations produced since 1890 have been from comedies and novels of a very much older date—works of Labiche and of Dumas *père* and *fils*. Attempts to acclimatize the poetical drama of the present generation—*Pour la Couronne*, *Le Chemineau*, *Cyrano de Bergerac*—have all been more or less unsuccessful.

Having noted the decline of adaptation, we may now trace a stage farther the development of the English drama. The first stage, already surveyed, ends with the production of *Sweet Lavender* in 1888. Up to this point its author, Mr Pinero (*b.* 1855), stood practically alone, and had won his chief successes as a humorist. Mr Henry Arthur Jones (*b.* 1851) was known as little more than an able melodramatist, though in one play, *Saints and Sinners* (1884), he had made some attempt at a serious study of provincial life. Mr R. C. Carton (*b.* 1856) had written, in collaboration, one or two plays of slight account. Mr Sydney Grundy (*b.* 1848) had produced scarcely any original work. None of the other dramatists of to-day had as yet appeared on the horizon. The second stage may be taken as extending from 1889 to 1893. On 24th April 1889 Mr John Hare opened the new Garrick Theatre with *The Profligate*, by Mr Pinero—an unripe and superficial piece of work in many ways, but still a great advance, both in ambition and achievement, upon any original work the stage had seen for many a year. With all its faults, this play notably enlarged at one stroke the domain open to the English dramatist. And it did not stand alone. The same year saw the production of two plays by Mr Jones, *Wealth* and *The Middleman*, in which a distinct effort towards a serious criticism of life was observable, and of two plays by Mr Grundy, *A Fool's Paradise* and *A White Lie*, which, though very French in method, were at least original in substance. Mr Jones during the next two years made a steady advance with *Judah* (1890), his first really mature production, and *The Dancing Girl* and *The Crusaders* (1891), in the latter of which he made his first attempt to work the vein of social satire. Mr Pinero in these years was putting forth less than his whole strength in *The Cabinet Minister* (1890), *Lady Bountiful* and *The Times* (1891), and *The Amazons* (March 1893). But meanwhile new talents were coming forward. The management of Mr George Alexander, which opened at the Avenue Theatre in 1890, but was transferred in the following year to the St James's, brought prominently to the front Mr Carton, Mr Haddon Chambers, and Mr Oscar Wilde. Mr Carton's two sentimental comedies, *Sunlight and Shadow* (1890) and *Liberty Hall* (1892), showed excellent literary workmanship, but did not yet reveal his true originality as a humorist. Mr Haddon Chambers's work (notably *The Idler*, 1891) was as yet sufficiently commonplace; but in *Lady Windermere's Fan* (1892) Mr Oscar Wilde showed himself at his first attempt a brilliant and accomplished dramatist. Mr Wilde's subsequent plays, *A Woman of No Importance* (1893) and *An Ideal Husband* and *The Importance of being Earnest* (1895), though marred by mannerism and insincerity, did much to promote the movement we are here tracing, and his painful downfall gave it a distinct, though temporary, check.

As the production of *The Profligate* marked the opening of the second period in the revival of English drama, so the production of the same author's *The Second Mrs Tanqueray* is very clearly the starting-point of the third period—of the phase of development still in progress. Before attempting to trace its course, however, we may do well to glance at certain conditions which probably influenced it.

In the first place, economic conditions. The Bancroft-Robertson movement at the old Prince of Wales's, between 1865 and 1870, was of even more importance from an economic than from a literary point of view. By making their little theatre a luxurious place of resort, and faithfully imitating in their productions the accent, costume, and furniture of upper and upper-middle class life, the Bancrofts had initiated a reconciliation between Society and the Stage. Throughout the middle decades of the century it was the constant complaint of the managers that the world of wealth and fashion was by no means to be tempted to the theatre. The Bancroft management changed all that. It was at the Prince of Wales's that half-guinea stalls were first introduced; and these stalls were always filled. As other theatres adopted the same policy of upholstery, both on and off the stage, fashion extended its complaisance to them as well. In yet another way the reconciliation was promoted—by the ever-increasing tendency of young men and women of good birth and education to seek a career upon the stage. For the past fifteen years, then, the theatre has been one of the favourite amusements of fashionable (though not necessarily of intellectual) Society. It is often contended that the influence of the sensual and cynical stall audience is a pernicious one. In some ways, no doubt, it is detrimental; but there is another side to the case. Even the cynicism of Society marks an intellectual advance upon the sheer rusticity which prevailed during the middle years of the 19th century and accepted without a murmur plays (original and adapted) which bore no sort of relation to life. In a celebrated essay published in 1879, Matthew Arnold dwelt on the sufficiently obvious fact that the result of giving English names and costumes to French characters was to make their sayings and doings utterly unreal and "fantastic." During the years of French ascendancy, audiences had quite forgotten that it was possible for the stage to be other than "fantastic" in this sense. They no longer thought of comparing the mimic world with the real world, but were content with what may be called abstract humour and pathos, often of the crudest quality. The cultivation of external realism, coinciding with, and in part occasioning, the return of Society to the playhouse, gradually led to a demand for some approach to plausibility in character and action as well as in costume and decoration. The stage ceased to be entirely "fantastic," and began to essay, however imperfectly, the representation, the criticism of life. It cannot be denied that the influence of Society tends to narrow the outlook of English dramatists and to trivialize their tone of thought. But this is, in all likelihood, a passing phase of development; and cleverly trivial representations of reality are, after all, to be preferred to brainless concoctions of sheer emptiness.

Quite as important, from the economic point of view, as the reconciliation of Society to the stage, was the reorganization of the mechanism of theatrical life in the provinces which took place between 1865 and 1875. From the Restoration to the middle of the 19th century the system of "stock companies" had been universal. Every great town in the three kingdoms had its established theatre with a resident company, playing the "legitimate" repertory, and competing, often by illegitimate means, for the possession of new London successes. The smaller towns, and even villages, were grouped into local "circuits," each served by one manager with his troupe of strollers. The "circuits" supplied actors to the resident stock companies, and the stock companies served as nurseries to the patent theatres in London. Metropolitan "stars" travelled from one country theatre to another, generally alone, sometimes with one or two subordinates in their train, and were "supported," as the phrase went, by the stock company of each theatre. Under this system, scenery, costumes, and appointments were often grotesquely inadequate, and performances almost always rough and unfinished. On the other hand, the constant practice in a great number and variety of characters afforded valuable training for actors, and developed many remarkable talents.

As a source of revenue to authors, the provinces were practically negligible. Stageright was unprotected by law; and even if it had been protected, it is doubtful whether authors could have got any considerable fees out of country managers, whose precarious ventures usually left them a small enough margin of profit.

The spread of railways throughout the country gradually put an end to this system. The "circuits" disappeared early in the 'fifties, the stock companies survived until about the middle of the 'seventies. As soon as it was found easy to transport whole companies, and even great quantities of scenery, from theatre to theatre throughout the length and breadth of Great Britain, it became apparent that the rough makeshifts of the stock company system were doomed. Here again we can trace to the old Prince of Wales's Theatre the first distinct impulse towards the new order of things. Robertson's comedies not only encouraged but absolutely required a style of art, in mounting, stage-management, and acting, not to be found in the country theatres. To entrust them to the stock companies was well-nigh impossible. On the other hand, to quote Sir Squire Bancroft, "perhaps no play was ever better suited than *Caste* to a travelling company; the parts being few, the scenery and dresses quite simple, and consequently the expenses very much reduced." In 1867, then, a company was organized and rehearsed in London to carry round the provincial theatres as exact a reproduction as possible of the London performance of *Caste* and Robertson's other comedies. The smoothness of the representation, the delicacy of the interplay among the characters, were new to provincial audiences, and the success was remarkable. About the same time the whole Haymarket company, under Buckstone's management, began to make frequent rounds of the country theatres; and other "touring combinations" were soon organized. It is manifest that the "combination" system and the stock company system cannot long coexist, for a manager cannot afford to keep a stock company idle while a London combination is occupying his theatre. The stock companies, therefore, soon dwindled away, and were probably quite extinct before the end of the 'seventies. Under the present system, no sooner is a play an established success in London than it is reproduced in one, two, or three exact copies and sent round the provincial theatres (and the numerous suburban theatres which have sprung up since 1895), Company A serving first-class towns, Company B the second-class towns, and so forth. The process is very like that of taking plaster casts of a statue, and the provincial companies often stand to their London originals very much in the relation of plaster to marble. Even the London scenery is faithfully reproduced in material of extra strength, to stand the wear-and-tear of constant removal. The result is that, instead of the square pegs in round holes of the old stock company system, provincial audiences now see pegs carefully adjusted to the particular holes they occupy, and often incapable of fitting any other. Instead of the rough performances of old, they are now accustomed to performances of a mechanical and soulless smoothness. In some ways the gain is undeniable, in other ways the loss is great. The provinces are no longer, in any effective sense, a nursery of fresh talents for the London theatres, for the art acquired in touring combinations is that of mimicry rather than of acting. Moreover, provincial playgoers have lost all personal interest and pride in their local theatres, which have no longer any individuality of their own, but serve as a mere frame for the presentation of a series of ready-made London pictures. Christmas pantomime is the only theatrical product that has any local flavour in it, and even it is very often only a second-hand London production, touched up with a few topical allusions. Again, the railways which bring London productions to the country take country playgoers by the thousand to London. The wealthier classes, in the Lancashire, Yorkshire, and Midland towns at any rate, do almost all their theatre-going in London, or during the autumn months when the leading London companies go on tour. Thus the better class of comedy and drama has a hard fight to maintain itself in the provinces, and the companies devoted to melodrama and musical farce enjoy an ominous preponderance of popularity.

On the whole, however—and this is the main point to be observed with regard to the literary development of the drama—the economic movement of the five-and-twenty years between 1865 and 1890 was enormously to the advantage of the dramatic author. A London success meant a long series of full houses at high prices, on which he took a handsome percentage. The provinces, in which a popular playwright would often have three or four plays going the rounds simultaneously, became a steady source of income. And, finally, it was found possible, even before international copyright came into force, to protect stageright in the United States, so that about the beginning of the 'eighties large receipts began to pour in from America. Thus successful dramatists, instead of living from hand to mouth, like their predecessors of the previous generation, found themselves in comfortable and even opulent circumstances. They had leisure for reading, thought, and careful composition, and they could afford to gratify their ambition with an occasional artistic experiment. Failure might mean a momentary loss of prestige, but it would not spell ruin. A distinctly progressive spirit, then, began to animate the leading English dramatists—a spirit which found intelligent sympathy in such managers as Mr John Hare, Mr George Alexander, Mr Beerbohm Tree, and finally Mr Charles Wyndham. Nor must it be forgotten that, though the laws of literary property, internal and international, are still far from perfect, it has been found possible during the past ten years to print and publish plays without incurring loss of stageright either at home or in America. The playwrights of the present generation have accordingly a motive for giving literary form and polish to their work which was quite inoperative with their predecessors, whose productions were either kept jealously in manuscript or printed only in miserable and totally unreadable stage editions. It is no small stimulus to ambition to know that even if a play prove to be in advance of the public to which it is originally presented, it will not perish utterly, but will, if it have any inherent vitality, continue to live as literature.

**Influence of foreign drama.**

Having now summed up the economic conditions which made for progress, let us glance at certain intellectual influences which tended in the same direction. The establishment of the Théâtre Libre in Paris, towards the close of 1887, unquestionably marked the beginning of a period of restless experiment throughout the theatrical world of Europe. M. Antoine and his supporters were in open rebellion against the artificial methods of Scribe and the Second Empire playwrights. Their effort was to transfer to the stage the realism, the so-called "naturalism," which had been dominant in French fiction since 1870 or earlier; and this naturalism was doubtless, in its turn, the outcome of the scientific movement of the century. New methods (or ideals) of observation, and new views as to the history and destiny of the race, could not fail to produce a profound effect upon art; and though the modern theatre is a cumbrous contrivance, slow to adjust its orientation to the winds of the spirit, even it at last began to revolve, like a rusty windmill, so as to fill its sails in the main current of the intellectual atmosphere.

Under the section *French Drama* (below), the history of the Théâtre Libre is outlined. Within three or four years of its inception M. Antoine's experiment had been imitated in Germany, England, and America. The Freie Bühne of Berlin came into existence in 1889, the Independent Theatre of London in 1891. Similar enterprises were set on foot in Munich and other cities. In America several less formal experiments of a like nature were attempted, chiefly in Boston and New York. Nor must it be forgotten that in Paris itself the Théâtre Libre did not stand alone. Many other *théâtres à côté* sprang up, under such titles as "Théâtre d'Art," "Théâtre Moderne," "Théâtre de l'Avenir Dramatique." The most important and least ephemeral was the "Théâtre de l'Œuvre," founded in 1893 by M. Lugné-Poë, which represented mainly, though not exclusively, the symbolist reaction against naturalism.

The impulse which led to the establishment of the Théâtre Libre was, in the first instance, entirely French. If any foreign influence helped to shape its course, it was that of the great Russian novelists. Tolstoi's *Puissance des Ténèbres* was the only "exotic" play announced in M. Antoine's opening manifesto. But the whole movement, in France and elsewhere, was soon to receive a potent stimulus from a somewhat unlikely quarter. Born in 1828, the Norwegian poet Henrik Ibsen was already an old man before his fame became European. His youth and middle life had been devoted to romantic tragedy and satiric drama in verse. Not till 1877 did he finally restrict himself to prose and to the modern world. In the series of plays which then followed he anticipated the process of evolution which was to lead, both in France and Germany, through prosaic realism to an intensely imaginative treatment of everyday life, touched here and there with symbolism. As a matter of fact, the author of *Brand* and *Peer Gynt* was above all things a poet. In essaying a literal and photographic transcript of reality, he was merely, as it were, trying a new set of tools. He is least himself in his most prosaic play, *Pillars of Society*. In its successors the poet gradually but decisively reasserts himself, and shakes off the trammels of the theoretic realist. Still, there was a sufficient element of realism, narrowly so called, in *A Doll's House*, *Ghosts*, *An Enemy of the People*, and *The Wild Duck* to awaken the enthusiasm of the realist party, just as the symbolists afterwards hailed with delight *The Lady from the Sea*, *The Master Builder*, and *Little Eyolf*.

Ibsen's early romantic plays had been known in Germany since 1875. In 1878 *Pillars of Society*, and in 1880 *A Doll's House*, achieved wide popularity, and held the German stage side by side with *A Bankruptcy*, by Björnstjerne Björnson (*b.* 1832). But these plays had little influence on the German drama. Their methods were, indeed, not essentially different from those of the French school of the Second Empire, which were then dominant in Germany as well as everywhere else. It was *Ghosts* (acted in Augsburg and Meiningen 1886, in Berlin 1887) that gave the impulse which, coalescing with the kindred impulse from the French Théâtre Libre, was destined in the course of a few years to create a new dramatic literature in Germany. During the middle decades of the century Germany had produced some dramatists of solid and even remarkable talent, such as Friedrich Hebbel (1813–1865), Heinrich Laube (1806–1884), Karl Gutzkow (1811–1878), and Gustav Freytag (1816–1895). Even the generation which held the stage after 1870, Paul Heyse (*b.* 1830), Paul Lindau (*b.* 1839), and Adolf Wilbrandt (*b.* 1837), with numerous writers of light comedy and farce, such as Wichert, Blumenthal, Von Moser, L'Arronge, and Schönthan, had produced a good many works of some merit. But, in the main, French artificiality and frivolity predominated on the German stage. In point of native talent and originality, the Austrian popular playwright Ludwig Anzengruber (1839–1889) was probably well ahead of his North German contemporaries. It was in 1889, with the establishment of the Berlin Freie Buhne, that the reaction definitely set in. In Berlin, as afterwards in London, *Ghosts* was the first play produced on the outpost stage, but it was followed in Berlin by a very rapid development of native talent. Less than a month after the performance of Ibsen's play, Gerhart Hauptmann (*b.* 1862) came to the front with *Vor Sonnenaufgang*, an immature piece of almost unrelieved Zolaism, which he soon followed up, however, with much more important works. In *Das Friedensfest* (1890) and *Einsame Menschen* (1891) he had transferred his allegiance from Zola to Ibsen. His true originality first manifested itself in *Die Weber* (1892); and since that time he has produced nine or ten plays in several different styles, but all bearing the stamp of a potent individuality. His most popular productions have been the dramatic poems *Hannele* and *Die Versunkene Glocke*, the low-life comedy *Der Biberpelz*, and the low-life tragedy *Fuhrmann Henschel*. Other remarkable playwrights belonging to the Freie Bühne group are Max Halbe (*b.* 1865), author of *Jugend* and *Mutter Erde*, and Otto Erich Hartleben (*b.* 1864), author of *Hanna Jagert* and *Rosenmontag*. These young men, however, so quickly gained the ear of the general public, that the need for a special "free stage" was no longer felt, and the Freie Bühne, having done its work, ceased to exist. Unlike the French Théâtre Libre and the English Independent Theatre, it had been supported from the outset by the most influential critics, and had won the day almost without a battle. The productions of the new school soon made their way even into some of the subventioned theatres; but it was the unsubventioned Deutsches Theater of Berlin that most vigorously continued the tradition of the Freie Bühne. One or two playwrights of the new generation, however, did not actually belong to the Freie Buhne group. Hermann Sudermann (*b.* 1857) produced his first play, *Die Ehre*, in 1888, the year before the Freie Bühne came into existence, and his most famous work, *Heimat*, in 1892. In him the influence of Ibsen is very clearly perceptible; while Arthur Schnitzler of Vienna, author of *Liebelei*, may rather be said to derive his inspiration from the Parisian "new comedy."

The promoters of the Théâtre Libre had probably never heard of Ibsen when they established that institution, but three years later his fame had reached France, and *Les Revenants* was produced by the Théâtre Libre, 29th May 1890. Within the next two or three years almost all his modern plays were acted in Paris, most of them either by the Théâtre Libre or by L'Œuvre. Close upon the heels of the Ibsen influence followed another, less potent, but by no means negligible. The exquisite tragic symbolism of Maurice Maeterlinck (*b.* 1862) began to find numerous admirers about 1890. In 1891 his one-act play *L'Intruse* was acted; in 1893, *Pelléas et Mélisande*. By this time, too, the reverberation of the impulse which the Théâtre Libre had given to the Freie Bühne began to be felt in France. In 1893 Hauptmann's *Die Weber* was acted in Paris, and, being frequently repeated, made a deep and lasting impression.

The English Théâtre Libre, the Independent Theatre, opened its first season, 13th March 1891, with a performance of *Ghosts*. This was not, however, the first introduction of Ibsen to the English stage. On 7th June 1889 (six weeks after the production of *The Profligate*), *A Doll's House* was acted at the Novelty Theatre, and ran for three

weeks, amid a storm of critical controversy. In the same year *Pillars of Society* was presented in London. In 1891 and 1892 *A Doll's House* was frequently acted; *Rosmersholm* was produced in 1891, and again in 1893; in May and June 1891 *Hedda Gabler* had a run of several weeks; and early in 1893 *The Master Builder* enjoyed a similar passing vogue. During these years, then, Ibsen was very much "in the air" in England, as well as in France and Germany. The Independent Theatre, in the meantime, under the management of Mr J. T. Grein, found but scanty material to deal with. It presented translations of Zola's *Thérèse Raquin*, and of *A Visit*, by the Danish dramatist Edward Brandes; but it brought to the front only one English author of any note, in the person of Mr George Bernard Shaw (*b.* 1856), whose "didactic realistic play," *Widowers' Houses*, it produced in December 1892. In France and Germany the Free Theatres were like artesian wells, tapping rich subterranean reservoirs which only awaited an outlet. In England it must be owned that the most industrious boring (ominous word!) produced only a meagre trickle. It appeared that all the available talent was already at the surface.

None the less is it true that the ferment of fresh energy, which between 1887 and 1893 had created a new dramatic literature both in France and in Germany, was distinctly felt in England as well. England did not take at all kindly to it. Rumours (some of them too well founded) of the excesses of cynical crudity perpetrated in the French *théâtres à côté* established a very general prejudice against the whole movement. Nor did the productions of Ibsen's plays tend to soothe the alarmed susceptibilities of the critics and the public. They were received with an outcry of horror and reprobation, the echoes of which have not yet died away. A great part of this clamour was due to sheer misunderstanding, but some of it, no doubt, arose from genuine and deep-seated distaste, which even perfect comprehension would have left unaltered. As for the dramatists of recognized standing, they one and all, both from policy and from conviction, adopted a hostile attitude towards Ibsen, expressing at most a theoretical respect overborne by practical dislike. To represent that they imitated him would be to misrepresent them grossly. Consciously and voluntarily they did nothing of the sort. Yet his influence permeated the atmosphere. He had revealed possibilities of technical stagecraft and psychological delineation that, once realized, were not to be banished from the mind of the thoughtful playwright. They haunted him in spite of himself. Still subtler was the influence exerted over the critics and the more intelligent public. Deeply and genuinely as many of them disliked Ibsen's works, they found, when they returned to the old-fashioned play, the adapted frivolity or the home-grown sentimentalism, that this they disliked still more. On every side, then, there was an instinctive or deliberate reaching forward towards something new; and once again it was Mr Pinero who ventured the decisive step.

On 27th May 1893 *The Second Mrs Tanqueray* was produced at the St James's Theatre. This is not the place for a detailed criticism of the play, or an attempt to forecast its ultimate status in English literature. Whether it will be acted fifty years hence is a question which the future may safely be left to answer. What here concerns us is the historical fact—questioned only by critics who have been denied a sense of proportion—that with *The Second Mrs Tanqueray* the English acted drama ceased to be a merely insular product, and took rank in the literature of Europe. Here was a play which, whatever its faults, was obviously comparable with the plays of Dumas, of Sudermann, of Björnson, of Echegaray. It might be better than some of these plays, worse than others; but it stood on the same artistic level. The fact that such a play could not only be produced, but could brilliantly succeed, on the London stage gave a potent stimulus to progress. It encouraged ambition in authors, enterprise in managers. What *Hernani* was to the romantic movement of the 'thirties, and *La Dame aux Camélias* to the realistic movement of the 'fifties, *The Second Mrs Tanqueray* has been to the movement of the 'nineties towards the serious stage-portraiture of English social life. All the forces which we have been tracing—Robertsonian realism of externals, the leisure for thought and experiment involved in vastly improved financial conditions, the substitution in France of a simpler, subtler technique for the outworn artifices of the Scribe school, and the electric thrill communicated to the whole theatrical life of Europe by contact with the genius of Ibsen—all these slowly converging forces coalesced to produce, in *The Second Mrs Tanqueray*, an epoch-marking play.

Even the critics, few but insistent, who deny all merit to *The Second Mrs Tanqueray*, cannot fail to be struck by what, on their theory, must seem an extraordinary coincidence: the fact that the English plays produced since 1893 have been, on an average, incomparably better than those produced before that date. Mr Pinero himself has given us five plays—*The Notorious Mrs Ebbsmith*, *The Benefit of the Doubt*, *The Princess and the Butterfly*, *Trelawny of the "Wells,"* and *The Gay Lord Quex*—any one of which it would be absurd to compare with the very best of his earlier productions. Though more unequal in workmanship than *The Second Mrs Tanqueray*, they all show a marked advance even upon that play in originality of conception and intellectual force. In January 1893 Mr Charles Wyndham initiated a new policy at the Criterion Theatre, and produced an original play, *The Bauble-Shop*, by Mr Henry Arthur Jones. Though not quite without merit, it belonged very distinctly to the pre-Tanqueray order of things; whereas in *The Case of Rebellious Susan*, produced in the following year at the same theatre, Mr Jones showed an almost startlingly sudden access of talent. From this level he has never seriously declined, and in some plays, notably in *Michael and his Lost Angel* (1896), in that admirable comedy *The Liars* (1897), and in *Mrs Dane's Defence* (1900), he has risen well above it. Mr Sydney Grundy has produced since 1893 by far his most important original works, *The Greatest of These* (1896) and *The Debt of Honour* (1900). Mr R. C. Carton, breaking away from the somewhat laboured sentimentalism of his earlier manner, has given us since 1898 three light comedies of thoroughly original humour and of excellent literary workmanship—*Lord and Lady Algy*, *Wheels within Wheels*, and *Lady Huntworth's Experiment*. Mr Haddon Chambers, in *The Tyranny of Tears* (1899) and *The Awakening* (1901), has produced two plays of a merit scarcely even foreshadowed in his earlier efforts. Moreover, a new generation of playwrights has come to the front which, if it has not as yet produced any quite masterly work, has time before it in which to fulfil its high promise. Its most notable representatives are Mr J. M. Barrie, whose *Wedding Guest* (1900), amid many crudities, showed real power; Mrs Craigie ("John Oliver Hobbes"), who has produced in *The Ambassador* (1898) a comedy of fine accomplishment; and Mr H. V. Esmond, who has passed from light comedy in *One Summer's Day* (1897) to sentimental tragedy in *Grierson's Way* (1899), and back to social comedy in *The Wilderness* (1901). The indubitable though too self-sufficient talent of Mr George Bernard Shaw defies classification. Passing, often in one and the same play, from serious drama to the most whimsical extravaganza, it entirely subordinates the

portrayal to the criticism of life, or in other words, to the expression of Mr Shaw's very peculiar individuality. Two of his comedies, however, *Arms and the Man* (1894) and *The Devil's Disciple* (1898), have had some success on the American stage; and occasional performances have proved that the wit of *Candida* and *You Never Can Tell* is at least as effective in the theatre as in the pages of *Plays, Pleasant and Unpleasant* (1898).

It is not, of course, suggested that *The Second Mrs Tanqueray* was the cause of that enlargement in the aims and methods of drama which has marked the years since its production. It was rather the decisive symptom of a pre-existent tendency. Mr Pinero demonstrated to authors, managers, and the public the unreality of that superstition which declared the modern English stage foredoomed to intellectual impotence. Other playwrights have succeeded, not by imitating him, but simply by availing themselves of the extension of frontier which, at two strides, as it were, marked by *The Profligate* and *Mrs Tanqueray*, he had vindicated for his craft. These two plays constituted an "effective occupation" of territory hitherto supposed inaccessible to the British dramatist—territory which now belongs to the public domain. To the unprejudiced observer it is manifest that the English drama of to-day stands on a totally different plane from that which it occupied twenty-five, or even fifteen, years ago. Yet it is still far from taking the place it ought to take in the intellectual life of the country. For one thing, it has still to struggle against unfortunate financial conditions, of which the most hampering is the necessity of appealing to an enormous public on pain of finding none at all. There is no middle course between a continuous run of at least three months and absolute failure. If only as offering a loophole of escape from the pressure of the long-run system, the endowed Repertory Theatre for which Professor Ward sighed in concluding, in 1877, his article DRAMA in the ninth edition of this work, is as much as ever to be desiderated. Some of the limitations of the modern English drama, however, are to be traced, not to external conditions, but to a certain narrowness of outlook on the part of the authors themselves, combined with a deficiency in what may be called, in the largest sense of the term, philosophic grasp of life. Most of the leading playwrights of Great Britain have served their apprenticeship either as actors or as adapters and melodramatists. They have begun at the bottom of the ladder, and have in their early years acquired technical skill (some of which they have afterwards had to unlearn) to the comparative exclusion of intellectual culture. Only a few have approached the special work of the dramatist from the side of general literary accomplishment. Chief among the latter class stands Mr Stephen Phillips (*b.* 1866), who had won distinction as a poet before his *Paolo and Francesca* (published 1899) gave proof of his power as a dramatist. The success of his tragedy of *Herod* (1900) has awakened hopes of a revival of poetic drama, which have been strengthened by the almost simultaneous revival in the younger generation of actors of the power of speaking verse with smoothness and sonority.

***United States.***

The American drama has during the past decade shown a progressive tendency as marked, if not quite as vigorous, as that which we have been tracing in England. Down to about 1890 the influence of France had been even more predominant in America than in England. The only American dramatist of eminence, Mr Bronson Howard (*b.* 1842), was a disciple, though a very able one, of the French school. A certain stirring of native originality manifested itself during the 'eighties, when a series of semi-improvised farces, associated with the names of two actor-managers, Harrigan and Hart, depicted low life in New York with real observation, though in a crude and formless manner. About the same time a native style of popular melodrama began to make its appearance—a play of conventional and negligible plot, which attracted by reason of one or more faithfully observed character-types, generally taken from country life. *The Old Homestead*, written and acted by Denman Thompson, was the most popular play of this class. Rude as it was, it distinctly foreshadowed the subsequent course of development. The drama, indeed, has simply followed in the track of fiction. Almost every district and every city in the Union has its novelist-interpreter who faithfully studies, with more or less ability, local character-types and their environment; and it is in similarly attaching itself to definite localities that the American drama has done its best work. Ibsen has had little or no influence in America, but the stimulus of the Théâtre Libre has been felt to some extent in various experimental enterprises. It was at a sort of Free Theatre in Boston that Mr James A. Herne (*d.* 1901) produced in 1891 his realistic drama of modern life, *Margaret Fleming*, which did a great deal to awaken the interest of literary America in the theatrical movement. Mr Herne, an actor and a most accomplished stage-manager, next produced a drama of rural life in New England, *Shore Acres* (1892), which made an immense popular success. It was a play of the *Old Homestead* type, but very much more coherent and artistic. His next play, *Griffith Davenport* (1898), founded on a novel, was a drama of life in Virginia during the Civil War, admirable in its strength and quiet sincerity; while in his last work, *Sag Harbour* (1900), Mr Herne returned to the study of rustic character, this time in Long Island. Mr Herne showed human nature in its more obvious and straightforward aspects, making no attempt at psychological subtlety; but within his own limits he was an admirable craftsman. The same preoccupation with local colour is manifest in the plays of Mr Augustus M. Thomas, a writer of genuine humour and originality. His localism announces itself in the very titles of his most popular plays—*Alabama*, *In Mizzoura*, *Arizona*. Mr Clyde Fitch, a young playwright of indubitable ability, has made experiments in several directions, notably in that of quasi-historical drama (*Nathan Hale*, *Barbara Frietchie*), but his chief bent seems to be in the direction of social drama on the French model. Mr William Gillette, a very popular actor, has written several melodramas of such marked originality and power as almost to raise them to the rank of literature. It must be said, however, that the financial conditions of the American stage are even more hostile to original drama than those which we have noted in England, while the fact that American managers have not only the French but the English stage to draw upon, tends to restrict the field open to native endeavour.

***Literary drama.***

It remains to say a few words of the English literary drama, as opposed to the acted drama. The two classes are not nearly so distinct as they once were; but plays continue to be produced from time to time which are wholly unfitted for the theatre, and others which, though they may be experimentally placed on the stage, make their appeal rather to the reading public. Concluding in 1877 his survey of the English drama, Dr Ward remarked, "The latest English dramatic poet is Tennyson." The late Poet Laureate had in his old age attempted an art which is scarcely to be mastered after the energy of youth has passed away. He continued to the last to occupy himself more or less with drama, and all his plays, except *Harold*, found their way to the stage. *The Cup* and *Becket*, as we have seen, met with a certain success, but *The Promise of May* (1882),

an essay in contemporary drama, was a disastrous failure, while *The Falcon* (1879) and *The Foresters* (acted by an American company in 1893) made little impression. Lord Tennyson was certainly not lacking in dramatic faculty, but he worked in an outworn form which he had no longer the strength to renovate. Mr Swinburne has continued now and then to cast his creations in the dramatic mould, but it cannot be said that his dramas have attained either the vitality or the popularity of his lyrical poems. *Mary Stuart* (1881) brought his Marian trilogy to a close. In *Locrine* he produced a tragedy in heroic couplets—a thing probably unattempted since the age of Dryden. *The Sisters* is a tragedy of modern date (1816), with a mediæval drama inserted by way of interlude. *Rosamund, Queen of the Lombards* (1899), perhaps approached more nearly than any of his former works to the concentration essential to drama. It may be doubted, however, whether his copious and ebullient style could ever really subject itself to the trammels of dramatic form. Of other dramas on the Elizabethan model, the most notable, perhaps, have been the works of two ladies who adopt the pseudonym of "Michael Field." They have written *Callirrhoë* (1884), *Brutus Ultor* (1887), and many other dramas, all of which show considerable power of imagination and expression, but are burdened by a deliberate archaism both of technique and style. Mr Alfred Austin has put forth several volumes in dramatic form, such as *Savonarola* (1881), *Prince Lucifer* (1887), and *England's Darling* (1896). They are laudable in intention and fluent in utterance. Notable additions to the purely literary drama were made by Mr Robert Bridges in his *Prometheus* (1883), *Nero* (1885), *The Feast of Bacchus* (1889), and other solid plays in verse, full of science and skill, but less charming than his lyrical poems. Sir Lewis Morris made a dramatic experiment in *Gycia*, but has not been encouraged to repeat it.

Poets of a younger generation have contributed some noteworthy works to the literary drama. Mr John Davidson's volume of *Plays* contains more poetry, perhaps, than drama properly so called, but is by no means a negligible production. In his earlier efforts, such as *An Unhistorical Pastoral*, Mr Davidson gave himself up to luxuriant imitation of Shakespeare in his most luxuriant mood; but there is strong writing in *Smith: a Tragedy* (1886), and genuinely dramatic vigour in *Bruce: a Chronicle Play* (1884). *Scaramouch on Naxos* (1888) is a somewhat too fantastic fantasy. Mr W. B. Yeats has written two plays on subjects borrowed from Irish folklore: *The Countess Kathleen* (1892) and *The Land of Heart's Desire* (1894). They are tender and exquisite poems, with a real element of drama in them, and both have met with some acceptance on the stage. "John Oliver Hobbes" (Mrs Craigie) has produced in *Osbern and Ursyne* (1899) a tragedy of considerable merit, marred by obscurities of style. Mention has already been made of the plays of Mr Stephen Phillips, which belong no less to theatrical than to literary drama. From the point of view of literary history, Mr Phillips may be regarded as a rebel against the supremacy of the Elizabethan tradition in English poetic drama. While choosing romantic subjects, he seeks to give them classic dignity, repose, and compression. He has shown a gift of dramatic story-telling unequalled among the poets of our time, while in his diction he has avoided at once the obscurity arising from over-conciseness and the tedium involved in redundant verbiage.

The collaboration of Robert Louis Stevenson with Mr William Ernest Henley produced a short series of interesting experiments in drama, two of which, *Beau Austin* (1883) and *Admiral Guinea* (1884), have more than a merely experimental value. The former is an emotional comedy, treating with rare distinction of touch a difficult, almost an impossible, subject; the latter is a nautical melodrama, raised by force of imagination and diction into the region of literature. It is much to be regretted that, in the later years of Stevenson's life, his health, and the absence from England which it entailed, should have kept the collaborators so much apart as to prevent the continuance of the series.

The most prolific and, it would seem, the ablest of the literary contingent—of those, that is to say, who do not approach the drama primarily through the stage-door—is Mr George Bernard Shaw, whose three volumes, *Plays, Pleasant and Unpleasant*, and *Plays for Puritans*, contain some very remarkable writing. After some insignificant and needlessly disagreeable 'prentice-pieces, Mr Shaw produced, in *Mrs Warren's Profession*, a drama of remarkable, though crude, power, and in *Arms and the Man* a brilliant comedy-extravaganza. The same description applies to *You Never Can Tell* and *Captain Brassbound's Conversion;* while *The Devil's Disciple* is a satiric melodrama, and *Cæsar and Cleopatra* a curious compound of historic drama with topical burlesque. Mr George Moore has made two experiments in drama—*The Strike at Arlingford* and *The Bending of the Bough.* The latter, with its somewhat ill-digested symbolism, is a characteristic outcome of the Irish Literary Movement, to which we also owe Mr Edward Martyn's sombre but able drama, *The Heather Field*, and his tragic fantasy entitled *Maeve.* Other published plays of interest are Mr Alfred Sutro's *Cave of Illusion*, and Mr Gilbert Murray's *Carlyon Sahib* and *Andromache*, the latter a noteworthy attempt to go to the very sources of Greek inspiration and treat a saga-theme in the saga spirit. (W. A.)

**French drama.**

*French Drama* (since 1875).—The last twenty-five years of the 19th century witnessed an important change in the constructive methods, as well as in the moral tendencies, of the French playwrights. The old favourites disappeared; new men came to the front. Various influences, some proceeding from foreign quarters, some closely connected with the evolution of national thought and manners, have been working, not very harmoniously, together, often in totally opposite directions. It would be rash, and indeed almost impossible, to offer a general opinion on the French drama of this period, as no identity of moral purpose, and hardly any artistic relationship, can be traced between the leading writers; but it may be profitable to note the different experiments which have been tried, more or less successfully, during the last quarter of a century, and the crisis through which the French theatre has been slowly and laboriously working its way towards an unknown future.

Of the two leading dramatists who reigned supreme over the *haute comédie* in 1875, one, Emile Augier, had almost ended his career; but the other, Alexandre Dumas, was to maintain his ascendancy for many years longer. Sardou's fertility of invention, and extraordinary cleverness at manipulating a complicated intrigue, were also greatly admired, and much was expected from Edouard Pailleron's brilliant and—as it seemed—inexhaustible wit in satirizing the whims and weaknesses of high-born and highly cultured society. Alexandre Dumas had created and still monopolized the problem play, of which *Le Demi-Monde, Le Fils Naturel, La Question d'Argent, Les Idées de Madame Aubray, La Femme de Claude, Monsieur Alphonse, La Visite de Noces, L'Etrangère, Francillon*, and *Denise* may be mentioned as the most characteristic specimens. The problem play is the presentation of a particular case, with a view to a general conclusion on some important question

of human conduct. This afforded the author, who was, in his way, a moralist and a reformer, excellent opportunities for humorous discussions and the display of that familiar eloquence which was his greatest gift and most effective faculty. Among other subjects, the social position of women had an all-powerful attraction for his mind, and many of his later plays were written with the object of placing in strong relief the remarkable inequality of the sexes, both as regards freedom of action and responsibility, in modern marriage. Like all the dramatists of his time, he adhered to Scribe's mode of play-writing—a mixture of the *drame bourgeois*, as initiated by Diderot, and the comedy of character and manners, long in vogue—from the days of Molière, Regnard, Destouches, and Marivaux, down to the beginning of the 19th century. In his prefaces Dumas often undertook the defence of the system which, in his estimation, was best calculated to serve the purpose of the artist, the humorist, and the moralist—a dramatist being, as he conceived, a combination of the three.

Though the majority of French playgoers continued to side with him, and to cling to the time-honoured theatrical beliefs, a few young men were beginning to murmur against the too elaborate mechanism and artificial logic. Scribe and his successors, whose plays were a combination of comedy and drama, were wont to devote the first act to a brilliant and witty presentation of personages, then to crowd the following scenes with incidents, until the action was brought to a climax about the end of the fourth act, invariably concluding, in the fifth, with an optimistic *dénouement*, just before midnight, the time appointed by police regulations for the closing of playhouses. At the same time a more serious and far-reaching criticism was levelled at the very principles on which the conception of human life was then dependent. A new philosophy, based on scientific research, had been gradually gaining ground and penetrating the French mind. A host of bold writers had been trying, with considerable firmness and continuity of purpose, to start a new kind of fiction, writing in perfect accordance with the determinist theories of Auguste Comte, Darwin, and Taine. The long-disputed success of the Naturalistic School carried everything before it during the years 1875–1885, and its triumphant leaders were tempted to make the best of their advantage by annexing a new province and establishing a footing on the stage. In this they failed signally, either when they were assisted by professional dramatists or when left to their own resources. It became evident that Naturalism, to be made acceptable on the stage, would have to undergo a special process of transformation and be handled in a peculiar way. M. Henry Becque succeeded in embodying the new theories in two plays, which at first met with very indifferent success, but were revived at a later period, and finally obtained permanent recognition in the French theatre—even with the acquiescence of the most learned critics, when they discovered, or fancied they discovered, that M. Becque's comedies agreed, in the main, with Molière's conception of dramatic art. In *Les Corbeaux* and *La Parisienne* the plot is very simple; the episodes are incidents taken from ordinary life. No extraneous character is introduced to discuss moral and social theories, or to acquaint us with the psychology of the real *dramatis personæ*, or to suggest humorous observations about the progress of the dramatic action. The characters are left to tell their own tale in their own words, which are sometimes very comical, sometimes very repulsive, but purport to be always true to nature. Human will, which was the soul and mainspring of French tragedy in the 17th century, and played such a paramount part in the *drame bourgeois* and the *haute comédie* of the 19th, appears in M. Becque's plays to have fallen from its former exalted position and to have ceased to be a free agent. It is a mere passive instrument to our inner desires and instincts and appetites, which, in their turn, obey natural laws. Thus, in M. Becque's comedies, as in the old Greek drama, Destiny, not man, is the chief actor, the real but unseen protagonist.

M. Becque was not a prolific writer, and when he died, in 1899, it was remarked that he had spent the last ten years of his life in comparative inactivity. But during these years his young and ardent disciples had spared no effort in putting their master's theories to the test. It had occurred to a gifted and enterprising actor-manager, named Antoine, that the time had come for trying dramatic experiments in a continued and methodical manner. For this purpose he gathered around him a number of young authors, and produced their plays before a select audience of subscribers, who had paid in advance for their season-tickets. The entertainment was a strictly private one. In this way M. Antoine made himself independent of the censors, and at the same time was no longer obliged to consider the requirements of the average playgoer, as is the case with ordinary managers, anxious, above all things, to secure long runs. At the Théâtre Libre the most successful play was not to be performed for more than three nights.

The reform attempted was to consist in the elimination of what was contrary to nature in Dumas's and Augier's comedies: of the *intrigue parallèle* or underplot, of the over-numerous and improbable incidents which followed the first act and taxed the spectator's memory to the verge of fatigue; and, lastly, of the conventional *dénouement* for which there was no justification. A true study of character was to take the place of Sardou's complicated fabrications and Dumas's problem plays. The authors would present the spectator with a fragment of life, but would force no conclusion upon him at the termination of the play. The reformation in histrionic art was to proceed apace. The actors and actresses of the preceding period had striven to give full effect to certain witty utterances of the author, or to preserve and to develop their own personal peculiarities or oddities. M. Antoine and his fellow-artists did their best to make the public realize, in every word and every gesture, the characteristic features and ruling passions of the men and women they were supposed to represent.

It was in the early autumn of 1887 that the Théâtre Libre opened its doors for the first time. It struggled on for eight years amidst unfailing curiosity, but not without encountering some adverse, or even derisive, criticism from a considerable portion of the public and the press. The Théâtre Libre brought under public notice such men as Courteline and George Ancey, who gave respectively, in *Bonbouroche* and *La Dupe*, specimens of a comic vein called the "*comique cruel*." M. Fabre, in *L'Argent*, approached, if not surpassed his master, Henry Becque. M. Brieux, in *Blanchette*, gave promise of talent, which he has since in a great measure justified. In *Les Fossiles* and *L'Envers d'une Sainte*, by M. François de Curel, were found evidences of dramatic vigour and concentrated energy, allied with a remarkable gift for the minute analysis of feeling. M. Antoine's activity was not exclusively confined to the efforts of the French Naturalistic School; he included the Norwegian drama in his programme, and successively produced several of Ibsen's plays. They received a large amount of attention from the critics, the views then expressed ranging from the wildest enthusiasm to the bitterest irony. Francisque Sarcey was decidedly hostile, and M. Jules Lemaître, who ranked next to him in authority, ventured to suggest that Ibsen's ideas were nothing better than long-discarded social and literary paradoxes, borrowed from Pierre Leroux through George Sand, and returned to

the French market as novelties. It was only quite recently that *John Gabriel Borckmann* received a warm tribute of admiration from M. Emile Faguet, the talented successor of M. Jules Lemaître on the *Journal des Débats.* Without entering into a close consideration of the subject, it may be affirmed that up to the year 1902 Ibsen had not yet been understood by the French public at large, though his influence could be clearly traced on thoughtful men like M. Paul Hervieu and M. François de Curel.

The authors of the Théâtre Libre were sadly wanting in tact and patience. They went at once to extremes, and, while trying to free themselves from an obsolete form of drama, fell into a state of anarchy. If a too elaborate plot is a fault, no plot at all is an absurdity. The old school had been severely taken to task for devoting the first act to the delineation of character, and the delineation of character was now found to have extended over the whole play; and worse still, most of these young men seemed to find pleasure in importing a low vocabulary on to the stage; they made it their special object to place before the spectator revolting pictures of the grossest immorality. In this they were supported by a knot of noisy and unwise admirers, whose misplaced approval largely contributed towards bringing an otherwise useful and interesting undertaking into disrepute. The result was that, after the lapse of eight years, the little group collected round M. Antoine had lost in cohesion and spirit, that it was both less hopeful and less compact than it had been at the outset of the campaign. But some authors who had kept aloof from the movement were not slow in reaping the moral and intellectual profit of these tentative experiments. Among them must be cited M. George de Porto-Riche, M. Henri Lavedan, M. Paul Hervieu, M. Maurice Donnay, and M. Jules Lemaître. The first-named is a veteran writer, but in *Amoureuse* he revealed qualities unsuspected by those who witnessed his first literary efforts. M. Henri Lavedan, who has succeeded Henri Meilhac at the French Academy, has also inherited some of that writer's brilliant faculty for light comedy and the portrayal of the gay Parisian world of pleasure and fashion. There is no wit, no humour, in M. Paul Hervieu, nothing bright or refreshing in his manner. In two successive plays, *Les Tenailles* and *La Loi de l'Homme,* he has made evident to all but prejudiced minds the inadequacy and injustice of the marriage laws now existing in France. It is admitted by fastidious judges that the third act of *Les Tenailles* is a model of masterly simplicity and dramatic concentration. M. Donnay, in his play entitled *Amants,* has presented a fascinating love-story, which goes through all its natural phases without the addition of a single incident borrowed from old scenic traditions. In his more recent works he has won only partial applause. He is still a master of light, easy-going dialogue, but his style and treatment become conventional and constrained when he attempts drama. M. Jules Lemaître, in his double capacity of critic and playwright, seems to have overlooked the salutary example set him by Maître Jacques, who was both cook and coachman in the household of Harpagon. He should have been warned against letting his two callings clash. His dramatic works may be described as successful and clever efforts in all branches of the art, from tragedy down to farce, but he has achieved no decisive triumph in any particular field, perhaps because his freedom of invention has been, to some extent, hampered by his critical faculties, or diverted towards the imitation of too many different lines. Alone among the authors of the Théâtre Libre, M. Brieux has come to the front and secured an assured position on the regular stage. Instead of attacking the vices and follies of his times, he has made a name by satirizing the weak points or the wrong application of certain fundamental principles by which modern institutions are supported. He mocked at universal suffrage in *L'Engrenage,* at art in *Ménages d'Artistes,* at popular instruction in *Blanchette,* at charity in *Les Bienfaiteurs,* at science in *L'Evasion,* and, finally, at law in *La Robe Rouge.* Of *Les Trois Filles de M. Pupont,* one is an old maid with a strong bent towards mysticism, another is a star in the demi-monde, and the third is married. Neither religion, nor free love, nor marriage has made one of the three happy. The strange fact about M. Brieux is that he propounds his uncomfortable ideas with an incredible amount of dash and spirit.

All the plays written by the above-mentioned authors, and by those who follow in their steps, have been said to constitute the "new comedy." But one may question the advisability of applying the same name to literary works which present so little, if any, family likeness. It was tacitly agreed to remove the intricacies of the plot and the forced *dénouement.* But no one will trace in those plays the uniformity of moral purpose which would justify us in comprising them under the same head, as products of the same school. Then, before the Naturalistic, or half-Naturalistic, School had attained to a practical result or taken a definite shape, a wave of Romanticism swept over the French public, and in a measure brought back the old artistic and literary dogmas propounded by Victor Hugo and the generation of 1830. Signs of an approaching revival in French dramatic poetry have not been lacking during the last few years. The success of *La Fille de Roland,* by the Vicomte de Bornier, was restricted to the more cultivated classes, but the vogue of M. Jean Richepin's *Chemineau* was at once general and lasting. *Cyrano de Bergerac,* produced in the last days of 1897, brought a worldwide reputation to its young author, M. Edmond Rostand. This play combines sparkling wit and brilliancy of imagination with delightful touches of pathos and delicate tenderness. It was assumed that M. Edmond Rostand was endowed to an extraordinary degree both with theatrical genius and the poetic faculty. *L'Aiglon* fell short of this too favourable judgment. It is more a dramatic poem than a real drama, and the author handles history with the same childish incompetence and inaccuracy as Hugo did in *Cromwell,* in *Ruy Blas,* and *Hernani.* The persistent approbation of the public seems, however, to indicate a growing taste for poetry, even when unsupported by dramatic interest—a curious symptom among the least poetical of modern European races.

To sum up, the French, as regards the present condition of their drama, are confronted with two alternative movements. Naturalism, furthered by science and philosophy, is contending against traditions three centuries old, and seems unable to crystallize into masterly works; while romantic drama, founded on vague and exploded theories, has become embodied in productions of real artistic beauty, which have been warmly welcomed by the general playgoer. It should nevertheless be noted that in *Cyrano* and *L'Aiglon* human will, which was the mainspring of Corneille's tragedy and Hugo's drama, tries to reassert itself, but is baffled by circumstance, and has to submit to inexorable laws. This shows that the victorious school will have to reckon with the doctrines of the defeated party, and suggests that a determinist theatre may be the ultimate outcome of a compromise. (A. Fi.)

**Drammen,** a seaport town of Norway, partly in co. Buskerud, partly in co. Jarlsberg and Laurvik, 33 miles by rail south-west from Christiania. In 1899 it owned a mercantile fleet of some 140 vessels of 88,700 tons aggregate, and its total foreign trade was valued at over one million sterling (exports, £704,100; imports, £373,750), as

against £530,000 in 1887. The exports consist principally of timber (7,000,000 cubic feet in 1898) and wood-pulp (136,250 tons), with paper, ice, and a little cobalt and nickel ore. Of these 58 per cent. of the timber and 64 per cent. of the wood-pulp go to Great Britain. The imports consist chiefly of coal (127,000 tons in 1898) from Great Britain and machinery from Germany. Population (1875), 18,643; (1900), 23,091.

**Draughts.**—The last decade of the 19th century witnessed a remarkable increase in the popularity of the game of draughts (known also in the United States as "checkers"). This was the result of several causes, chief among which were the establishment of championship tournaments, the institution of leagues similar to the football leagues, the insertion of "draughts columns" in several weekly newspapers, and the publication of the late James Lees's *Guide to the Game of Draughts*, a handbook at once accurate, fairly well arranged, and cheap. To these causes, and to the correspondence tournaments conducted by the editors of draughts columns, is also to be attributed the improvement which took place in the standard of play of the average player, an improvement which manifested itself both in the variety of openings played and in more accurate mid-game play.

*Championships.*

In January 1893 the first of the annual tournaments for the championship of Scotland was held. These tourneys deservedly rank first among the events of the draughts year, on account of the number and ability of Scottish players and the high standard of play which they have maintained throughout the competitions. The following is a list of the winners since the competition was instituted:—

| | |
|---|---|
| 1893. W. Bryden, Glasgow. | 1898. H. Freedman, Glasgow. |
| 1894. R. Stewart, Blairadam. | 1899. H. Freedman, Glasgow. |
| 1895. R. Stewart, Blairadam. | 1900. R. Stewart, Blairadam. |
| 1896. R. Jordan, Edinburgh. | 1901. R. Stewart, Blairadam. |
| 1897. J. Ferrie, Coatdyke. | 1902. R. Stewart, Blairadam. |

The series of tournaments for the championship of England commenced in 1885. The English Draughts Association now holds these competitions biennially. The following is a list of winners:—

| | |
|---|---|
| 1885. J. Smith, Spennymoor. | 1898. W. Gardner, Leeds. |
| 1891. H. Christie, Sunderland. | 1900. A. Hynd, Manchester. |
| 1892. A. Jordan, London. | |

Similar tournaments are held in the Australian colonies and in New Zealand, but not in America, though the game has obtained a firm hold both in Canada and in the United States. In these countries the championship is decided by matches.

In 1894 James Ferrie of Coatdyke challenged James Wyllie, the famous "Herd Laddie," for the title of Champion Draughts Player of the World, an honour which the latter had held since 1877. Ferrie won easily by thirteen games to six, but no doubt the severity of the defeat was in part due to Wyllie's advancing years. Ferrie, however, did not long retain his honours. In the Scottish tournament held in January 1896 he met Richard Jordan and was defeated by him. In consequence a match was arranged between them for Ferrie's title of Champion of the World, and the result was a win for Jordan by four games to three. In 1897 Jordan successfully defended his recently won title against R. Stewart, who had made a name for himself in the Scottish championship tournaments. The match, which was played at Edinburgh, resulted in a victory for Jordan by four wins to two. In 1900 the champion visited Boston, U.S.A., in response to a challenge from C. F. Barker, the American champion. The result of the contest which ensued was a draw of two wins each, Jordan thus retaining his title.

In 1884 the first international match between Scotland and England took place. It resulted in so decisive a victory for the north-countrymen that the contest was not renewed until ten years later. The matches played in 1894 and 1899 also went strongly in favour of the Scotsmen, but the disparity between the teams was not so marked as in the first match, a result which may be attributed rather to improvement in the skill of the English players than to any falling off on the part of their opponents. The following are the scores in the three matches:—

1884. Scotland won by 36 games to 7.
1894. Scotland won by 29 games to 15.
1899. Scotland won by 42 games to 25.

*Computation of draughts variations.*

An objection frequently urged against draughts, and especially as compared with chess, is that the game lacks scope for variety. The charge is easily disproved by a rough computation of the variations possible at draughts. We see that the first player has seven different ways in which he may make his first move, and that to each of these seven moves his opponent has seven possible replies, making in all 49 "openings." Two of these openings, however (9–14, 21–17, and 10–14, 21–17), are unsound, since white loses a piece without any compensating gain in position, thus reducing the number of recognized "openings" to 47. Taking the Jordan-Ferrie and Jordan-Barker match-games as the standard, the average number of moves in a game is over 50—say 52 for convenience of calculation,—and, as may be proved by an examination of the specimen games given below, it is within the mark to say that there are, on an average, four possible variations at each point in the game after the opening is formed. In computing the latter average, moves which would obviously result in the loss of a piece without any corresponding gain in position have been neglected. To ascertain, therefore, the total number of possible moves, the number of openings must be multiplied by $4^{50}$. The logarithm of $47 \times 4^{50}$ shows the expression to represent a number of thirty-one digits, a number so large that the imagination utterly fails to grasp its significance.

Players have been accustomed to consider the unlimited scope for variety which the game possesses as an unmixed benefit, the reason being that it tends to foster original play. There is, however, another side to the question. Suppose a player to hold such a position that he has the choice of four moves, and that his opponent may reply to each of these in four different ways. Sixteen possible positions may thus be formed, and if, as is probable, they each permit of as many continuations as the first-mentioned position, we see that the first player must examine 256 moves in order to make sure of his ground four moves ahead. The best chess and draughts players agree that, to play well, one should look ten moves ahead. Obviously, then, a player cannot possibly examine all continuations open to him, nor indeed can he do more than select a few of the most likely, relying on his judgment of position to aid him in his choice. The drawback undoubtedly exists in both chess and draughts, but of course it applies, in theory at least, with greater force to the former game, from the fact that an average chess position will give more possible continuations than a similar position at draughts.

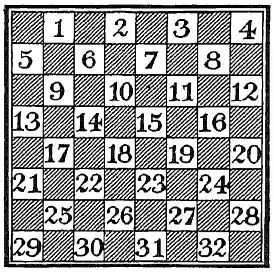
Draughts-players claim, among minor considerations, that their game possesses, for the busy man, an advantage over chess in that a good game—say one worthy of publication—occupies less time than a similar game at

chess. This is probably the case; but on the other hand, it must be pointed out that chess is the more picturesque in appearance; and this is a fact the value of which should not be underestimated in considering the game's claim to popular favour or its desirability as a pastime.

Both games, played in moderation, undoubtedly assist the mind towards a habit of concentrated and consecutive thought, coupled with carefulness in matters of detail; both games allow almost unlimited scope for brilliant and critical combinations. It is worthy of note, perhaps, that while so far the bulk of draughts-players have been members of the working and lower middle classes, the majority of chess-players have been drawn from the middle and upper classes.

The calculations given above as to the variation possible at draughts will convince most inquirers that no player, however expert at the game, could claim to know the replies to every possible move. Were further proof necessary, one might find it in the fact that more than one-third of the games played in the Scottish Championship Tournament of 1901 resulted in wins; and this proportion is not affected even if the games of the first round, in which less able players were more likely to be engaged, be omitted.

***Draughts "openings."*** In different districts and at different times the greatest diversity of opinion has existed regarding the relative strength of the various openings. It used to be generally held that for the black side 11–15 was considerably superior to any other opening move. Towards the end of the 19th century this view became much modified, and though 11–15 still remained the favourite, it was recognized that 10–15, 9–14, and 11–16 were little, if at all, inferior; 10–14 and 12–16 were rightly rated as somewhat weaker than the four moves named above, whilst 9–13, the favourite of the "unscientific" player, was found to be weakest of all.




The white replies to 11–15 have gone through many vicissitudes. The seven possible moves have each at different times figured as the general favourite. Thus 24–19, which more thorough analysis proved to be the weakest of the seven, was at one period described by the title of "Wyllie's Invincible." In course of time it came to be regarded as decidedly weak, and doubts began to be entertained as to whether the opening even admitted of a draw for white, its name being, in consequence, dropped for the less pretentious title of "Second Double Corner." In the Scottish Tournament of 1894 the opening was played between Ferrie and Stewart, and the latter won the game with white. The new play then introduced has stood the test of analysis, and the opening now ranks as but little inferior to those formed by the other possible replies, its main drawback consisting in the lack of scope for variations favourable to the player of the white pieces. The 21–17 reply to 11–15 was introduced by Wyllie, who was so successful with it that it became known as the "Switcher." The opening is perhaps lacking in the solid strength of some of the others, but it so abounds in traps as to be well worthy of its name. The other five replies to 11–15, namely, 24–20, 23–19, 23–18, 22–18, and 22–17, are productive of games which are generally held to give equal chances to both sides.

The favourite replies to 10–15 are 23–18, 22–18, and 21–17, but they do not appear to be appreciably stronger than the others, with the possible exception of 24–20.

In response to 11–16, 23–18 is held to give white a trifling advantage, but it is more apparent than real. With the exception of 23–19, which is weak, the other replies are of equal strength, and are only slightly, if at all, inferior to the more popular 23–18.

Against 10–14 the most popular move is 22–17, which gives white an advantage. Next in strength come 22–18 and 24–19. 23–18 is weak.

The strongest reply to 12–16 is 24–20. The others, except 23–19, which is weak, give no initial advantage to either side.

As already mentioned, 9–13 is black's weakest opening move, both 22–18 and 24–19 giving white a distinct advantage. Nevertheless 9–13 is a favourite début with certain expert players, especially when playing with inferior opponents.

The three following games are typical examples of the play arising from three of the most frequently played openings:—

Game No. 1.—"Ayrshire Lassie" Opening.

| | | | | | |
|---|---|---|---|---|---|
| *a* 11–15 | 25–18 | 10–15 | 22–17 | *b* 15–18 | 24– 6 |
| *a* 24–20 | 3– 8 | 23–19 | 13–22 | 24–20 | 2– 9 |
| 8–11 | 26–22 | 6–10 | 26–17 | 18–27 | 17–10 |
| 28–24 | 5– 9 | *c d* 27–23 | 11–16 | 31–24 | 8–11 |
| 9–13 | 30–26 | 9–14 | 20–11 | 16–23 | Drawn. |
| 22–18 | 1– 5 | 18– 9 | 7–16 | 20–16 | R. Jordan. |
| 15–22 | 32–28 | 5–14 | 29–25 | 12–19 | |

*a.* 11–15, 24–20 forms the "Ayrshire Lassie" opening, so named by Wyllie. It is generally held to admit of unusual scope for the display of critical and brilliant combinations.

*b.* 16–20, 25–22, 20–27, 31–24, 8–11, 17–13, 2–6, 21–17, 14–21, 22–17, 21–25, 17–14, 10–17, 19–1. Drawn. R. Jordan.

(*c*)

| | | | | | |
|---|---|---|---|---|---|
| 26–23 | 28–19 | 20–16 | 7–11 | 14–10 | 15–10 |
| 9–14 | 2– 6 | 6–10 | 19–24 | 26–23 | 23–18 |
| 18– 9 | 20–11 | 16–11 | 11–18 | 10– 7 | 10–15 |
| 5–14 | 8–24 | 10–15 | 24–27 | 4– 8 | 20–16 |
| 29–25 | 27–20 | 11– 7 | 18–15 | 7– 3 | 15–22 |
| 11–16 | 10–15 | 14–18 | 27–31 | 8–12 | 16– 7 |
| 20–11 | 31–26 | 7– 3 | 22–18 | 3– 7 | Drawn. |
| 7–16 | 15–19 | 18–23 | 31–27 | 27–24 | A. B. Scott |
| 24–20 | 23–16 | 3–7 | 18–14 | 7–11 | *v.* |
| 15–24 | 12–19 | 23–30 | 30–26 | 24–20 | R. Jordan. |

(*d*)

| | | | | | |
|---|---|---|---|---|---|
| 19–16 | 7–10 | 23–19 | 11–15 | 16–11 | 25–30 |
| 12–19 | 6– 1 | 15–24 | 27–24 | 18–25 | 20–16 |
| 22–17 | 9–14 | 28–19 | 22–25 | 17–14 | Drawn. |
| 15–22 | 26–23 | 8–11 | 29–22 | 10–17 | R. Jordan. |
| 24– 6 | 11–15 | 19–16 | 14–18 | 21–14 | |

Game No. 2.—"Kelso-Cross" Opening.

| | | | | | |
|---|---|---|---|---|---|
| *a* 10–15 | 8–12 | 13–22 | 5– 9 | 14–18 | 22–25 |
| *a* 23–18 | 25–21 | 26–17 | 20–16 | 17–14 | 29–22 |
| 12–16 | 1– 6 | *d* 19–26 | 2– 7 | 10–17 | 17–26 |
| 21–17 | 32–27 | 30–23 | 24–19 | 21–14 | 5– 1 |
| 9–13 | 12–16 | 15–22 | 15–24 | 6–10 | 26–30 |
| 17–14 | 27–23 | 24–19 | 23–19 | 14– 9 | 1– 5 |
| 16–19 | 7–10 | 9–14 | 24–27 | 10–14 | 30–26 |
| 24–20 | 14– 7 | 19–12 | 31–24 | 19–15 | 5– 9 |
| 6– 9 | 3–10 | 11–15 | 9–13 | 14–17 | 26–23 |
| *b* 27–24 | *c* 22–17 | 28–24 | 24–20 | 9– 5 | Drawn. |
| | | | | | R. Jordan. |

*a.* These two moves form the "Kelso-Cross" opening.

*b.* 27–23 is also a strong line for white to adopt.

*c.* 30–25, 4–8, 18–14, 9–27, 22–18, 15–22, 24–15, 11–18, 20–4, 27–32, 26–17, 13–22, 4–8, 22–26, and black appears to have a winning advantage. R. Jordan.

*d.* Taking the piece on 18 first seems to lose, thus:—

| | | | | | |
|---|---|---|---|---|---|
| 15–22 | *e* 9–13 | 13–17 | 6– 9 | 5–14 | |
| 24– 8 | 17–14 | 23–18 | 14–10 | 10– 7 | White |
| 4–11 | 10–17 | 17–21 | 9–14 | 2– 6 | wins. |
| 31–27 | 21–14 | 28–24 | 18– 9 | 7– 2 | Dallas. |

*e.* 2–7, 27–24, 22–26, 23–18, 26–31, 18–15, 11–18, 20–2, 9–13, 2–9, 5–14, 24–19, 13–22, 30–26. White wins.

Game No. 3.—"Dundee" Opening.

| | | | | | |
|---|---|---|---|---|---|
| 12–16 | 11–15 | *c* 8–12 | 4– 8 | 9–14 | 1–26 |
| 24–20 | 20–11 | 17–13 | 18–15 | 26–22 | 31–22 |
| 8–12 | 7–16 | 5– 9 | 2– 7 | 14–17 | 19–23 |
| 28–24 | 24–20 | 22–18 | 30–26 | 21–14 | 13– 9 |
| 9–14 | *b* 16–19 | 15–22 | 10–14 | 18–23 | 12–19 |
| 22–17 | 23–16 | 25–18 | 29–25 | 27–18 | 9– 6 |
| 3– 8 | 12–19 | 14–23 | 14–18 | 6–10 | 7–11 |
| *a* 26–22 | 20–16 | 27–18 | 32–27 | 15– 6 | Drawn. |
| | | | | | R. Jordan. |

*a.* This move is the favourite at this point on account of its "trappiness," but 25–22 is probably stronger, thus: 25–22, 16–19, 24–15, 11–25, 29–22, 8–11, 17–13, 11–16, 20–11, 7–16, and white can with advantage continue by 27–24, 22–17, 23–19, or 22–18.

*b.* 15–19, 20–11, 8–15, 23–16, 12–19, 17–13, 5–9, 30–26, 4–8, 27–23, 8–12, 23–16, 12–19, 31–27, 1–5, 27–23, 19–24, 32–27, 24–31, 22–17. White wins. C. F. Barker.

| | | | | | |
|---|---|---|---|---|---|
| *c.* 8–11 | 27–18 | 15–18 | 14–10 | 24–27 | 7–10 |
| 16– 7 | 15–22 | 14–10 | 19–24 | 31–24 | 27–31 |
| 2–11 | 25–18 | 6–15 | 10– 7 | 16–20 | 10–26 |
| 22–18 | 10–15 | 17–14 | 18–23 | 3– 7 | 31–22 |
| 14–23 | 18–14 | 11–16 | 7– 3 | 20–27 | 30–25 |

Drawn. R. Stewart *v.* R. Jordan.

The problem diagrammed on next page is the simplest form of that known to draughts-players as the "First Position." It is of more frequent occurrence in actual play than any other end-game,

and is, besides, typical of a class of draughts problems which may be described as analytical, in contradistinction to "strokes."

Problem No. 1, by Wm. Payne.

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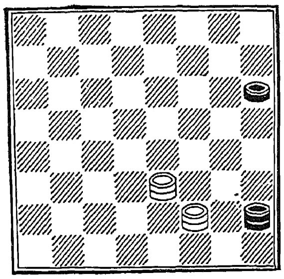

WHITE.

White to move and win.

Solution :—

| | | | | | |
|---|---|---|---|---|---|
| 27–32 | 18–15 | 15–11 | 11–15 | 28–32 | 19–24 |
| 28–24 | 2–28–24 | 12–16 | 19–24 | 27–31 | White |
| 23–18 | 32–28 | 28–32 | 32–28 | 15–19 | wins. |
| 3–*a*–24–28 | 1–24–20 | 16–19 | 24–27 | 31–26 | |

*a*. 12–16 same as Var. I. at 5th move.

Var. I.

| | | | | | |
|---|---|---|---|---|---|
| 24–27 | 18–15 | 19–16 | 28–32 | 8–12 | 15–11 |
| 15–18 | *b* 16–20 | 18–23 | 8–12 | 23–18 | White |
| 12–16 | 15–18 | 16–11 | 32–27 | 12– 8 | wins. |
| 28–32 | 24–19 | 23–19 | 12– 8 | 18–15 | |
| 27–24 | 32–28 | 11– 8 | 27–23 | 8–12 | |

*b*. 24–28 same as Var. II. at 1st move.

Var. II. 12–16, 15–11, 16–19, 32–27, 28–32, 27–31, 32–28, 11–16, 19–23, 16–19. White wins.

Var. III. 24–19, 32–28, *c* 19–16, 28–24, 16–11, 24–20, 11–8, 18–15. White wins.

*c*. 12–16, 28–32, 19–24 or 16–20, same as Var. II. at 5th or 9th moves respectively. White wins.

Problem No. 2.

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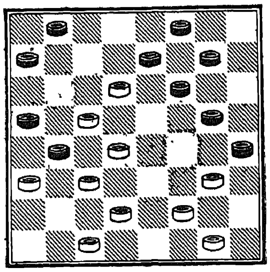


WHITE.

White to move and win.

The above position is a fine example of another class of problems, namely, "strokes." It is formed from the "Paisley" opening, thus :—

| | | | | | |
|---|---|---|---|---|---|
| 11–16 | 22–17 | 11–16 | 26–19 | 9–13 | 15–10 |
| 24–19 | 9–13 | 25–21 | 4– 8 | 25–22 | *a* 2– 7 |
| 8–11 | 17–14 | 6– 9 | 29–25 | 7–11 | |
| 28–24 | 10–17 | 23–18 | 13–17 | 19–15 | |
| 16–20 | 21–14 | 16–23 | 31–26 | 12–16 | |

*a*. This forms the position on the diagram. The solution is as follows :—

| | | | | |
|---|---|---|---|---|
| 27–23 | 7–14 | 18– 9 | 14–23 | 26– 3 |
| 20–27 | 9– 6 | 5–14 | 21– 7 | 27–31 |
| 14– 9 | 1–10 | 23–18 | 3–10 | 3– 7 |

White wins. Jacques and Campbell.

*Recent Books on Draughts.*—The most important recent works on the game are Lees's *Guide to the Game of Draughts*, Hill's *Manual* (for beginners), Kear's reprint of Sturges' and Drummond's works on the game, and Gould's *Problem Book*. The *Encyclopædia of Draughts* bids fair to be a most useful compilation of the best published play on each opening. The principal magazines devoted to the game are the *Draughts World*, the *North American Checker Board*, both monthly publications, and the *Draughts Players' Quarterly Review*. (J. M. M. D. ; R. J.)

**Dráva** or **Drave,** one of the right-bank affluents of the Danube, 668 kilometres long. Its sources are in Tirol under the mountain of Rohrwald, at a height of 1670 metres, whence, after passing across Carinthia and Styria, it penetrates into Hungary, where it forms the frontier-line between the mother country and Croatia-Slavonia. From Villach it is navigable by rafts, but by steamers only from Barcs downwards, to a distance of 155 kilometres. Of its confluents only the Mura is considerable, but it receives the excess of many alpestrine ponds. The Dráva flows into the Danube close under the town of Eszék; at this spot it has already a breadth of 325 metres, and a depth of 6·5 metres. Because of its tortuousness from Barcs downwards it is defended by strong dams; its length is 501 kilometres, with a water-region of 47,191 square kilometres. In the escutcheon of the Kingdom of Hungary the Dráva is represented, with the Danube, the Tisza, and the Száva, as one of the largest rivers of the country.

**Dredging.**—The use of dredging plant and the selection of special appliances to be used in different localities and under varying circumstances requires the exercise of sound judgment on the part of the engineer. In rivers and estuaries where the bottom is composed of light soils, and where the scour of the tide can be so guided, by training walls or other works constructed at reasonable expense, as to keep the channel clear without dredging, it is manifest that dredging machinery, with its great cost for annual upkeep, should be as far as possible avoided. On the other hand, where the bottom consists of clay, rock, or other hard material, dredging must, in the first instance at any rate, be employed to deepen or widen the channel. In other instances, as in the Mississippi, a deep channel has for twenty years been maintained by jetties, with occasional resort to dredging to preserve the required channel section and to hasten its enlargement. The bar of the Mersey is 11 miles from the land, and the cost of training works would be so great as to render them impracticable; but by a capital expenditure of £120,000, and an annual expense of £20,000 for three years, the depth of water over the bar at low water has been increased by dredging from 11 ft. to 27 ft., the channel being 1500 ft. wide.

The effects of dredging operations upon the trade and prosperity of a port are nowhere more forcibly shown than in the case of Glasgow. In 1755 only small vessels with a draught of 3 ft. or less could reach Glasgow at high water of spring tides. Now vessels drawing 27 ft. come up on an ordinary tide. Formerly some of the river streets of Glasgow were often flooded; now, consequent upon the straightening, deepening, and widening of the river, flooding never occurs. In 1755 the rise of tide was only about 2 ft. 5 in. The extreme range of tide in Glasgow harbour is now 22 ft. These remarkable results have been due to the dredging carried on in the river Clyde. Between 1844 and 1897 the quantity of material dredged from the river and deposited outside its mouth was 50,721,710 cubic yards. The tonnage of goods imported and exported has risen from 1,023,216 tons in 1851 to 5,673,152 tons in 1897. Similar results have been obtained in the rivers Tyne and Tees. In the Tyne dredging amounting to 96,362,136 tons was done between 1860 and 1896, at a cost of £1,766,639; the average rate was 4·4 pence per ton, which, however, does not include interest upon the first cost of the dredging plant. The registered tonnage of ships clearing the port has risen from 3,120,265 tons in 1860 to 6,752,252 tons in 1896. At Rotterdam, Antwerp, Calais, Dunkirk, and Ostend equally satisfactory results have followed the dredging operations undertaken, and similar results have been obtained by the dredging works at the Sulina mouth of the Danube. It will be seen, therefore, that dredging operations form a most important de-

partment of civil engineering. It is proposed in this article to describe the improvements which have been made in dredgers and in dredging operations since the publication of the article in the ninth edition of this work (vol. vii., published in 1877), and to give the cost of dredging operations in various instances.

*Bucket-Ladder Dredgers.*—Barge-loading dredgers used formerly to be provided with two ladders, one on each side of the vessel or contained in wells formed in the vessel near each side. Two ladders were adopted, partly to permit the dredger to excavate material close to a quay or wall, and partly to enable one ladder to work while the other was being repaired. Of late years, however, bucket-ladder dredgers have generally been constructed with one central ladder working in a well, and this is the type now generally followed. Such dredgers are frequently made with the bucket ladder projecting either at the head or stern of the vessel, to enable it to cut its own way through a shoal or a bank, a construction which has been found very useful. In one modification of this method the bucket ladder is supported upon a traversing frame which slides along the fixed framing of the dredger and moves the bucket ladder forward as soon as it has been sufficiently lowered to clear the end of the well. In places where a large quantity of dredging has to be done, a stationary dredger with three or four large hopper barges proves generally to be the most economical kind of plant. It has, however, the disadvantage of requiring large capital expenditure, while the dredger and its attendant barges take up an amount of space which is sometimes inconvenient where traffic is large and the navigable width narrow. The principal improvements made in barge-loading dredgers have been the increase in the size of the buckets, in the strength of the dredging gear, in the application of more economical engines for working the machinery, and in the use of frictional gearing for driving the ladder-hoisting gear. It is very important that the main drive be fitted with friction blocks or clutches which shall slip and prevent breakage in the machinery when hidden obstacles causing unusual strain come in the path of the buckets.

Up to the year 1877 dredgers were seldom made with buckets of a capacity exceeding 9 cubic ft., but since that time they have been gradually increased to 14, 16, and 18 cubic ft. capacity, while in the dredger *Melbourne*, constructed by Messrs William Simons & Co. to the design and specification of Messrs Coode, Son, & Matthews about the year 1886, the buckets had a capacity of 22 cubic ft., the dredger being capable of making 37 feet of water. The driving power consisted of two pairs of compound surface condensing engines, each of 250 I.H.P., having cylinders 20 in. and 40 in. in diameter respectively, with a 30-in. stroke, the boiler pressure being 90 ℔ per square inch. The vessel was 200 ft. long by 36 ft. wide and 11 ft. 6 in. deep, and was driven by twin-screw propellers. The gearing was arranged so that either pair of engines could be employed for dredging. The speed under steam was 7 knots, and in free-getting material 800 tons per hour could be dredged with ease. On one occasion the dredger loaded 400 tons in 20 minutes. The speed of the bucket chain was 83 lineal ft. per minute. The draught of the dredger in working trim was 7 ft. forward and 9 ft. aft. The efficiency of the machine, or the net work done in raising materials compared with the power exerted in the cylinders, was about 25 per cent. The dredged material was delivered into barges moored alongside. Contrasting favourably with former experience, the *Melbourne* worked for the first six months without a single breakage. She was fitted with very powerful mooring winches, a detail which is of great importance to ensure efficiency in working.

The *St Austell* (Fig. 1), another powerful barge-loading dredger, 195 ft. long by 35 ft. 6 in. beam by 13 ft. deep, fitted with twin-screw compound surface-condensing propelling engines of 1000 I.H.P., either set of engines being available for dredging, was constructed for H.M. Dockyard, Devonport, by Messrs William Simons & Co. in 1896. This dredger loaded thirty-five 500-ton hopper barges in the week ended 2nd April 1898, dredging 17,500 tons of material in the working time of 29 hours 5 minutes.

An instance of a still larger and more powerful dredger is the *Devolant*, constructed by Messrs William Simons & Co. for Nicolaieff, South Russia. She is a bow well, barge-loading, bucket-ladder dredger. Length 186 ft., breadth, moulded, 36 ft., depth, moulded, 13 ft. The bucket ladder is of sufficient length to dredge 36 ft. below the water-level. The buckets are exceptionally large, each having a capacity of 36 cubic ft., or fully two tons weight of material, giving a lifting capacity of 1890 tons per hour. At the dredging trials 2000 tons of spoil were lifted in one hour with an expenditure of 250 I.H.P. The propelling power is supplied by one pair of compound surface-condensing marine engines of 850 I.H.P., having two cylindrical boilers constructed for a working pressure of 120 ℔ per square inch. Each boiler is capable of supplying steam to either the propelling or the dredging machinery, thus allowing the vessel always to have a boiler in reserve. On the trials a speed of 8½ knots was obtained. The bucket ladder, which weighs over 100 tons, exclusive of dredgings, is raised and lowered by a set of independent engines. For manœuvring, powerful winches driven by independent engines are placed at the bow and stern. The vessel is fitted throughout with electric light, arc lamps being provided above the deck to enable dredging to be carried on at night. Steam steering gear, a repairing shop, a 3-ton crane, and all the latest appliances are installed on board.

The *Majestic*, constructed by Messrs Lobnitz & Co., is a good example of a dredger fitted with their patent rock cutters, as used on the Suez Canal. These rock cutters consist of stamps passing down through the bottom of the dredger, slightly in advance of the bucket chain, and are employed for breaking up rock in front of the bucket ladder so that it may afterwards be raised by the buckets.

In regard to the depth of water which can be made by dredging, it is interesting to note that the dredger *Diver*, constructed by Messrs Hunter & English for Mr Samuel Williams of London, is capable of working in 60 ft. of water. In this vessel an ingenious arrangement was devised by Mr Williams, by which part of the weight of the dredger was balanced while the ladder itself could be drawn up through the bucket well and placed upon the deck, enabling a long ladder to be used with a comparatively short vessel. The *Tilbury* dredger, constructed by the same firm, is able to dredge to a depth of 45 ft. below the surface of the water.

*Hopper Dredgers.*—In places where barge-loading dredgers are inconvenient, owing to confined space and interference with the navigation, and where it is further necessary to curtail capital expenditure, hopper dredgers are convenient and economical. The vessel for this type of dredger is made of sufficient length and floating capacity to contain its own dredgings, which it carries out to the depositing ground as soon as its hopper is full. Considerable time is of course occupied in slipping and recovering moorings and in conveying material to the depositing ground, but these disadvantages are in many instances counterbalanced by the fact that less capital is required for plant and that less room is taken up by the dredger. If the depositing ground is far away, the time available for dredging is much curtailed, but the four-screw hopper dredger constructed by Messrs W. Simons & Co. for Bristol has done good work at the cost of 5d. per ton, including wages, repairs, coals, grease, sundries, and interest on the first cost of the plant, notwithstanding that the material has to be taken 10 miles from the Bristol docks. It can lift 400 tons of stiff clay per hour from a depth of 36 ft. below the water-line, and the power required varies from 120 I.H.P. to 150 I.H.P., according to the nature of the material. The speed is 9 knots, and four propellers were provided, two at the head and two at the stern, to enable the vessel to steam equally well either way, as the river Avon is too narrow to permit her to be turned round.

The largest bucket hopper dredger in the world is *La Puissante* (Fig. 2), constructed by Messrs William Simons & Co. Ltd. for the Suez Canal Company, for the improvement of Port Said roads. It is 275 ft. long by 47 ft. beam by 19 ft. deep. The hopper capacity is 2000 tons, and the draught loaded 16 ft. 5 ins. The maximum dredging depth is 40 ft. and the minimum dredging depth is only limited by the vessel's draught, it being able to cut its own way. The bucket ladder working through the well in the stern weighs, with buckets, 120 tons. The buckets each have a capacity of 30 cubic ft., and raised on trial 1600 tons per hour. The dredger is propelled by two sets of independent triple-expansion surface-condensing engines of a combined indicated horse-power of 1800, working with steam at 160 ℔ pressure, supplied by two mild steel multitubular boilers. Each set of engines is capable of driving the buckets independently at speeds of sixteen and twenty buckets per minute. The bucket ladder is fitted with buffer springs at its upper end to lessen the shock when working in a sea-way. The

dredger can deliver the dredged material either into its own hopper or into barges lying on either side. The vessel attained a speed of 9¾ knots per hour on trial. The coal consumption during six hours steaming trial was 1·66 ℔ per I.H.P. per hour.

*Dredgers fitted with Long Shoot or Shore Delivering Apparatus.*—The first instance of dredgers being fitted with long shoots was in the Suez Canal. The soil in the lakes was very variable, the surface being generally loose mud which lay in some places on sand, but frequently on more or less hard clay. Mr Lavalley employed shoots 230 ft. long, supported on pontoons connected with the hull of the dredger. The sand flowed away with a moderate supply of water to the shoots when they were fixed at an inclination of about 1 in 20, but when the sand was mixed with shells, these formed a coating which prevented the stream of water from washing out the shoot, and even with an inclination of 1 in 10 the material could not be delivered. A pair of endless chains working down the long shoot overcame the difficulty, and also enabled hard clay in lumps to be dealt with. One dredger turned out about 2000 cubic yards of thick clay in 15 hours, and when the clay was not hard it could deliver 150,000 cubic yards in a month for several consecutive months.

A dredger (Fig. 3) constructed by Messrs Hunter & English for reclamation works on Lake Copais in Greece was fitted with delivery belts running on rollers in steel lattice frames on each side of the vessel, supported by masts and ropes. It could deliver 100 cubic metres per hour at 85 ft. from the centre of the dredger, at a cost of 1·82d. per cubic metre for working expenses, with coal at 45s. per ton, including 0·66d. per cubic metre for renewal of belts, upon which the wear and tear was heavy.

Another instance of the successful application of shore-delivery apparatus is that of a dredger for Lake Titicaca, Peru, which was fitted with long shoots on both sides, conveying the dredged material about 100 ft. from the centre of the dredger upon either side. The shoots were supported by shear-legs and ropes, and were supplied with water from a centrifugal pump in the engine-room. This dredger could excavate and deliver 120 cubic yards per hour at a cost of 1·725d. per cubic yard with coal costing 40s. per ton. If coal had been available at the ordinary rate in England of 20s. per ton, the cost of the dredging and delivery would have been 0·826d. per cubic yard for wages, coal, oil, &c., but not including the salary of the superintendent.

An interesting example of a shore-delivering dredger is a light-draught dredger for the Lakes of Alberpera at the mouth of the Ebro in Spain. The conditions laid down for this dredger were that it should float in 18 in. of water and deliver the dredged material at 90 ft. from the centre of its own hull. In order to meet the latter requirement, the vessel was made of steel plates ⅛ in. thick, and longitudinal girders ran from end to end of the vessel, the upward strain of flotation being conveyed to them from the skin plating by transverse bulkheads at short intervals. The dredger was 94 ft. long, 25 ft. wide, and 3 ft. deep, and the height of the top tumbler above the water was 25 ft. When completed it drew 17 in. of water. The dredgings were delivered by the buckets upon an endless belt, driven from the main compound surface condensing engine, which ran over pulleys supported upon a steel lattice girder, the outer end of which rested upon an independent pontoon. This belt delivered the dredgings at 90 ft. from the centre of the dredger round an arc of 180 degrees. The dredger delivered 125 cubic yards per hour of compact clay at a cost of 1·16d. per cubic yard or 0·86d. per ton for wages, coal, and stores.

Another method of delivering dredgings is that of pneumatic delivery, introduced by Mr F. E. Duckham, of the Millwall Dock Company, by which the dredgings are delivered into cylindrical tanks in the dredger, closed by air-tight doors, and are expelled by compressed air either into the sea or through long pipes on to the land. The Millwall Dock dredger is 113 ft. long, with a beam of 17 ft. and a depth of 12 ft. The draught loaded is 8 ft. It contains two cylindrical tanks, having a combined capacity of 240 cubic yds., and is fitted with compound engines of about 200 I.H.P., with a 20-in. air-compressing cylinder. The discharge pipe is 15 in. diameter by 150 yds. long. The nozzles of the air-injection pipes must not be too small, otherwise the compressed air, instead of driving out the material, simply pierces holes through it and escapes through the discharging pipe, carrying with it all the liquid and thin material in the tanks. The cost of working the Millwall Dock dredger is given by Mr Duckham at 1·75d. per cubic yard of mud lifted, conveyed, and deposited on land 450 ft. from the water-side, for working expenses only. This dredger is believed to be the first one constructed with a traversing ladder, as suggested by the late Captain Gibson when dock-master of the Millbank Docks.

*Sand-Pump Dredgers.*—Perhaps the most important development which has taken place in dredging during recent years has been the employment of sand-pump dredgers, which are very useful for removing sandy bars where the particular object is to remove quickly a large quantity of sand or other soft material. They are, however, apt to make large holes, and are therefore not fitted for positions where it is necessary to finish off the dredging work to a uniform flat bottom, for which purpose bucket dredgers are better adapted. Pump dredgers are, however, admirable and economical machines for carrying out the work for which they are specially suited.

In a discussion upon Mr J. J. Webster's paper upon "Dredging Appliances" at the Institution of Civil Engineers in 1886, Sir John Coode stated that he had first seen sand-pump dredgers at the mouth of the Maas in Holland. The centrifugal pump was placed against the bulkheads in the after part of the vessel, and the sand and water were delivered into a horizontal breeches-piece leading into two pipes running along the full length of the hopper. The difficulty in preventing the sand from running overboard was entirely obviated by its being propelled by the pump through these pipes, the bottoms of which were perforated by a series of holes. In addition, there were a few small flap-doors fixed at intervals, by means of which the men were able to regulate the discharge. On being tested, the craft pumped into this hopper 400 tons of sand in 22 minutes. The coamings round the well of the hoppers were constructed with a dip, and when the hopper was full the water ran over in a steady stream on either side. The proportion of sand delivered into the hopper was about 20 per cent. of the total capacity of the pump. The dredger was constructed by Messrs Smit of Kinderdijk, near Rotterdam.

In the same discussion Mr A. A. Langley, then engineer to the Great Eastern Railway Company, gave particulars of a sand pump upon the Bazin system, which had been used successfully at Lowestoft. The boat was 60 ft. long by 20 ft. wide, and the pump was 2 ft. in diameter, with a two-bladed disc. The discharge pipe was 12 in. in diameter. The pump raised 400 tons of sand, gravel, and stones per hour as a maximum quantity, the average quantity being about 200 tons per hour. The depth dredged was from 7 ft. to 25 ft. The pump was driven by a double-cylinder engine, having cylinders of 9 in. diameter by 10 in. stroke, and making 120 revolutions per minute. An important addition was introduced by Mr Ball in fitting the working faces of the pump with indiarubber, which was very successful and largely reduced the wear and tear. The cost of the dredging at Lowestoft was given by Mr Langley at 2d. per ton, including delivery two miles out at sea. The quantity dredged was about 200,000 tons per annum.

One of the earliest applications of pumps for dredging, made by Mr Woodford, consisted of a horizontal disc with two or more arms working in a case somewhat similar to the ordinary centrifugal pump. The disc was keyed to a vertical shaft which was driven from above by means of belts or other gear coupled to an ordinary portable engine. The pump within rested on the ground; the suction pipe was so arranged that water was drawn in with the sand or mud, the proportions being regulated to suit the quality of the material. The discharge pipe was rectangular and carried a vertical shaft, the whole apparatus being adjustable to suit different depths of water. This arrangement was very effective, and has been used on many works. Burt and Freeman's sand pump, a modification of the Woodford pump, was used in the construction of the Amsterdam Ship Canal, for which it was designed. The excavations from the canal had to be deposited on the banks some distance away from the dredgers, and after being raised by the ordinary bucket dredger, instead of being discharged into barges, they were led into a vertical chamber on the top side of the pump, suitable arrangements being made for regulating the delivery. The pump was 3½ ft. in diameter, and made about 230 revolutions per minute. It drew up the water on the bottom side which mixed with the descending mud on the top side, and the two were discharged into a pipe 15 in. in diameter. The discharge pipe was a special feature of this work, and consisted of a series of wooden pipes jointed together with leathern hinges and floated on buoys from the dredger to the bank. In some cases this pipe was 300 yds. long, and discharged the material 8 ft. above the water-level. Each dredger and pump was capable of discharging an average of 1500 cubic yds. per day of 12 hours. Schmidt's sand pump is claimed to be an improvement on the Burt and Freeman pump. It consists of a revolving wheel 6 ft. in diameter, with cutters revolving under a hood which just allows the water to pass underneath. To the top side of the hood a 20-in. suction pipe of an ordinary centrifugal pump is attached. The pump is driven by two 16-in. by 20-in. cylinders, at 134 revolutions per minute, and the cutter by two 12-in. by 12-in. cylinders, working at 120 revolutions per minute, the boiler pres-

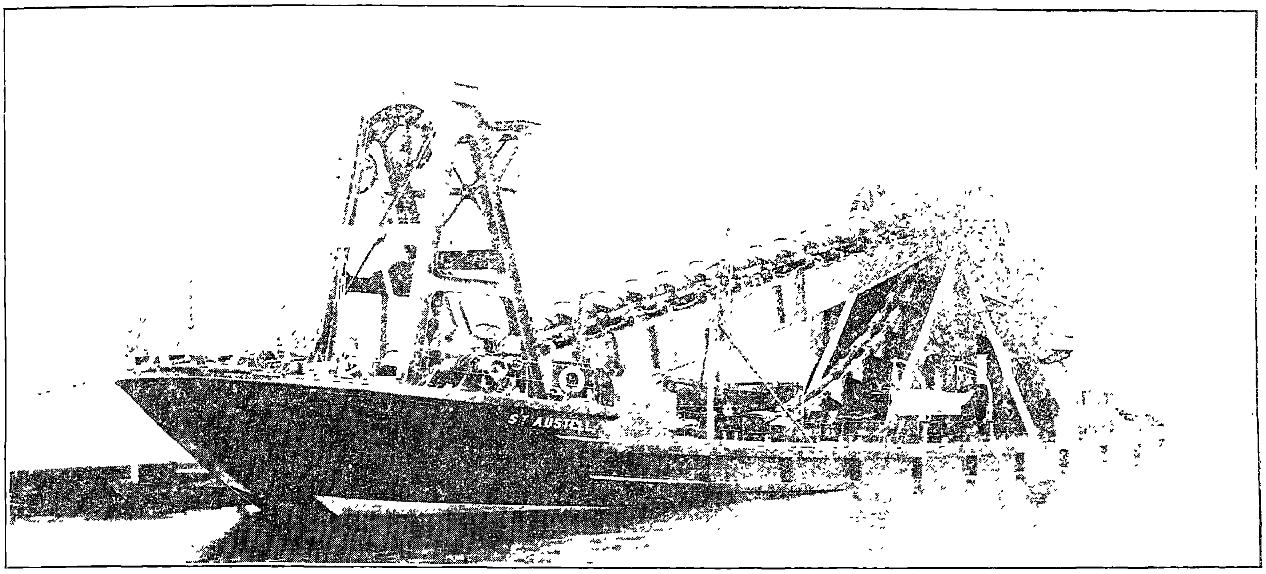


Fig. 1.

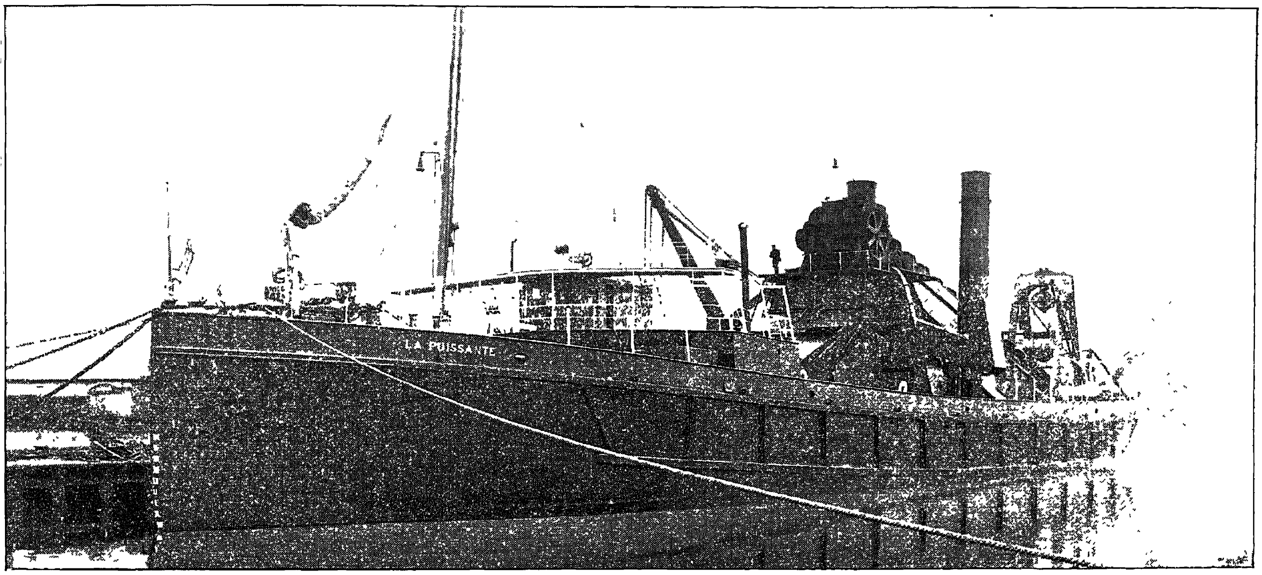



Fig. 2.

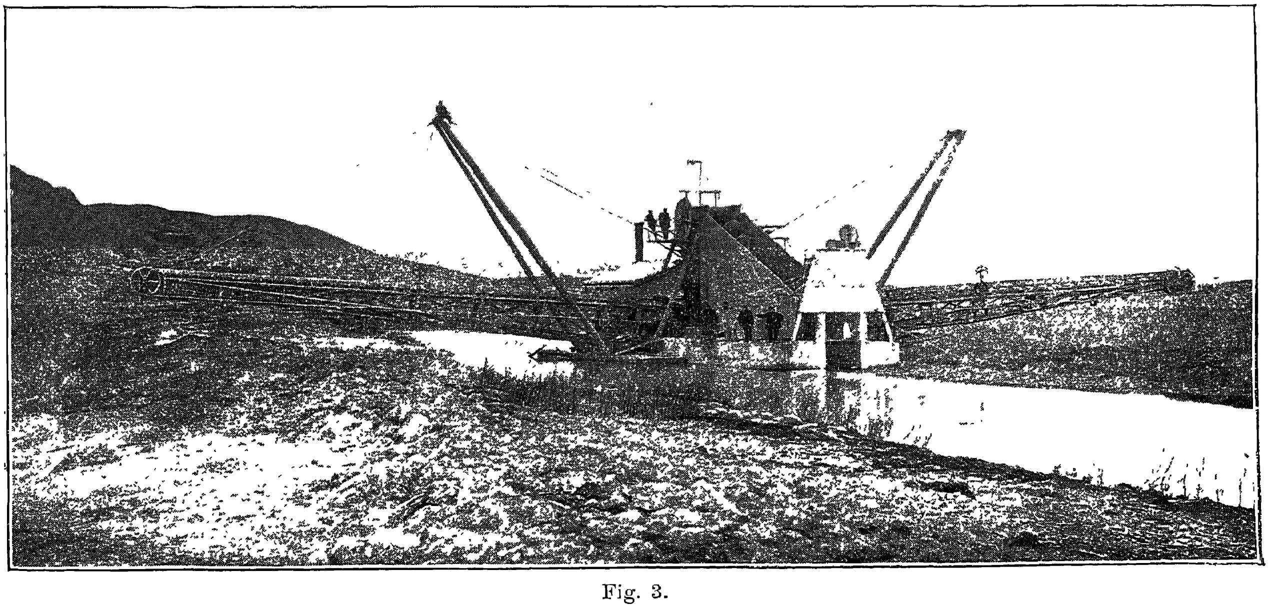


Fig. 3.

DREDGING.

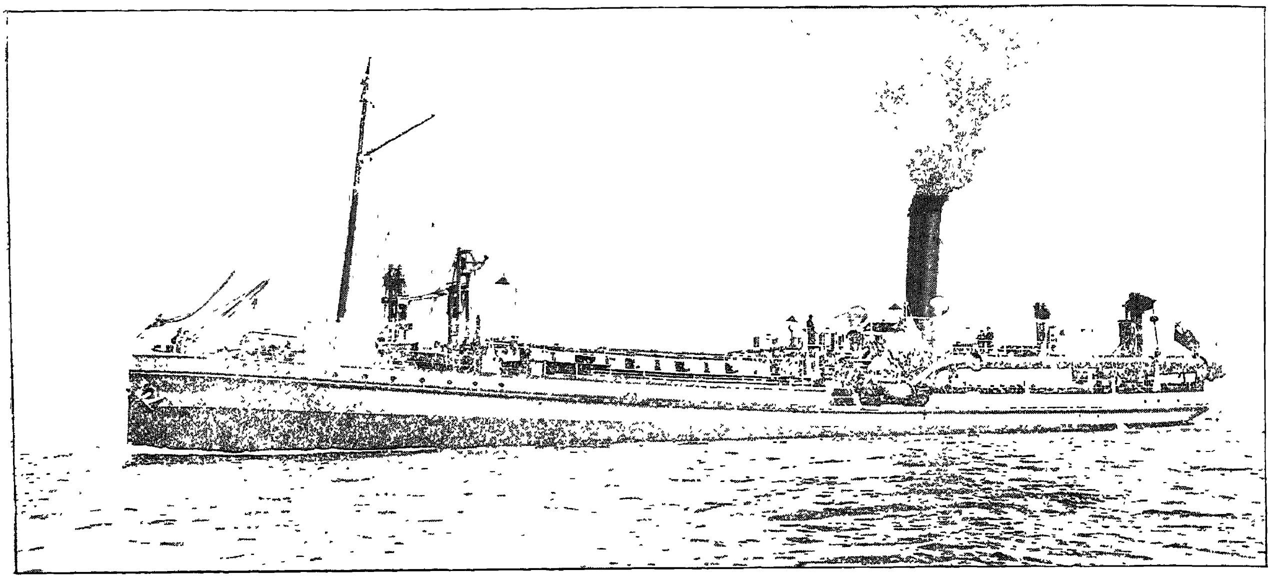


Fig. 4.

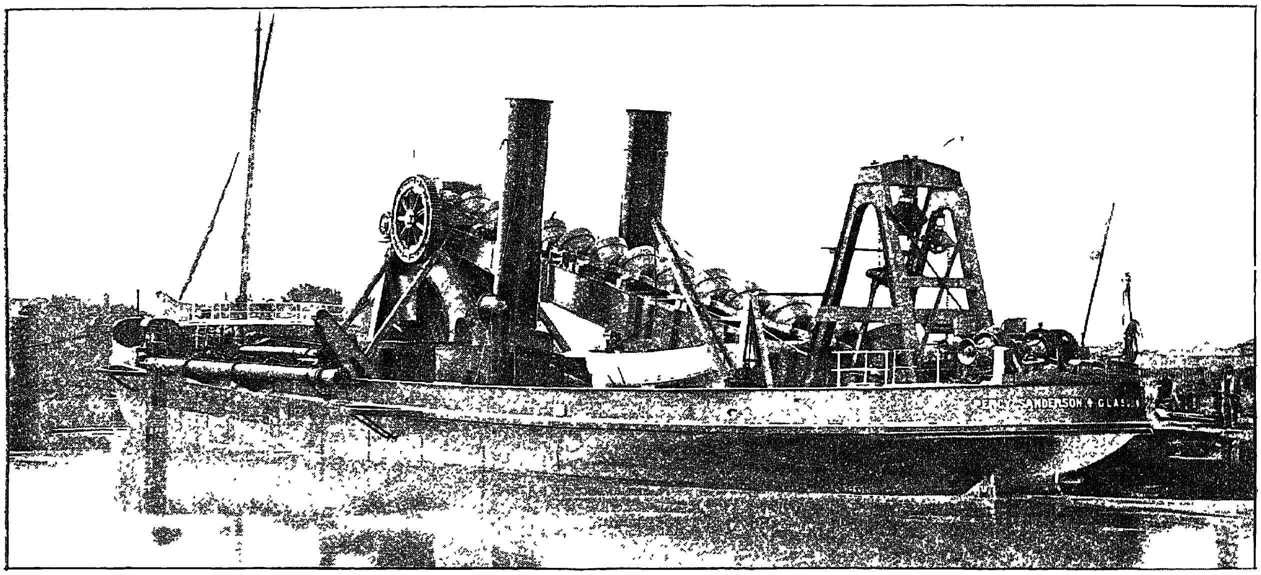


Fig. 5.

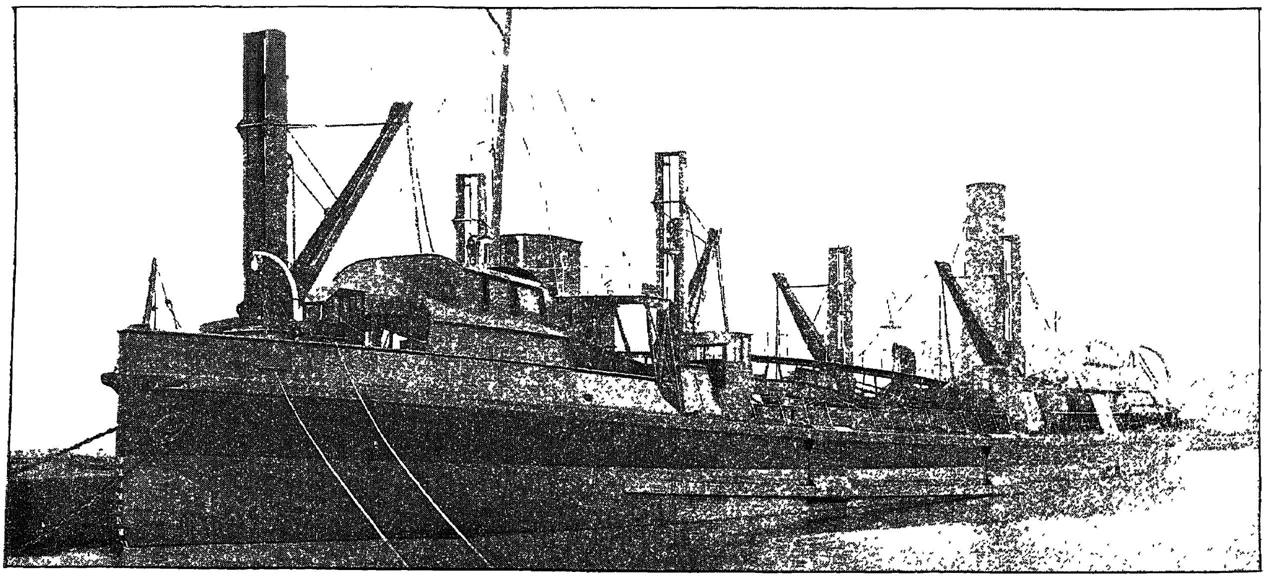


Fig. 6.

DREDGING.

sure being 95 lb per square in. This apparatus is capable of excavating sticky blue clayey mud, and will deliver the material at 500 to 650 yds. distance. The best results are obtained when the mixture of mud and water is as 1 to 6·5. The average quantity excavated per diem by the apparatus is 1300 cubic yds., the maximum quantity being 2500 cubic yds.

Kennard's sand pump is entirely different from the pumps already described, and is a direct application of the ordinary lift pump. A wrought-iron box has a suction pipe fitted at the bottom rising about half-way up the inside of the box; on the top of the box is fitted the actual pump and the flat valves. The apparatus was lowered by chains, and the pump worked from above. As soon as the box was filled with sand it was raised, the catches holding up the bottom were released, and the contents discharged into a punt.

Sand-pump dredgers, designed and arranged by Mr Darnton Hatton, were extensively used on the Amsterdam Ship Canal. A centrifugal pump with a fan 4 ft. in diameter was employed, the suction and delivery pipes, each 18 in. in diameter, being attached to an open wrought-iron framework. The machine was suspended between guides fixed to the end of the vessel, which was fitted with tackle for raising, lowering, and adjusting the machine. The vessel was fitted with a steam-engine and boiler for working and manipulating the pumps and the heavy side chains for the guidance of the dredger. The engine was 70 horse-power, and the total cost of one dredger was £8000. The number of hands required for working this sand-pump dredger was one captain, one engineer, one stoker, and four sailors. Each machine was capable of raising about 1300 tons of material per day, the engines working at 60 and the pump at 180 revolutions per minute. The sand was delivered into barges alongside the dredger. The cost of raising the material and depositing it in barges was about 1d. per ton when the sand pumps were working, but upon the year's work the cost was 2·4d. per cubic yd. for working expenses and repairs, and 1·24d. per cubic yd. for interest and depreciation at 10 per cent. upon the cost of the plant, making a total cost for dredging of 3·64d. per cubic yd. The cost for transport was 3·588d. per cubic yd., making a total cost for dredging and transport of 7·234d. per cubic yd. Dredging and transport on the same works by an ordinary bucket dredger and barges cost 8·328d. per cubic yd.

Two of the largest and most successful instances of sand-pump dredgers are the *Branker* and the *G. B. Crow*, belonging to the Mersey Dock and Harbour Board. Mr A. G. Lyster gave particulars of the work done by these dredgers in a paper read before the Engineering Congress in 1899. They are each 320 ft. long, 47 ft. wide, and 20·5 ft. deep, the draught loaded being 16 ft. They are fitted with 2 centrifugal pumps, each 6 ft. in diameter, with 36 in. suction and delivery pipes, united into a 45-in. diameter pipe, hung by a ball and socket joint in a trunnion, so as to work safely in a sea-way when the waves are 10 ft. high. The suction pipe is 76 ft. long, and will dredge in 53 ft. of water. The 8 hoppers hold 3000 tons, equivalent when solid to 2000 cubic yds.; they can be filled in three-quarters of an hour and discharged in five minutes. Mr Lyster stated that up to May 1899 the quantity removed from bar and main-channel shoals amounted to 41,240,360 tons, giving a width of channel of 1500 ft. through the bar, with a minimum depth of 27 ft. The cost of dredging on the bar by the *G. B. Crow* during 1898, when 4,309,350 tons of material were removed, was 0·61d. per ton for wages, supplies, and repairs. These figures include all direct working costs and a proportion of the charge for actual superintendence, but no allowance for interest on capital cost or for depreciation. On an average, 20 per cent. of the sand and mud that are raised escapes over the side of the vessel. Mr Lyster has, however, to a considerable extent overcome this difficulty by a special arrangement added to the hoppers. (See *Proc. Inst. C. E.* vol. cxxxviii.)

Another powerful and successful sand-pump dredger is the twin-screw dredger *Kate* (see Fig. 4), built in 1897 by Messrs William Simons & Co. Limited for the East London Harbour Board, South Africa. Its dimensions are: length 200 ft., breadth 39 ft., depth 14 ft. 6 in., hopper capacity 1000 tons. The pumping arrangements for filling the hopper with sand or discharging overboard consist of two centrifugal pumps, each driven from one of the propelling engines. The suction pipes are each 27 in. in diameter, and are so arranged that they may be used for pumping either forward or aft, as the state of the weather may require. Four steam cranes are provided for manipulating the suction pipes. Owing to the exceptional weather with which the vessel has to contend, special precautions were taken in designing the attachments of the suction pipes to the vessel. The attachment is above deck, and consists of a series of joints, which give a perfectly free and universal movement to the upper ends of the pipes. The joints, on each side of the vessel, are attached to a carriage, which is traversed laterally by hydraulic gear. By this means the pipes are pushed out well clear of the vessel's sides when pumping, and brought inboard when not at work. Hydraulic cushioning cylinders are provided to give any required resistance to the fore and aft movements of the pipes. When the vessel arrived at East London on the 18th July 1897 there was a depth of 14 ft. on the bar at high water. On 10th October, scarcely three months afterwards, there was a depth of 20 ft. on the bar at low water. Working 22 days in rough weather during the month of November 1898, the *Kate* raised and deposited $2\frac{1}{2}$ miles at sea 60,000 tons of dredgings. Her best day's work (12 hours) was on the 7th November, when she dredged and deposited 6440 tons.

A large quantity of sand-pump dredging has been carried out at Boulogne and Calais by steam hopper pump dredgers, workable when the head waves are not more than 3 ft. high and the cross waves not more than $1\frac{1}{2}$ ft. high. The dredgings are taken 2 miles to sea, and the price for dredging and depositing from 800,000 to 900,000 cubic metres in 5 or 6 years was 7·25d. per cubic yard. The contractor offered to do the work at 4·625d. per cubic yard on condition of being allowed to work either at Calais or Boulogne, as the weather might permit. Sand-pump dredging has also been extensively carried out at the mouth of the ports of Amsterdam, Rotterdam, and on the north coast of France by sand dredgers constructed by Messrs L. Smit & Son and G. & K. Smit. The largest dredger, the *Amsterdam*, is 141 ft. by 27 ft. by 10 ft. 8 in., and has engines of 190 I.H.P. The hopper capacity is 10,600 cubic ft., and the vessel can carry 600 tons of dredgings. The pump fan is 6 ft. 3 in. in diameter by 10 in. wide, the plates being of wrought-iron, and makes 130 revolutions a minute. The pump can raise 230 cubic ft. a minute from a depth of 33 ft., which, taking the proportion of 1 of sand to 7 of water, gives a delivery of 29 cubic ft. of sand per minute. The hopper, containing 10,600 cubic ft., was under favourable circumstances filled in 40 minutes. The vessels are excellent sea boats.

*Combined Bucket-Ladder and Sand-Pump Dredgers.*—Recently bucket ladders and sand pumps have both been fitted to the same dredger. A successful example of this practice is furnished by the hopper dredger *Percy Sanderson* (see Fig. 5), constructed under the direction of Sir Charles L. Hartley, engineer of the Danube Commission for the deepening of the river Danube and the Sulina bar. This dredger is 220 ft. by 40 ft. by 17 ft. 2 in., and has a hopper capacity for 1250 tons of dredgings. The buckets have each a capacity of 25 cubic ft., and are able to raise 1000 tons of ordinary material per hour. The suction pump, which is driven by an independent set of triple-expansion engines, is capable of raising 700 tons of sand per hour, and of dredging to a depth of 35 ft. below the water-line. The lower end of the suction pipe is controlled by special steam appliances by which the pipe can be brought entirely inboard. The *Percy Sanderson* raises and deposits on an average 5000 tons of material per day.

*Hopper Barges.*—Where dredging operations on a large scale are being carried out, steam hopper barges are generally employed. Good examples of these vessels are the two steam hopper barges built for the Conservators of the river Thames in 1898. Their dimensions are: length 190 ft., breadth 30 ft., depth 15 ft. 3 in., hopper capacity 900 tons. They are propelled by a set of triple-expansion engines of 1200 I.H.P., with two return tubular boilers having a working pressure of 160 lb. Special appliances are provided to work the hopper doors by steam power from independent engines placed at the forward end of the hopper. A steam windlass is provided forward and a steam capstan aft. The vessels are fitted with cabins for the officers and crew. On their trial trip, the hoppers having their full load, a speed of 11 knots was attained, the coal consumption being 1·44 lb per I.H.P.

*Grabs.*—Various kinds of apparatus have been designed in the shape of grabs or buckets for dredging purposes. These are usually worked by a steam crane, which lets the open grab down to the surface of the ground to be excavated and then closes it by a chain which forces the tines into the ground; the grab is then raised by the crane, which deposits the contents either into the hopper of the vessel upon which the crane is fixed or into another barge.

The Priestman grab has perhaps been more extensively used than any other apparatus of this sort. It is very useful for excavating mud, gravel, and soft sand, but is less effective with hard sand or stiff clay, which is a general defect in this class of dredger. It is

also capable of lifting large loose pieces of rock weighing from one to two tons. A dredger of this type, with grab holding one ton of mud, dredged during six days, in 19 ft. of water, an average of 52½ tons and a maximum of 68½ tons per hour, and during 12 days, in 16 ft. of water, an average of 48 tons and a maximum of 58 tons per hour, at a cost of 1·63d. per ton, excluding interest on the capital and depreciation. The largest dredger to which this apparatus has been applied is the grab bucket hopper dredger *Miles K. Burton* (see Fig. 6), belonging to the Mersey Docks and Harbour Board. It is equipped with five grabs on Morgan's patent system, which is a modification of Priestman's, the grabs being worked by five hydraulic cranes. It raised and deposited, 12 to 15 miles out at sea, 11 loads of about 1450 tons each with a double shift of hands, at a cost of about 1·5d. per cubic yard of spoil, including the working expenses for wages of crew, fuel, and stores. Mr Marillier of Hull has stated that "the efficiency of these grabs is not at all dependent upon the force of the blow in falling for the penetration and grip in the material, as they do their work very satisfactorily even when lowered quite gently on to the material to be cut out, the jaws being so framed as to draw down and penetrate the material as soon as the upward strain is put on the lifting chain. Even in hard material the jaws penetrate so thoroughly as to cause the bucket to be well filled. The grab is found to work successfully in excavating hard clay from its natural bed on dry land." It is claimed on behalf of grabs that they lift a smaller proportion of water than any other class of dredger.

Wild's single chain half-tine grab works entirely with a single chain, and has been found very useful in excavating the cylinders in Castries harbour. Upon experimenting with an ordinary grab a rather curious condition of things was observed with respect to sinking. On penetrating the soil to a certain depth the ground was found, as it were, nested, and nothing would induce the grab to sink lower. Mr Matthews suggested that an additional set of external tines might possibly get over this difficulty. A new grab having been made with this modification, and also with a large increase of weight—all the parts being steel—it descended to any required depth with ease, the outside tines loosening the ground effectually, whilst the inside bucket or tines picked up the material.

*Miscellaneous Appliances.*—Under this head may be classed several machines or appliances which perhaps can hardly be called dredgers, although they are used for cleansing and deepening rivers and harbours.

Kingsfoot's dredger, used for cleansing the river Stour, consisted of a boat with a broad rake fitted to the bow, capable of adjustment to different depths. At the sides of the boat were hinged two wings of the same depth as the rake and in a line with it. When the rake was dropped to the bottom of the river and the wings extended to the side, they formed a sort of temporary dam, and the water began to rise gradually. As soon as a sufficient head was raised, varying from 6 to 12 in., the whole machine was driven forward by the pressure, and the rake carried the mud along with it. A progress of about 3 miles an hour was made in this manner, and to prevent the accumulation of the dredgings, operations were begun at the mouth of the river and carried on backwards. The apparatus was very effective and the river was cleansed thoroughly, but the distance travelled by the dredger must have been great.

In 1876 J. J. Rietschoten designed a "propeller dredger" for removing the shoals of the river Maas. It consisted of an old gunboat fitted with a pair of trussed beams—one at each side—each of which carried a steel shaft and was capable of being lowered or raised by means of a crab. An ordinary propeller 3 ft. 6 in. in diameter was fixed to the lower end of each shaft, and driven by bevel-gear from a cross shaft which derived its motion by belting from the fly-wheel of a 12 H.P. portable engine. The propellers were lowered until they nearly reached the shoals, and were then worked at 150 revolutions per minute. This operation scoured away the shoal effectively, for in about 40 minutes it had been lowered about 3 ft. for a space 150 yards long by 8 yards wide.

Mr Lavalley in 1877 designed an arrangement for the harbour of Dunkirk to overcome the difficulty of working an ordinary bucket-ladder dredger when there is even a small swell. A pump injects water into the sand down a pipe terminating in three nozzles to stir up the sand, and another centrifugal pump draws up the mixed sand and water and discharges it into a hopper, the pumps and all machinery being on board the hopper. To allow for the rising and falling of the vessel—either by the action of the tide or by the swell—the ends of the pipes are made flexible. The hopper has a capacity of 190 cubic yards, and is propelled and the pumps worked by an engine of 150 I.H.P. From 50 to 80 cubic yards per hour can be raised by this dredger.

The "Aquamotrice," designed by Mr Popie and used on the Garonne at Agen, appears to be a modification of the old bag and spoon arrangement. A flat-bottomed boat 51½ ft. long by 6½ ft. wide was fitted at the bow with paddles, which were actuated by the tide. Connected with the paddles was a long chain, passing over a pulley on uprights and under a roller, and a beam was attached to the chain 14 ft. 8 in. long, passing through a hole in the deck. At the end of the beam was an iron scoop 2 ft. wide and 2 ft. 6 in. deep. When the tide was strong enough it drew the scoop along by means of the paddles and chains, and the scoop when filled was discharged by means of a lever opening it. About 65 cubic yards of gravel can be raised by the apparatus in 12 hours. When the tide failed, the apparatus was worked by men.

The Danube Steam Navigation Co. removed the shingle in the shallow parts of the river by means of a triangular rake with wrought-iron sides 18 ft. long, and fitted with 34 teeth of chilled cast-iron 12 in. deep. This rake was hung from the bow of a steamer 180 ft. long by 21 ft. beam, and dragged across the shallows, increasing the depth of water in one instance from 5 ft. 6 in. to 9 ft., after passing over the bank 355 times.

A combination of a harrow and high-pressure water jets, arranged by Mr Tydeman, was found very efficacious in removing a large quantity of mud which accumulated in the Tilbury Dock basin, which has an area of about 17 acres, with a depth of 26 ft. at low-water spring tides. In the first instance chain harrows merely were used, but the addition of the water jets added materially to the success of the operation. The system accomplished in six tides more than was done in twelve tides without their aid. The water jets worked at about 80 ℔ pressure per square in., attaining an effective pressure of about 60 ℔ per square in. at the bottom of the dock.

Ives's excavator consists of a long weighted spear, with a sort of large spade at the end of it. The spade is hinged at the top, and is capable of being turned at right angles to the spear by a chain attached to the end of the spear. The spade is driven into the ground and, after releasing the catch which holds it in position during its descent, it is drawn up at right angles to the spear by the chain, carrying the material along with it. Milroy's excavator is similar, but instead of having only one spade it generally has eight, united to the periphery of an octagonal iron frame fixed to a central vertical rod. When these eight spades are drawn up by means of chains, they form one flat table or tray at right angles to the central rod. In operation the spades hang vertically, and are dropped into the material to be excavated; the chains are then drawn up, and the table thus formed holds the material on the top, which is lifted and discharged by releasing the spade. This apparatus has been extensively used both in this country and in India for excavating in bridge cylinders.

The clam-shell dredger consists of two hinged buckets, which, when closed, form one semi-cylindrical bucket. The buckets are held open by chains attached to the top of a crosshead, and the machine is dropped on to the top of the material to be dredged. The chains holding the buckets open are then released, while the spears are held firmly in position, the buckets being closed by another chain. Bull's dredger, Gatmell's excavator, and Fouracres's dredger are modifications with improvements of the clam-shell dredger, and have all been used successfully upon various works.

Bruce and Batho's dredger, when closed, is of hemispherical form, the bucket being composed of three or four blades. It can be worked either by a single chain or by means of a spear, the latter being generally used for stiff material. The advantage of this form of dredger bucket is that the steel points of the blades are well adapted for penetrating hard material. Messrs Bruce and Batho have also designed a novel dredger consisting of one of these buckets, but worked entirely by hydraulic power. This was made for working on the Tyne. The excavator or dredger is fixed to the end of a beam which is actuated by two hydraulic cylinders, one being used for raising the bucket and the other for lowering it; the hydraulic power is supplied by the pumps in the engine-room. The novelty in the design is the ingenious way in which the lever in ascending draws the shoot under the bucket to receive its contents, and draws it away again as the bucket descends. The hydraulic cylinder at the end of the beam is carried on gimballs to allow for the irregularities of the surface being dredged. The hydraulic pressure is 700 ℔ per square in., and the pumps are used in connexion with a steam accumulator.

An unloading apparatus was designed by Mr A. Manning for the East and West India Dock Company for unloading the dredged materials out of barges and delivering it on the marsh at the back of the bank of the river Thames at Crossness, Kent. A stage constructed of wooden piles commanded a series of barge beds, the unloading dredger running from end to end of the stage, lifting and delivering the materials on to the marsh behind the river wall at the cost of 1d. per cubic yard.

*Dredging combined with Blasting.*—In the *Encyclopædia Britannica*, vol. vii. p. 466, a description was given of blasting and dredging upon the river Tees. This may profitably be supplemented by an account of similar operations in Blyth harbour (cp. *Proc. Inst. C. E.* vol. lxxxi. p. 302). Here it became necessary to provide extensive deep-water berths, and the site determined upon was on

the south side of Blyth, about a mile from the harbour entrance. The bottom of the river at this place was formed of a large patch of rock, which had long been a serious obstruction to dredging operations, and which it was necessary to remove in order to provide the required depth. The rock was 700 ft. long by 139 ft. 6 in. at its widest part, a width of 85 ft. being dry at low water of spring tides. The material consisted of yellow sandstone, rocky shale, and clay, lying in horizontal beds; there was also a considerable proportion of very hard quartzite in the form of large boulders and irregular beds. The shoal was of very irregular character and the clay layers were the worst feature, as they rendered effective blasting difficult.

The means employed were, first, boring and blasting; secondly, dredging. The boring was effected by hand labour, from rafts 25 ft. by 13 ft., made of yellow pine logs decked over with planking. The bore-holes were $2\frac{7}{8}$ in. diameter. The drills were chisel-pointed, $2\frac{3}{4}$ in. broad, the shanks being $1\frac{1}{4}$ in. diameter. Boring tubes 3 in. diameter were firmly driven into the ground after the raft was moored, and drills were worked within them. The tubes prevented the sand from getting into the bore-holes, and enabled cartridges to be rammed home without the aid of a diver. Four men were required at each drill. The average speed of boring was about 3 lin. ft. per hour, and the cost for labour was 1s. per lin. ft. At first the work was carried on as tide-work, but afterwards by day-work irrespective of the tide, which was found to be cheaper. It was originally intended to do the operation in one lift, but the dredger was not powerful enough, so the operation was effected in two lifts, the first 9 ft. deep and the second to the finished depth of 15 ft. below water at spring tides.

The bore-holes were arranged in diagonal squares of 6 ft. 3 in., the upper series being bored to 9 ft. 10 in. and the lower to 15 ft. 6 in. below low water. The blasting charges were contained in water-tight tin cases 2 in. diameter, closed at the top with wood plugs 2 in. deep. Bickford's double-coated gutta-percha fuzes and Nobel's detonators were used, and there were few misfires, except in frosty weather, when the dynamite was liable to burn. No tamping material was employed. After blasting, the material was removed by dredging, the greater portion being loaded into hopper barges and deposited about three miles from the site of the works. The dredger employed belonged to the harbour authorities, and was 100 ft. long by 25 ft. beam by 10 ft. deep. Thirty-two buckets and claws, capable of dredging 90 tons per hour of soft sand and mud from a depth of 23 ft., excavated only 6 tons of rock per hour. The buckets had a capacity of 2·82 ft. and weighed 5 cwt. The hoppers were each of 120 tons capacity. The Priestman grab was occasionally used, and was found effective for lifting large loose pieces of rock up to 2 tons in weight. When the blocks exceeded this weight, they were lifted by a floating steam crane in conjunction with a diver. Dredging was carried on both by day and night, two crews working alternately in twelve-hour shifts. Small ridges and patches about 12 in. high, missed by the dredger, were removed by a diver with pick and bar. In this way 24,500 cubic yds. of rock, with a large quantity of mud and sand, were removed; 4500 $2\frac{7}{8}$ in. holes were fired; and after deducting the gunpowder which was not efficacious, 11,820 ℔ of explosives, principally nitro-glycerine compounds, were used, being 0·482 ℔ of explosives per cubic yard. The cost of the explosives per cubic yard was 1s. 4d., of boring 1s. 9d. per cubic yard, and of dredging 3s. per cubic yard, including repairs, but nothing for the use of plant. The whole cost worked out to 6s. 1d. per cubic yard on the average.

*Dredging in the River Scheldt below Antwerp.*—This dredging took place at Krankeloon and the Belgian Sluis under the direction of Mr L. Van Gansberghe. At Melsele there is a pronounced bend in the river, causing a bar at the Pass of Port Philip, and just below the Pass of Lillo there is a cross-over in the current, making a neutral point and forming a shoal. After dredging to 8 metres (26·24 ft.) below low tide, in clay containing stone and ferruginous matter, a sandstone formation was encountered, which was very compact and very difficult to raise. A suction dredger being unsuited to the work, a bucket-ladder dredger was employed. The dredging was commenced at Krankeloon in September 1894 and continued to the end of 1897. A depth of six metres (19·68 ft.) was excavated at first, but was afterwards increased to eight metres (26·24 ft.). The place of deposit was at first on lands acquired by the State, 2·17 miles above Krankeloon, and placed at the disposal of the contractor. The dredgings excavated by the bucket-ladder dredger were deposited in scows, which were towed to the front of the deposit ground and discharged by a suction pump fixed in a special boat, moored close to the bank of the river. The material brought by the suction dredger in its own hull was discharged by a plant fixed upon the dredger itself. In both instances the material was deposited at a distance of 1640 ft. from the river, the spoil bank varying in depth from 6·56 ft. to 22·96 ft. The water thrown out behind the dyke with the excavated material returned to the river, after settlement, by a special discharge lock built under the dyke. Since 1896 the material was delivered into an abandoned pass by means of barges with bottom hopper doors or by the suction dredger. One suction dredger and three bucket-ladder dredgers were employed upon the work, and a vessel called *Scheldt I.* used for discharging the material from the scows. Four tug-boats and twenty scows were also employed.

The largest dredger, *Scheldt III.*, was 147·63 ft. long by 22·96 ft. wide by 10·98 ft. deep, and had buckets of 21·18 cubic ft. capacity. The output per hour was 10,594 cubic ft. This dredger had also a complete installation as a suction dredger, the suction pipe being 2 ft. diameter. The fan of the centrifugal pump was 5·25 ft. diameter, and was driven by the motor of the bucket ladder. The three bucket dredgers worked with head to the ebb tide. They could also work with head to the flood tide, but it took so long a time to turn them about that it was impracticable. The work was for from 13 to 14 hours a day on the ebb tide. The effective daily excavation averaged 4839 cubic yds. Each dredger was fitted with six anchors. The excavated cut was 164 ft. wide by 6·56 ft. deep. *Scheldt III.* was capable of lifting a mass 9·84 ft. thick. The suction dredger *Scheldt II.* was of the multiple type, and is stated to be unique in construction. It can discharge material from a scow alongside, fill its own hopper with excavations, discharge its own load upon the bank or into a scow by different pipes provided for the purpose, and discharge its own load through hopper doors. The machinery is driven by a triple-expansion engine of 300 I.H.P. working the propeller by a clutch. Owing to the rise and fall in the tide of 23 ft., the suction pipe is fitted with spherical joints and a telescopic arrangement. The vessel is 157·5 ft. by 28·2 ft. by 12·8 ft. The diameter of the pump is 5·25 ft. The wings of the pump are curved, the surface being in the form of a cylinder parallel to the axis of rotation, the directrix of which is an arc of a circle of 2·62 ft. radius with the straight part beyond. The suction and discharge pipes are 2 ft. diameter. A centrifugal pump is provided for throwing water into the scows to liquefy the material during discharge. The dredger, which is fitted with electric lights for work at night, is held by two anchors, to prevent lurching backwards and forwards; it can work on the flood as well as on the ebb tide, and can excavate to a depth of 42·65 ft., the output depending upon the nature of the material. With good material it can fill its tanks in thirty minutes. To empty the tanks by suction and discharge upon the bank over the dyke takes about fifty minutes, depending upon the height and distance to which the material requires to be delivered. The daily work has averaged eighteen hours, ten trips being made when the distance from the dredging ground to the point of delivery is about one mile. When the dredged material is discharged into the *Scheldt*, a quantity of 5886 cubic yards has been raised and deposited in a day, the mean quantity being 4700 cubic yards. When the distance of transportation is increased to $2\frac{1}{2}$ miles, six voyages were made in a day, and the day's work amounted to 3530 cubic yards.

The work was let to the contractor at the following prices:—

| | |
|---|---|
| For excavation, transportation, and deposit 2·17 miles in Polder of Borgerwoort . . . . . | 4·5d. per cubic yd. |
| For excavation, transportation, and discharge in disused parts of the Scheldt . . . . . | 2·0d. ,, ,, |
| For excavation and leading into a scow | 1·2d. ,, ,, |
| the transportation by water per kilometre being . . . . | ·15d. ,, ,, |
| For discharge of scows in the Scheldt . | ·55d. ,, ,, |
| For dredging into scows and delivering on to the embankments in Polder of Borgerwoort . . . . | 2·0d. ,, ,, |
| The extra price for dredging heaps of stone found in the bed of the river was . . . . . . | 1·75d. ,, ,, |

The output and cost of dredging and delivering were as follows from the different dredgers:—

| | |
|---|---|
| *Geisendam*—For excavating and transporting 6·2 miles and discharging into the Scheldt, requiring a tug and 5 scows. The work done was 1765 cubic yds. per diem | 5·2d. per cubic yd. |
| *Elizabeth*—For transporting 1·55 miles and discharging into Scheldt with tug and 3 scows, 3793 cubic yds. per diem | 2·4d. ,, ,, |
| *Scheldt III.*—Transporting 2·17 miles and discharging upon lands of Polder 1312 ft. behind the dyke, 1 tug and 5 scows, and using a suction boat for discharging over the dyke, 4839 cubic yds. per diem. | 4·8d. ,, ,, |
| *Scheldt II.*—This suction dredger excavated, transported 2·48 miles, and delivered upon the Polder 2943 cubic yds. per diem | 4·8d. ,, ,, |

The above prices are those paid to the contractor. It is estimated that the cost was about 2·5d. delivered on the bank and ·15d. delivered into the Scheldt.

*River Garonne.*—The cost of dredging upon this river was given in a paper by M. H. Desprez of Paris. The mean cost of dredging, transporting, and placing upon the bank 14,271 cubic ft. was 4·625d. per cubic yd., made up as under:—

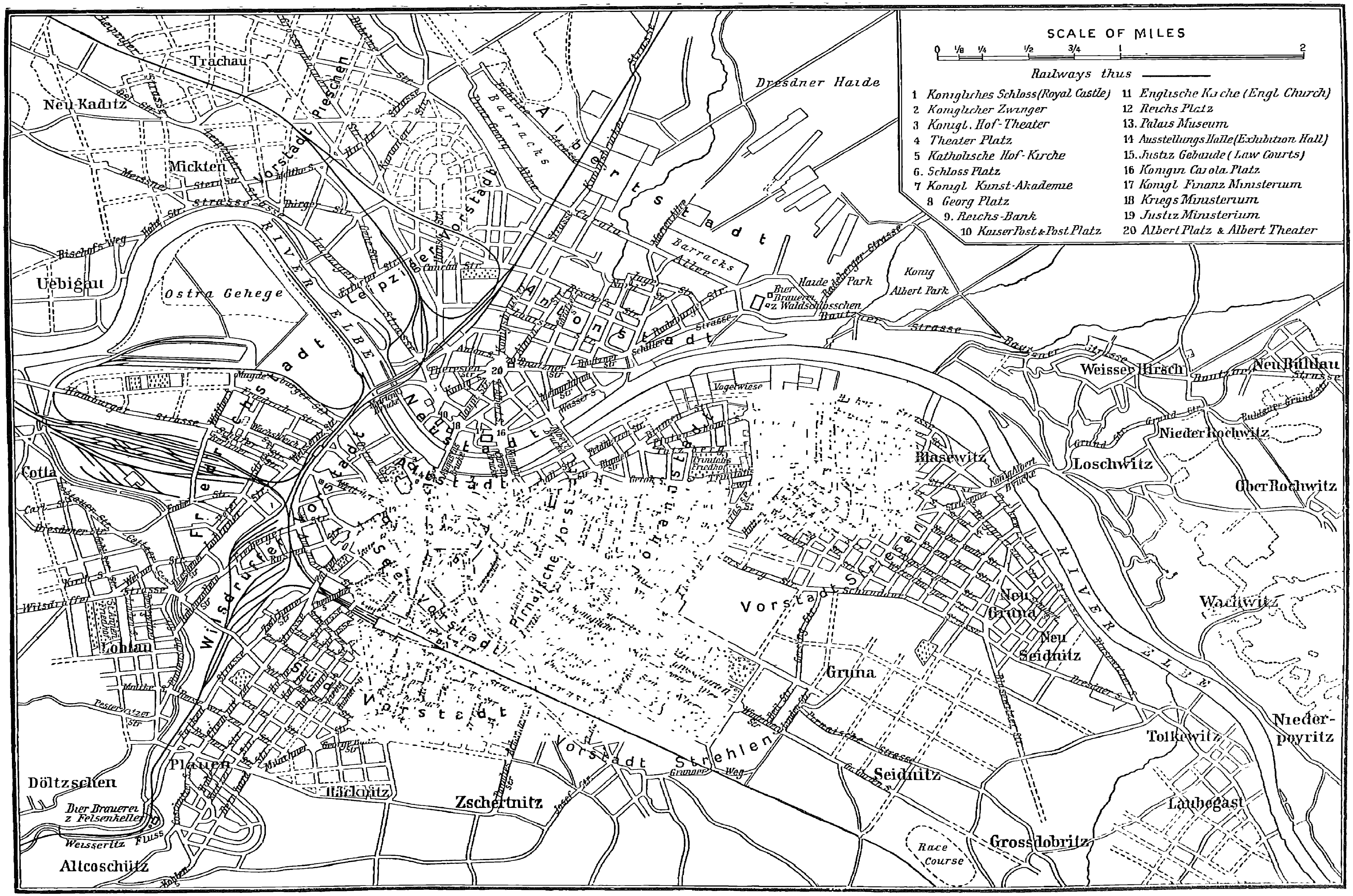
| | |
|---|---|
| Dredging | 1·425d. |
| Transportation | 1·68d. |
| Placing on bank | 1·3d. |
| Management, &c. | 0·22d. |
| Total | 4·625d. |

*River Loire.*—In 1897 the dredging of 1,233,670 cubic yds. with three bucket-ladder dredgers cost 2·5d. and 3·75d. per cubic yd., made up as follows:—

| | |
|---|---|
| Dredging | 1·25d. per cubic yd. |
| Transporting for a short distance and discharging from hoppers | 1·25d. ,, ,, |
| | 2·5d. ,, ,, |
| If discharged upon bank with floating elevator, including tow-boats, elevators, and barges | 3·75d. ,, ,, |
| Transport and discharge, transporting 21¾ miles | 4·65d. ,, ,, |

With suction dredger and transportation not exceeding 21¾ miles, the cost was 2·25d. per cubic yard. (W. H*.)

**Dresden** (the name is derived from the old Slav word *Drezga* = forest; *Drezgajan* = forest-dwellers), the capital city of the kingdom of Saxony, headquarters of the 12th German Army Corps, and the fifth largest town in the German Empire. It lies in a broad valley on both banks of the Elbe, 111 miles south from Berlin. Its delightful situation, no less than the richness of its art treasures and the educational advantages it offers, has ever made it a favourite resort of strangers, and during the last few years the numbers of foreigners who have made it their home have largely increased. Particularly is this the case with the so-called Russian, British, and American "colonies." Within two decades (1880–1900) Dresden almost at a bound advanced into the front ranks of German commercial and industrial towns; but whilst gaining in prosperity, it has lost much of its picturesque mediæval aspect. Old buildings in the heart of the Altstadt have been swept away, and their place occupied by modern business houses and new streets. König Johann-strasse has opened up the Altmarkt to the eastern suburbs, while the Schloss-strasse has been widened, an operation involving the demolition of the famous Georgenthor. The city, in its expansion in all directions, is gradually assimilating the more distant suburbs, which through a well-arranged tramway system are now brought into easy connexion with its centre. The prospect of the Elbe and of the undulating and pine-clad hills beyond, as formerly enjoyed from the Brühlsche Terrasse, has become somewhat marred, owing to the extension of the town up the river and to the two new bridges (both east of the old Augustus-brücke)—the Queen Carola-brücke, 1070 ft. long, resting on a couple of pillars in the stream, built in 1892–95, and the König Albert-brücke, 1037 ft. long, with four arches, each 102 ft. span, built in 1875–77. But in spite of its having become to a certain extent modernized, it cannot be denied that, architecturally, Dresden has gained in general embellishment by the new buildings which have lately been erected. In the old town the most striking of the new edifices is the Maler-akademie. It consists of a complex of buildings, constructed from designs by Lipsius, in the Italian Renaissance style, in the years 1890–94, and is profusely decorated with busts and medallions of famous artists, poets, and illustrious men. It contains not only the academy proper, but also the permanent exhibition of the Kunst-verein. The Albertinum, formerly the arsenal, built in 1559–63, was rebuilt in 1884–89, and fitted up as a museum of Oriental and classical antiquities, and as the depository of the state archives. There are also a bronze statue of Semper by Schilling (1891), a statue of Ludwig Richter by Kircheisen (1898), and the Moritz monument (removed here in 1895). The royal palace has undergone a radical restoration since 1890. The Brühl Palace is about to be reconstructed; the central portion of it is destined to form part of a new Parliament House for the kingdom. An elaborate equestrian monument of König Johann, by Schilling, unveiled in 1889, faces the Hoftheater. The latter is a magnificent creation, rebuilt after the designs of Semper on the site of the theatre burnt down in 1869, and was completed by his son Manfred in 1878. The exterior and interior are sumptuously decorated. In the old town there are further the Saxon industrial art museum, with a school, collection of drawings, and library attached; the Kreuz-kirche, rebuilt after destruction by fire in 1897; the municipal museum (antiquities, archives, coins, pictures, &c.); the Reformierte Kirche (1894); the Holy Trinity church; the Renaissance Victoria-Haus (1891–92); the Luther monument (1885), a copy of the Rietschel model at Worms; and the Dresdner Bank. In the suburbs which encircle the old town on west, south, and east there are to be noted the central railway station (1893–98), occupying the site of the old Böhmischer Bahnhof; a new station in the Neustadt, comprising the Leipziger and Schlesischer Bahnhöfe, is in course of construction; the vast premises of the municipal infirmary; the graves of Friedrich von Schlegel and von Weber (the musician) in the Roman Catholic cemetery; the bronze statue of Körner (1871), and a bust of Gutzkow (1887); in the Grosser Garten is the botanical garden, laid out in 1891, and a large exhibition building: the imposing law courts; the Johannes Kirche, richly sculptured in the interior; the Schilling Museum; and two ornamental fountains (Gerechtigkeit und Gänsedieb). On the right bank of the Elbe stands the fine ministry of finance (1896), the war ministry, the ministry of justice, the Körner Museum, and the Japanese Palace, this last containing the royal library of 400,000 vols., 6000 MSS., and 20,000 maps. Albert-platz is adorned with two fine fountains by Diez. In this same quarter are also the Luther church (1887) and the architects' school. On the Bismarck-platz is the technical high school, which since 1870 has enjoyed the privilege of conferring the degrees of doctor of engineering, doctor of technical sciences, &c. Beyond the Neustadt, and extending for more than a mile at half height on the range of hills which form its background, lies the Albertstadt, the military quarter, consisting of an imposing line of barracks and other military buildings, reference to which has been made in the article BARRACKS. Behind these stretches away the romantic pine forest—the so-called Dresdener Heide. Dresden is




Map of Dresden.

the seat of very various industries, its famous breweries occupying a prominent place. Population (1885), 246,086; (1890), 276,522; (1895), 336,440; (1900), 395,349.

**Dreux,** chief town of arrondissement, department of Eure-et-Loir, France, 20 miles north-north-west of Chartres, on railway from Paris to Granville. The manufacture of hardware and heavy iron goods has become important, as now are nurseries. There is considerable commerce in grain, fowls, and boots and shoes. The remains of Louis Philippe and his queen were brought from Weybridge, England, their first resting-place, in 1876, and interred in the chapel of St Louis. Population (1881), 6867; (1901), 9697.

**Drewenz,** a river of Germany. It rises south-east of Osterode in East Prussia, passes through the lake of Drewenz (7 miles long), and after a south-west course of 148 miles enters the Vistula from the right a little above Thorn. It is navigable only for rafts. Lake Drewenz is connected with Elbing (and so with the Baltic) by the navigable Elbing-Oberland Canal.

**Driffield, Great,** a market-town and railway station in the Buckrose parliamentary division of Yorkshire, England, 13 miles north of Beverley. All Saints' Church has been restored, and a Roman Catholic church, a Wesleyan Methodist chapel, and a new court-house have been erected. There are oil-cake works. Area of township (an urban district), 4998 acres. Population (1881), 5939; (1901), 5765. Area of ecclesiastical parish, 7599 acres. Population (1881), 6323; (1901), 6036.

**Drogheda,** a seaport in the county of Louth, Ireland, on the river Boyne and the Great Northern Railway, 31½ miles north of Dublin. It ceased to be a parliamentary borough in 1885, and a separate county in 1898, but it retains its mayor and corporation, which, however, has now practically the status of an urban district council. Steamers maintain almost daily communication with Liverpool, carrying chiefly agricultural produce of various kinds. In 1899, 454 vessels of 99,441 tons entered and 346 of 105,658 tons cleared. There are valuable salmon fisheries on the Boyne, which in 1899 gave employment to 711 persons. Population (1881), 12,297; (1901), 12,765. The area of the borough was extended in 1896, increasing the population by about 1500.

**Drohobycz,** a town in Galicia, Austria. Population (1890), 17,916 (6200 German, 4500 Ruthenians, the remainder Poles; the Jews number 8700); in 1900, 19,146. The principal industries are the production of salt (from the local brine wells), naphtha, and oil. Also considerable trade in cattle, corn, earthenware, and petroleum.

**Droitwich,** a municipal borough and market-town in the Droitwich parliamentary division (since 1885) of Worcestershire, England, 20½ miles south-west by south of Birmingham by rail. There are three parish churches. Recent erections are a Wesleyan chapel (rebuilt), new hospital, private bath hospital, St Andrew's Baths, and a large Salters' Hall. There are a town-hall and Royal Brine Baths. Owing to the pumping of the brine for the salt works there is a continual subsidence of the ground detrimental to the buildings, and the houses are now mostly built in the suburbs. Area, 1856 acres. Population (1881), 3761; (1901), 4163.

**Drôme,** a department in the south-east of France, traversed by the Alps of Vercors and watered by the Rhône, the Isère, and the Drôme.

Area, 2533 square miles. The population, numbering 314,615 in 1886, decreased to 294,704 in 1901. Births in 1899, 5802, of which 259 were illegitimate; deaths, 6405; marriages, 2126. There were, in 1896, 908 schools with 44,000 pupils; the illiterate form 3 to 4 per cent. of the population. The area under cultivation in 1896 amounted to 1,242,985 acres; 644,968 acres arable, and 358,314 acres forest. The wheat crop in 1899 yielded a value of £1,110,000; mangel-wurzel, £103,000; potatoes, £420,000; grass lands, £190,000; olive, £21,000; mulberry, £61,000. The production of silkworm cocoons is one of the largest among those of the departments of France, amounting in 1899 to 25,320 cwts. avoir. The live-stock in 1899 included 17,290 horses, 13,850 asses, 421,000 sheep, 120,540 pigs, and 96,750 goats. Mining and metallurgy are in a backward state. The textile industry is more advanced. Valence, the capital, has 25,000 inhabitants.

**Droylsden,** a township and parish in the Prestwich parliamentary division of Lancashire, England, formed in 1844, in the civil parish of Manchester, 4 miles east of Manchester by rail. There are an educational institute, and a Moravian theological college. The industries comprise cotton spinning, chemical and dye works, brickmaking, and iron-founding. Area of urban district, 1014 acres. Population (1881), 8687; (1901), 11,087.

**Droysen, Johann Gustav** (1808–1884), German historian, was born 6th July 1808 at Treptow, Pomerania. His father was a pastor who held several cures in Pomerania, and was chaplain to a regiment of cuirassiers, in which capacity he was present at the celebrated siege of Kolberg in 1806–7. The young Droysen, as a child, was also witness of some of the military operations during the War of Liberation, for his father was pastor of Greifenhagen, in the immediate neighbourhood of Stettin, which was held by the French during the greater part of 1813. The impressions of these early years laid the foundation of the ardent attachment to Prussia which distinguished him, as so many other historians of his generation. He was educated at the gymnasium of Stettin and at the University of Berlin; in 1829 he became a master at the Graue Kloster (or Grey Friars), one of the oldest schools in Berlin; besides his work there he gave lectures at the university, from 1833 as privat-docent, and from 1835 as Professor, without a salary. During these years he was occupied with classical antiquity; he published a translation of Æschylus and a paraphrase of Aristophanes, but the work by which he made himself known as an historian was his *Life of Alexander the Great*, published in 1832, a book which still remains probably the best work on the subject. It was in some ways the herald of a new school of German historical thought, for it shows that idealization of power and success which he had learnt from the teaching of Hegel. It was followed by other volumes dealing with the successors of Alexander, published under the title of *The History of Hellenism*. A new and revised edition of the whole work was published in 1885; it has been translated into French, but not into English. In 1840 Droysen was appointed Professor of History at Kiel. He was at once attracted into the political movement for the defence of the rights of the Elbe Duchies, of which Kiel was the centre. Like his predecessor Dahlmann, he placed his historical learning at the service of the Estates, and composed the address of 1844, in which the Estates protested against the claim of the king of Denmark to alter the law of succession in the Duchies. In 1848 he was elected as a member of the Frankfort Parliament, and acted as secretary to the committee for drawing up the Constitution. He was a determined supporter of Prussian ascendancy, and was one of the first members to retire after the king of Prussia refused the crown in 1849. During the next two years he continued to support the cause of the Duchies, and in 1850, with Carl Samwer, he published a history of the dealings of Denmark with Schleswig-Holstein, *Die Herzogthümer Schleswig-Holstein und das Königreich Dänemark seit dem Jahre 1806*, Hamburg, 1850. A translation was published in London in the same

year under the title *The Policy of Denmark towards the Duchies of Schleswig-Holstein.* The work was one of great political importance, and had much to do with the formation of public opinion on the rights of the Duchies in their struggle with Denmark. After 1851 it was impossible for him to remain at Kiel, and he was appointed to a professorship at Jena; in 1859 he was called to Berlin, where he remained till his death in 1884. In his later years he was almost entirely occupied with Prussian history. In 1851 he brought out a life of Count Yorck v. Wartenberg, one of the best biographies in the German language, and then began his great work on the *History of Prussian Policy*, Berlin, 1855–86. Seven volumes were published, the last not till after his death. It forms a complete history of the growth of the Prussian monarchy down to the year 1756. This, like all Droysen's work, shows a strongly marked individuality, and a great power of tracing the manner in which important dynamic forces worked themselves out in history. This quality also gave him great influence as a teacher. Droysen was twice married; his eldest son, Gustav, is the author of several well-known historical works, namely, *Life of Gustavus Adolphus* (Leipzig, 1869–70); *Life of Bernhard of Saxe-Weimar*, London, 1885; a *History of the Thirty Years' War* in Oncken's Universal History; and an admirable *Historical Atlas.* Another son, Hans Droysen, is the author of some works on Greek history and antiquities. (J. W. HE)

**Drummond, Henry** (1851–1897), Scottish evangelical writer and lecturer, was born in Stirling on 17th August 1851. He was educated at Edinburgh University, where he displayed a strong inclination for physical and mathematical science. The religious element was an even more powerful factor in his nature, and disposed him to enter the Free Church of Scotland. While preparing for the ministry, he was for a time carried away by the evangelizing mission of Messrs Moody and Sankey, in which he actively cooperated for two years. In 1875 he became Lecturer on Natural Science in the Free Church College, which enabled him to combine all the pursuits for which he felt a vocation. His studies resulted in a book whose title expressed the mediating position he was called upon to occupy, *Natural Law in the Spiritual World.* As it was about to issue from the press (1883), a sudden invitation from the African Lakes Company drew him away to Central Africa. Upon his return in the following year he found himself famous. Large bodies of serious readers, alike among the religious and the scientific classes, discovered in *Natural Law* the common standing-ground which they needed; and the universality of the demand proved, if nothing more, the seasonableness of its publication. Drummond continued to be actively interested in missionary and other movements among the Free Church students. In 1888 he published *Tropical Africa*, a valuable digest of information. In 1890 he travelled in Australia, and in 1893 delivered the Lowell Lectures at Boston. It had been his intention to reserve them for mature revision, but an attempted piracy compelled him to hasten their publication, and they appeared in 1894 under the title of *The Ascent of Man.* Their object was to vindicate for altruism, or the disinterested care and compassion of animals for each other, an important part in effecting "the survival of the fittest," a thesis previously maintained by Professor Fiske. Drummond's health failed shortly afterwards, and he died on 11th March 1897. His character was full of charm. His writings are too nicely adapted to the needs of his own day to justify the expectation that they will long survive it, but few men have exercised more influence upon certain circles in their own generation. (R. G.)

**Dublin,** a maritime county of Ireland, province of Leinster, bounded on the N. by Meath, on the E. by the Irish Sea, on the W. by Kildare and Meath, and on the S. by Wicklow. The area of the administrative county in 1900 was 226,686 acres, of which 68,913 were tillage, 122,373 pasture, 502 fallow, 3986 plantation, 1194 marsh, 55 turf bog, 13,305 barren mountain, and 16,358 water, roads, fences, &c. The new administrative county under the Local Government (Ireland) Act, 1898, does not include the portion of the township of Bray formerly situated in Dublin. The population in 1881 was 418,910, and in 1891, 419,216, of whom 197,409 were males and 221,807 females, divided as follows among the different religions: Roman Catholics, 322,822; Protestant Episcopalians, 77,896; Presbyterians, 7724; Methodists, 4129; and other denominations, 6645. The increase of population between 1881 and 1891 was ·07. The average number of persons to an acre (including the city of Dublin) was 1·85, being by far the largest number of any county in Ireland. Of the total population, 66,675 persons inhabited the rural districts, being an average of 241 persons to each square mile under crops and pasture. The population in 1901 was 447,266 (Roman Catholics, 348,701; Protestant Episcopalians, 78,921; Presbyterians, 7538; Methodists, 4464; others, 7642), being an increase of 7·3 per cent. The following table gives the number of births, deaths, and marriages in various years:—

| Year. | Births. | Deaths. | Marriages. |
|---|---|---|---|
| 1881 | 12,047 | 10,839 | 2987 |
| 1891 | 11,496 | 10,322 | 2943 |
| 1899 | 12,055 | 11,806 | 3178 |

In 1899 the birth-rate per 1000 was 28·9, and the death-rate 28·3; the rate of illegitimacy was 2·7 per cent. of the total births. The total number of emigrants who left the county between 1st May 1851 and 31st December 1899 was 110,832, of whom 61,751 were males and 49,081 females. The county contains the following townships, which are all practically suburbs of Dublin: Rathmines and Rathgar (27,706), Pembroke (24,269), Blackrock (8401), Kilmainham (6510), Drumcondra, Clonliffe, and Glasnevin (7621), and Clontarf (5104), and the town of Kingstown (17,352), the populations given in each case being those of 1891. In 1901 the population of the urban districts of Rathmines and Rathgar, Pembroke, Blackrock, and Kingstown was respectively 32,472, 25,524, 8719, and 17,356.

*Education.*—The following table gives the degree of education (excluding the city of Dublin) in 1891:—

| | Males. | Females. | Total. | Percentage. | | |
|---|---|---|---|---|---|---|
| | | | | R. C. | Pr.Ep. | Presb. |
| Read and write | 58,710 | 72,458 | 131,168 | 78·1 | 94·7 | 95·1 |
| Read only | 4,653 | 5,853 | 10,506 | 8·7 | 2·1 | 1·9 |
| Illiterate | 8,130 | 7,836 | 15,966 | 13·2 | 3·2 | 3·0 |

The percentage of illiterates among Roman Catholics in 1881 was 17·1. Excluding the city of Dublin, the number of superior schools in 1891 was 80, with 5338 pupils (Roman Catholics 2392 and Protestants 2946), and 284 primary schools with 23,891 pupils (Roman Catholics 19,478 and Protestants 4513). The number of pupils on the rolls of the national schools on 30th September 1899 was 55,405, of whom 46,256 were Roman Catholics and 9149 Protestants.

*Administration.*—The county is divided into two parliamentary divisions, north and south, the number of registered electors in 1900 being respectively 12,429 and 10,762. The ratable value in 1900 (excluding the county borough of Dublin) was £859,044. By the Local Government (Ireland) Act, 1898, the fiscal and administrative duties of the grand jury and (to a less extent) of other bodies were transferred to a county council, urban and rural district councils were established, and under that Act the county now comprises 9 urban and 5 rural sanitary districts. The city of Dublin constitutes a separate county.

*Agriculture.*—The following tables show the acreage under crops, including meadow and clover, and the amount of live-stock in 1881, 1891, 1895, and 1900. The figures for 1900 are for the new administrative county:—

| Year. | Wheat. | Oats. | Barley, Beans, &c. | Potatoes. | Turnips. | Other Green Crops. | Meadow and Clover. | Total. |
|---|---|---|---|---|---|---|---|---|
| 1881 | 5599 | 14,212 | 2282 | 9831 | 2045 | 3846 | 50,909 | 88,724 |
| 1891 | 4023 | 11,915 | 2436 | 8053 | 2315 | 3701 | 41,048 | 73,491 |
| 1895 | 2392 | 12,325 | 2587 | 7459 | 2407 | 3159 | 44,553 | 74,882 |
| 1900 | 3056 | 9,887 | 1995 | 6666 | 2363 | 3705 | 41,241 | 89,113 |

For 1899 the total value of the cereal and other crops was estimated by the Registrar-General at £470,899. The number of acres under pasture in 1881 was 103,698; in 1891, 118,355; and in 1900, 122,373.

| Year. | Horses and Mules. | Asses. | Cattle. | Sheep. | Pigs. | Goats. | Poultry. |
|---|---|---|---|---|---|---|---|
| 1881 | 22,060 | 1881 | 57,683 | 50,440 | 13,460 | 5327 | 236,018 |
| 1891 | 22,502 | 1862 | 68,516 | 78,443 | 12,794 | 5766 | 250,093 |
| 1895 | 24,550 | 1941 | 61,534 | 57,365 | 11,095 | 4718 | 265,801 |
| 1900 | 22,492 | 2055 | 70,355 | 69,578 | 8,983 | 3619 | 249,147 |

The number of milch cows in 1891 was 17,322, and 1900, 17,748. It is estimated that the total value of cattle, sheep, and pigs in 1899 was £1,140,644. In 1900 the number of holdings not exceeding 1 acre was 2997, between 1 and 5, 1651, between 5 and 15, 1628, between 15 and 30, 911, between 30 and 50, 585, between 50 and 100, 628, between 100 and 200, 387, between 200 and 500, 138, and above 500, 13—total 8938. The number of loans issued (the number of loans being the same as the number of tenants) under the Land Purchase Acts, 1885, 1891, and 1896, up to 31st March 1900, was 148, amounting to £170,350. The number of loans sanctioned for agricultural improvements under sect. 31 of the Land Act, 1881, between 1882 and 1900 was 202, and the amount issued was £25,030. The total amount issued on loan for all classes of works under the Land Improvement Acts from the commencement of operations in 1847 to 31st March 1900, was £98,770.

*Fisheries.*—In 1899, 134 vessels, employing 546 hands, were registered in the deep sea and coast fishing district of Kingstown. In the same year 175 persons were employed in the salmon fishery district of Dublin. (W. H. Po.)

**Dublin,** a maritime city, county and parliamentary borough, metropolis of Ireland, on the river Liffey, 292 miles west-north-west of London. The population in 1881 was 249,602; in 1891, 245,001, of whom 117,503 were males and 127,498 females, divided as follows among the different religions: Roman Catholics, 201,418; Protestant Episcopalians, 35,125; Presbyterians, 3492; Methodists, 1708; and other denominations, 3258. The population in 1901 was 289,108, the increase being due to the extension of the municipal area in 1900. Between 1891 and 1901 the population of the chief suburbs also increased, as will be seen from the following figures:—Rathmines and Rathgar (1891), 27,796; (1901), 32,472; Pembroke (1891), 23,992; (1901), 25,524; Blackrock (1891), 8401; (1901), 8719; Kingstown (1891), 17,183; (1901), 17,356. Of recent years blocks of artisans' dwellings have been erected, some from a fund provided by the munificence of Lord Iveagh in 1889. The following table shows the standard of general education attained in 1891:—

| | Males. | Females. | Total. | Percentage. | | | |
|---|---|---|---|---|---|---|---|
| | | | | Roman Cath. | Protes. Epis. | Presby-terians. | Metho-dists. |
| Read and write | 83,294 | 85,897 | 169,191 | 74·6 | 92·2 | 94·5 | 95·3 |
| Read only . . | 6,890 | 10,020 | 16,910 | 8·8 | 3·1 | 2·6 | 2·0 |
| Illiterate . . | 13,520 | 17,996 | 31,516 | 16·6 | 4·7 | 2·9 | 2·7 |

In 1881 the percentage of illiterates among Roman Catholics was 18·1, among Protestant Episcopalians 5·2, among Presbyterians 3·5, and among Methodists 3·5. In 1891 there were 40 superior schools with 4024 pupils (Roman Catholics 2238, and Protestants 1786), and 197 primary schools with 26,513 pupils (Roman Catholics 21,117, and Protestants 5296). The yearly average of births registered in the registration district (population in 1891, 349,594) between 1890 and 1899, both inclusive, was, males 5200, and females 4952, and of deaths registered, males 4711, and females 4859. The number of persons proceeded against in the metropolitan police district in 1899 for indictable offences was 1256, of whom 933 were convicted or committed for trial; for non-indictable offences, 36,195, of whom 27,752 were fined and 2785 otherwise punished. Though the number of public-houses within the same limits fell from 897 in 1896 to 888 in 1899, the charges of drunkenness (including cases where some other offence was charged) rose from 7677 in 1896 to 9277 in 1899.

Something has been done since 1880 to improve the condition of the poorer parts of the city, but only a few important changes have been effected in the outward aspect of the city. The restoration of Christchurch Cathedral was completed in 1878. What was then known as Carlisle Bridge was rebuilt in 1880, and now under its name of O'Connell Bridge forms one of the finest structures of its kind in the United Kingdom. The Royal University, established in 1880, is housed in the permanent building of the International Exhibition of 1865, to which many additions have been made. It possesses a fine hall, much used for concerts. In the same year St Stephen's Green, converted into a public park at the expense of Lord Ardilaun, was opened to the public; a statue of its donor has been erected in it. Statues have also been erected of Father Mathew, the temperance reformer, in Sackville Street, and of Surgeon-Major Parke and Sir R. P. Stewart in Leinster Lawn, Merrion Square. The most noteworthy new building is the museum and library of the Royal Dublin Society, erected at a cost of about £150,000, and opened in 1890. To it were transferred the collection of Irish antiquities belonging to the Royal Irish Academy and the old library from Leinster House. Considerable attention has been paid of late years to providing facilities for the travelling public. A loop line now connects the various railway systems, thus facilitating the transit of passengers and goods between the various parts of Ireland and between England and Ireland. Steam tramways are in operation between Parkgate Street and Lucan and between Terenure and Blessington, and electric trams connect all the important suburban districts with the city.

*Administration.*—Dublin was formerly represented by two members of Parliament, but in 1885 the parliamentary borough, the population of which in 1901 was 286,328, was divided into four divisions, College Green, Harbour, St Stephen's Green, and St Patrick's, each returning one member. The number of registered electors in 1900 was 38,361. Dublin University, with a constituency of over 4000, returns two members. In 1898 Dublin was constituted a county borough, but the position and duties of its corporation were otherwise left practically unaltered. The ratable value in 1900 was £742,413, and the total receipts of the corporation in 1898 were £565,448. A new body was created in 1898 for governing the port and harbour, comprising the Lord Mayor, six members of the corporation, twelve traders' members, and nine shipping members. A scheme is on foot for reviving the shipbuilding industry in Dublin.

*Commerce and Shipping.*—By continual dredging a greater depth of water is now available in the harbour than ever before. The Custom House Docks, which cover an area of about 8 acres, have 16 feet of water and can accommodate 40,000 tons of shipping. A basin constructed by the Port and Docks Board was named the Alexandra Basin by the Prince and Princess of Wales in April 1885. The lighting of the harbour has also been much improved, and a fog siren placed at Poolbeg light-

house. Dublin continues to produce little for exportation except whisky and porter. Since 1895 whisky has been exported in the following quantities:—

| Years. | Butts and Puncheons. | Hogsheads. | Casks. | Quarter Casks. |
|---|---|---|---|---|
| 1895 | 4521 | 15,519 | 2765 | 8989 |
| 1896 | 5192 | 14,696 | 2635 | 9231 |
| 1897 | 4947 | 13,398 | 3509 | 8181 |
| 1898 | 4762 | 15,401 | 2621 | 9156 |
| 1899 | 5092 | 13,955 | 2159 | 8985 |

The number of hogsheads of porter exported in 1895 was 379,131; in 1896, 376,199; in 1897, 377,247; in 1898, 368,628; and in 1899, 409,415. The number of horses exported to Great Britain in 1899 was 13,814; of cattle, 304,187; of sheep and lambs, 406,709; and of pigs, 327,980. The value of British and Irish produce exported direct to foreign countries has considerably declined of late years. In 1893 it was £155,243; in 1896, £68,809; and in 1899, £63,385. The total value of the foreign and colonial imports in 1899, which included 89,157 tons of wheat, 100,475 tons of maize, 739,549 sacks and bags of flour, and 51,653 quarters of barley, was £2,565,817. The total amount of customs duties collected at the port in the same year was £615,566, as compared with £804,214 in 1894 and £817,391 in 1890. In 1899 the harbour receipts derived from tonnage and quay wall dues on shipping amounted to £58,727. The following table shows the number of vessels in the foreign and coasting trades that entered and cleared with cargoes from the port, and the number of vessels registered from 1895 to 1899:—

| Years. | Entered. | | Cleared. | | Registered. | |
|---|---|---|---|---|---|---|
| | Vessels. | Tonnage | Vessels. | Tonnage. | Vessels. | Tonnage. |
| 1895 | 7171 | 1,745,409 | 4484 | 1,170,948 | 329 | 58,657 |
| 1896 | 7047 | 1,769,065 | 4526 | 1,215,806 | 327 | 59,877 |
| 1897 | 7085 | 1,800,564 | 4499 | 1,213,444 | 322 | 63,456 |
| 1898 | 7174 | 1,764,223 | 4612 | 1,226,111 | 318 | 60,916 |
| 1899 | 7247 | 1,804,175 | 4549 | 1,220,700 | 317 | 61,667 |

(W. H. PO.)

**Dubois**, a borough of Clearfield county, Pennsylvania, U.S.A., at the intersection of three railways, the Allegheny Valley, the Buffalo, Rochester, and Pittsburg, and the Pennsylvania. It is in the midst of a coal-mining region, and its industries consist largely in handling coal. Population (1880), 2718; (1890), 6149; (1900), 9375, of whom 1655 were foreign-born.

**Dubois, Clément Francois Théodore** (1837-——), French musical composer and director of the Paris Conservatoire, was born at Rosnay on 24th August 1837. He studied at the Conservatoire under Ambroise Thomas, and won the Grand Prix de Rome in 1861 with a cantata entitled *Atala*. After the customary sojourn in Rome, Dubois returned to Paris and devoted himself to teaching. He was appointed "maître de Chapelle" at the Church of Ste Clotilde, where César Franck was organist, in 1863, and remained at this post for five years, during which time he composed a quantity of sacred music, notably *Les Sept Paroles du Christ* (1867), a work which has become well known in France. In 1868 he became "maître de Chapelle" at the Church of the Madeleine, and nine years later succeeded Camille Saint-Saëns there as organist. He became Professor of Harmony at the Conservatoire in 1871, and was appointed Professor of Composition in succession to Léo Delibes in 1891. At the death of Ambroise Thomas in 1896, he became director of the Conservatoire. Dubois is an extremely prolific composer, and has written in a variety of forms. His sacred works include four masses, a requiem, *Les Sept Paroles du Christ*, a large number of motets and pieces for organ. For the theatre he has composed *La Guzla de l'Emir*, an opéra comique in one act, played at the Théâtre Lyrique de l'Athénée in 1873; *Le Pain Bis*, an opéra comique in one act, given at the Opéra Comique in 1879; *La Farandole*, a ballet in three acts, produced at the Grand Opéra in 1883; *Aben-Hamet*, a four-act opera, heard at the Théâtre Italien in 1884; *Xavière*, a dramatic idyll in three acts, played at the Opéra Comique in 1895. His orchestral works include two concert overtures, the overture to *Frithioff* (1880), several suites, *Marche Héroïque de Jeanne d'Arc* (1888), &c. He is also the author of *Le Paradis Perdu*, an oratorio which gained for him the prize offered by the City of Paris in 1878; *L'Enlèvement de Proserpine* (1879), a *scène lyrique*; *Délivrance* (1887), a cantata; *Hylas* (1890), a *scène lyrique* for soli, chorus, and orchestra. In addition, he has composed much for the piano and voice. If his musical personality is not a very marked one, M. Dubois is nevertheless a musician of lofty aims and undoubted ability.

**Dubois, Paul** (1829-——), French sculptor and painter, was born at Nogent-sur-Seine, 18th July 1829. He studied law to please his family and art to please himself, and finally abandoned the former in favour of the latter, and placed himself under Toussaint. For a short while a student at the École des Beaux Arts, M. Dubois sojourned in Rome, and by the study there of the great masters of sculpture developed his eye and his feeling for form so that he well-nigh equalled the greatest in knowledge and refinement. His first contributions to the Salon (1860) were busts of "The Countess de B." and "A Child." For his first statues, "St John the Baptist" and "Narcissus at the Bath" (1863), Dubois was awarded a medal of the second class. The statue of "The Infant St John," which had been modelled in Florence in 1860, was exhibited in Paris in bronze, and was acquired by the Luxembourg Museum. "A Florentine Singer of the Fifteenth Century," to this day one of the most popular statuettes "published" in Europe, was shown in 1865, and at once attracted great attention. "The Virgin and Child" appeared in the Paris Universal Exhibition in 1867; "The Birth of Eve" was produced in 1873, and was followed by striking busts of Henner, Dr Parrot, Paul Baudry, Dr Pasteur, Gounod, and Bonnat, remarkable alike for life, vivacity, likeness, refinement, and subtle handling. His chief work was "The Tomb of General Lamoricière," a brilliant masterpiece, conceived in the Renaissance spirit, with allegorical figures and groups representing Warlike Courage, Charity, Faith, and Meditation, as well as bas-reliefs and enrichments; the two first-named works were separately exhibited in the Salon of 1877. The medallions represent Wisdom, Hope, Justice, Force, Rhetoric, Prudence, and Religion. The statue of the "Constable Anne de Montmorency" was executed for Chantilly, and that of "Joan of Arc" (1889) for the town of Rheims. The Italian influence which characterizes Dubois's earlier work disappears as his own individuality became clearly asserted. As a painter M. Dubois has restricted himself mainly to portraiture, "My Children" (1876) being probably the most noteworthy. His work in painting is of a high order, admirable alike in colour, drawing, and taste. His drawings and copies after the Old Masters are also of peculiar excellence: they include "The Dead Christ" (after Sebastian del Piombo) and "Adam and Eve" (after Raphael). In 1873 M. Dubois was appointed Keeper of the Luxembourg Museum, which contains the "Infant St John" and several other works from his hand. He succeeded M. Guillaume as Director of the École des Beaux Arts, 1878; and Perraud as member of the Académie des Beaux Arts. Twice at the Salon he

obtained the Medal of Honour (1865 and 1876), and once at the Universal Exhibition (1878). He also won numerous other distinctions, and was appointed Grand Cross of the Legion of Honour. He is a member of several European orders, and in 1895 received the rare distinction of election as Honorary Foreign Academician of the Royal Academy of London.

**Du Bois-Reymond, Emil** (1818–1896), German physiologist, was born in Berlin on 7th November 1818. The Prussian capital was the place both of his birth and of his life's work, and he will always be counted among Germany's great scientific men, yet he was not of German blood. His father belonged to Neufchatel, his mother was of Huguenot descent, and he has spoken of himself as "being of pure Celtic blood." Educated first at the French College in Berlin, then at Neufchatel, whither his father had returned, he entered in 1836 the University of Berlin. He seems to have been uncertain at first as to the bent of his studies, for he sat at the feet of the great ecclesiastical historian Neander, and dallied with geology; but eventually he threw himself into the study of medicine, with such zeal and success as to attract the notice of the great teacher of anatomy and physiology, who was then making Berlin famous as a school for the sciences ancillary to medicine. Johannes Müller may be regarded as the central figure in the history of modern physiology, the physiology of the 19th century. Müller's earlier studies had been distinctly physiological; but his inclination, no less than his position as Professor of Anatomy as well as of Physiology in the University of Berlin, led him later on into wide studies of comparative anatomy, and these, aided by the natural bent of his mind towards problems of general philosophy, gave his views of physiology a breadth and a depth which profoundly influenced the progress of that science in his day. He had, about the time when the young Du Bois-Reymond came to his lectures, published his great *Elements of Physiology*, the dominant note of which may be said to be this:—"Though there appears to be something in the phenomena of living beings which cannot be explained by ordinary mechanical, physical, or chemical laws, much may be so explained, and we may without fear push these explanations as far as we can, so long as we keep to the solid ground of observation and experiment." Müller recognized in the Neufchatel lad a mind fitted to carry on physical researches into the phenomena of living things in a legitimate way. He made him in 1840 his assistant in physiology, and as a starting-point for an inquiry put into his hands the essay which the Italian Matteucci had just published on the electric phenomena of animals. This determined the work of Du Bois-Reymond's life. He chose as the subject of his graduation thesis "Electric Fishes," and so commenced a long series of investigations on animal electricity, by which he enriched science and made for himself a name. The results of these inquiries were made known partly in papers communicated to scientific journals, but also and chiefly in his work *Researches on Animal Electricity*, the first part of which appeared in 1848, the last in 1884.

This great work may be regarded under two aspects. On the one hand it is a record of the exact determination and approximative analysis of the electric phenomena presented by living beings. Viewed from this standpoint, it represents a remarkable advance of our knowledge. Du Bois-Reymond, beginning with the imperfect observations of Matteucci, built up, it may be said, this branch of science. He did so by inventing or improving methods, by devising new instruments of observation or by adapting old ones. The debt which science owes to him on this score is a large one indeed. On the other hand, the volumes in question contain an exposition of a theory. In them Du Bois-Reymond put forward a general conception by the help of which he strove to explain the phenomena which he had observed. He developed the view that a living tissue, such as muscle, might be regarded as composed of a number of electric molecules, of molecules having certain electric properties, and that the electric behaviour of the muscle as a whole under varying circumstances was the outcome of the behaviour of these native electric molecules. It may perhaps be said that this theory has not stood the test of time so well as have Du Bois-Reymond's other more simple deductions from observed facts. It was early attacked by Ludimar Hermann, who maintained that a living untouched tissue, such as a muscle, is not the subject of electric currents so long as it is at rest, is isoelectric in substance, and therefore need not be supposed to be made up of electric molecules, all the electric phenomena which it manifests being due to internal molecular changes associated with activity or injury. Although most subsequent observers have ranged themselves on Hermann's side, it must nevertheless be admitted that Du Bois-Reymond's theory was of great value if only as a working hypothesis, and that as such it has greatly helped in the advance of science.

Du Bois-Reymond's work lay chiefly in the direction of animal electricity, yet he carried his inquiries—such as could be studied by physical methods—into other parts of physiology, more especially into the phenomena of diffusion, though he published little or nothing concerning the results at which he arrived. For many years, too, he exerted a great influence as a teacher. In 1858, upon the death of Johannes Müller, the chair of Anatomy and Physiology, which that great man had held, was divided into a chair of Human and Comparative Anatomy, which was given to Reichert, and a chair of Physiology, which naturally fell to Du Bois-Reymond. This he held to his death, carrying out his researches for many years under the unfavourable circumstances of inadequate accommodation. In 1877, through his influence, the Government provided the University with a proper physiological laboratory. In 1851 he was admitted into the Academy of Sciences of Berlin, and in 1867 became its Perpetual Secretary. For many years he and his friend Helmholtz, who like him had been a pupil of Johannes Müller, were prominent men in the German capital. Acceptable at Court, they both used their position and their influence for the advancement of science. Both, from time to time as opportunity offered, stepped out of the narrow limits of the professorial chair and gave the world their thoughts concerning things on which they could not well dwell in the lecture-room. Du Bois-Reymond, as has been said, had in his earlier years wandered into fields other than those of physiology and medicine, and in his later years he went back to some of these. His occasional discourses, dealing with general topics and various problems of philosophy, show that to the end he possessed the historic spirit which had led him as a lad to listen to Neander; they are marked not only by a charm of style, but by a breadth of view such as might be expected from Johannes Müller's pupil and friend. He died in the city of his birth and adoption on 26th November 1896. (M. F.)

**Dubuque,** capital of Dubuque county, Iowa, U.S.A., and in 1900 the second city in size in the state, in 42° 30′ N. lat. and 90° 40′ W. long., on the western bank of the Mississippi, at an altitude on the river bank of 611 feet. The business part stands in the level bottom land at the foot of the bluffs, while the residence portion climbs the

bluffs, 200 feet or more, and spreads over the high prairie above. The city is divided into five wards, is well paved with brick, macadam, and gravel, and is connected with the other side of the Mississippi by two bridges. It is entered by four great railway systems, the Chicago, Burlington, and Quincy, the Chicago Great Western, the Chicago, Milwaukee, and St Paul, and the Illinois Central. These, with steamboat lines on the river, give the city a large commerce. Its manufactures had, in 1900, an invested capital of $8,117,358, an average number of 5503 wage-earners receiving $2,012,153 in wages, and a product valued at $10,952,204. The chief articles of manufacture were lumber, men's clothing, carriages and waggons, and malt liquors. The assessed valuation of real and personal property was, in 1900, $23,907,583, the net debt $1,617,020, and the rate of taxation $37 per $1000. The lead and zinc mines of the adjacent region, which first induced the settlement of Dubuque, are at present producing but little. Population (1880), 22,254; (1890), 30,311; (1900), 36,297, of whom 6955 were foreign-born and 115 negroes. The death-rate in 1900 was about 12.

**Ducamp, Maxime** (1822–1894), French writer, the son of a successful surgeon, was born in Paris, 8th February 1822. He had a strong taste for travel, which his father's means enabled him to indulge as soon as his college days were over. Between 1844 and 1845, and again between 1849 and 1851, he travelled in Europe and the East, and made excellent use of his experiences in books published after his return. In 1851 he was one of the founders of the *Revue de Paris*, to which he contributed for some six or seven years. In 1853 he was made an officer of the Legion of Honour. In 1870 he was nominated for the Senate, but his election was frustrated by the downfall of the Empire. He was elected a member of the French Academy in 1880, mainly, it is said, on account of his history of the Commune, published under the title of *Les Convulsions de Paris* (1878–80). His writings include *Paris* (6 vols., 1869–75), and the entertaining *Souvenirs Littéraires* (1882). The latter book contains much information respecting Flaubert, of whom Ducamp was an early and intimate friend. He died on 9th February 1894. Ducamp was one of the earliest amateur photographers, and his books of travel were among the first to be illustrated by means of what was then a new art. (R. F. S.)

**Du Chaillu, Paul Belloni** (1835-——), traveller and anthropologist, was born at New Orleans on 31st July 1835, and in his youth accompanied his father, an African trader, to the West Coast of Africa. From 1855 to 1859 he regularly explored the regions bordering upon the equator, and his travels resulted in the rediscovery of the great anthropoid ape called the gorilla, mentioned by Carthaginian navigators, and not entirely unknown to modern science, but practically forgotten. A subsequent expedition, from 1863 to 1865, enabled him to confirm the accounts given by the ancients of a pigmy people inhabiting the African forests. Narratives of both expeditions were published in 1861 and 1867 respectively: the former excited a warm controversy. After writing several books for the young founded upon his African adventures, M. Du Chaillu turned his attention to Northern Europe, and published in 1881 *The Land of the Midnight Sun*, and in 1889 *The Viking Age*.

**Dudley**, a municipal, county (1888) and parliamentary borough, and market-town of England, 8 miles west-north-west of Birmingham, 122 miles north-west of London, in a portion of the county of Worcester enclaved in Staffordshire. It has a joint station of the Great Western and the London and North-Western Railways, and is on the Birmingham and Stourbridge Canals. The parish church of St Thomas has been restored. The grammar school has been reorganized, and a new building with chemical laboratory was opened in 1899. Of recent erection are a technical school, free library and school of art, public baths, and an hospital for infectious diseases. Area of municipal and county borough, 3604 acres. Population (1891), 45,724; (1901), 48,809. Area of parliamentary borough, 7794 acres, of which 3615 are in Worcestershire and 4179 in Staffordshire. Included in the parliamentary borough, and $2\frac{1}{2}$ miles by rail to the south-west of Dudley, stands Brierley Hill, a market-town on the river Stour and the Stourbridge and Birmingham Canals. There is a town-hall and a free library. The industries are similar to those of Dudley—coal and iron mining, iron manufacture, engineering, &c. Area of urban district, 1023 acres; population (1881), 11,603; (1901), 12,005.

**Dudweiler**, a village of Prussia, in the Rhine province, 4 miles by rail north-east from Saarbrucken, with coal mines, ironworks, and production of fire-proof bricks. Population (1885), 11,550; (1900), 16,323.

**Duehring, Eugen Karl** (1833-——), German philosopher and political economist, was born on 12th January 1833 in Berlin. After a legal education he practised at Berlin as a lawyer till 1859. A weakness of the eyes, ending in total blindness, occasioned his taking up the studies with which his name is now connected. In 1864 he became *docent* of the University of Berlin, but, in consequence of a quarrel with the professoriate, was deprived of his licence to teach in 1874. Among his works are *Kapital und Arbeit* (1865); *Der Wert des Lebens* (1865); *Natürliche Dialektik* (1865); *Kritische Geschichte der Philosophie* (1869); *Kritische Geschichte der allgemeinen Principien der Mechanik* (1872)—one of his most successful works; *Kursus der National- und Sozialökonomie* (1873); *Kursus der Philosophie* (1875), entitled in a later edition *Wirklichkeitsphilosophie*; *Logik und Wissenschaftstheorie* (1878); *Der Ersatz der Religion durch Vollkommeneres* (1883). He published his autobiography in 1882 under the title *Sache, Leben und Feinde*; the mention of "Feinde" (enemies) is characteristic. Duehring's philosophy claims to be emphatically the philosophy of reality. He is passionate in his denunciation of everything which, like mysticism, tries to veil reality. He is almost Lucretian in his anger against religion which would withdraw the secret of the universe from our direct gaze. His "substitute for religion" is a doctrine in many points akin to Comte and Feuerbach, the former of whom he resembles in his sentimentalism. Duehring's opinions have changed considerably since his first appearance as a writer. His earlier work, *Natürliche Dialektik*, in form and matter not the worst of his writings, is entirely in the spirit of the Critical Philosophy. Later, in his movement towards Positivism, he strongly repudiates Kant's separation of phenomenon from noumenon, and affirms that our intellect is capable of grasping the whole reality. This adequacy of thought to things is due to the fact that the universe contains but one reality, *i.e.*, matter. It is to matter that we must look for the explanation both of conscious and of physical states. But matter is not, in his system, to be understood with the common meaning, but with a deeper sense as the substratum of all conscious and physical existence; and thus the laws of being are identified with the laws of thought. In this materialistic or quasi-materialistic system Duehring finds room for teleology; the end of Nature, he holds, is the production of a race of conscious beings. From his belief in teleology he is not deterred by the enigma of pain; he is a determined optimist. Pain exists to throw pleasure into conscious relief. In ethics Duehring follows Comte in

making sympathy the foundation of morality. In political philosophy he teaches an ethical communism, and attacks the Darwinian principle of struggle for existence. In economics he is best known by his vindication of the American writer H. C. Carey, who attracts him both by his theory of value, which suggests an ultimate harmony of the interests of capitalist and labourer, and also by his doctrine of "national" political economy, which advocates protection on the ground that the morals and culture of a people are promoted by having its whole system of industry complete within its own borders. His patriotism is fervent, but narrow and exclusive. He idolizes Frederick the Great, and denounces Jews, Greeks, and the cosmopolitan Goethe. Duehring's clear, incisive writing is disfigured by arrogance and ill-temper, failings which may be extenuated on the ground of his physical affliction.

**Duelling.**—While in England the law against duelling has, supported by public opinion, sufficed to condemn the practice and entirely to suppress it, a recrudescence of the custom in foreign countries, and especially in France and Germany, was observable towards the close of the 19th century. Although most penal codes make duelling an offence punishable by pains and penalties of more or less severity, no country has as yet gone so far in this direction as England, where the slayer in a duel is held to be guilty of the capital offence, and the principals and accessories, even where no fatal issue supervenes, of a misdemeanour. This survival of the trial by battle flourishes, as would be expected, in countries in which militarism reigns supreme, and where, as a corollary, the civil tribunals are supposed to furnish but inadequate guarantees for personal liberty in cases where the delicate sense of honour of the military caste is concerned. The antagonism subsisting between the combatant class and the civil population is further intensified in the "nations in arms," and notably in Germany, by the fact that an officer on retiring from the army still preserves in civil life his character as officer, and cannot seek satisfaction for personal affronts before the civil tribunals without forfeiting his position as a "man of honour." The spirit of mediævalism, which still in tradition is strong enough to support an anomaly which sober public opinion has been unable to abolish, is further fostered by the prerogative of pardon, which, except in very flagrant cases, is almost always exercised by the ruling powers in favour of the offenders.

Although French writers on the subject, notably Chateauvillard, claim for the duel a French origin, there appears to be little doubt that it was in Germany that, about the middle of the 16th century, it became established as an institution. No other country has clung to the duel with such tenacity. Academically it has found many staunch advocates among jurists in that country, and recent attempts to deal with the evil have been rather in the nature of palliatives than of measures directed towards eradicating it. Since 1896, when a tragic duel between two officers of the reserve, von Schrader and von Kotze, at Potsdam, resulting in the death of the former, more than ordinarily aroused public opinion, attempts have on various occasions been made to enlist the sympathies of the Reichstag with a view to fresh legislative enactment on the subject—but unsuccessfully. The German Emperor, in a Cabinet Order of 1897, confirmed in 1901, issued directions to the military courts of honour, insisting upon the causes of the alleged affront being in each case properly sifted, the blame brought home to the proper party, the illegality of the duel pointed out to the parties by the president of the court, and every attempt made to effect a reconciliation. It is only fair to say that where these instructions have been disregarded, rigorous punishment has not failed to be meted out to the responsible persons. The German penal code (*Reichsstrafgesetzbuch*, pars. 101–110) only punishes a duel when it is fought with lethal weapons; and much controversy has raged round the question of the *Mensuren* or students' duels (*vide infra*), which, as being conducted with sharpened rapiers, have, despite the precautions taken, in the way of bandaging the vital parts of the body which a cut could reach, to reduce the risk of a fatal issue to a minimum, been declared by the Supreme Court of the Empire to fall under the head of duels, and as such to be punishable. The so-called American duel, where the two parties draw lots, and the loser is under a moral obligation to kill himself within a specified time, is not recognized as a duel (not being a battle) by any foreign code except that of Austria (*Strafgesetzentwurf*, 1889), which makes it a penal offence "where predetermined chance shall determine which of two persons shall kill himself." The French claim for their writer Chateauvillard that he first formulated the rules of affairs of honour, and his treatise is, in effect, the accepted authority in all civilized countries. The recognized weapons are pistol, fleuret, and broadsword; and it seems to be an established rule that a civilian may, though a military man may not, refuse to fight with the sword. In July 1889 M. Freycinet (French Minister for War), in an Order addressed to the Generals commanding Army Corps, after stating that his attention had been drawn to the risk to life resulting from the use of the fleuret in military duels, communicated his decision that in the rare cases where an armed encounter was not perhaps prescribed, but authorized, by the chief of the corps, the combatants should make use, not of the fleuret, but of service swords. The German Emperor William I. also declared in favour of the broadsword; but the pistol is in Germany almost always the weapon selected. In France, unlike Germany, in which latter country military duels largely preponderate, it is parliamentarians and pressmen who mostly seek satisfaction in *affaires d'honneur*, which are often merely nominal; the weapon employed is generally the fleuret.

The Roman Catholic Church does not admit any reason justifying the duel; and it is generally understood that both Roman Catholics and Jews may, without detriment to their social position, refuse one, as being expressly prohibited by the canons of their religion. Moreover, the practice is visited by ecclesiastical censures, by excommunication, denial of the last rites of sacrament and, in the Protestant Church also, of burial by the Church.

The *Mensuren* (German students' duels) above referred to are frequently misunderstood. They bear little resemblance, save in form, to the duel *à outrance*, and should rather be considered in the light of athletic games, in which the overflow of high animal spirits in young Germany finds its outlet. These combats are indulged in principally by picked representatives of the "corps" (recognized clubs), and according to the position and value of the *Schmisse* (cuts which have landed) points are awarded to either side. Formerly these so-called duels could be openly indulged in at most universities without let or hindrance. Gradually, however, the academic authorities took cognizance of the illegality of the practice, and in many cases inflicted punishment for the offence. Nowadays, owing to the decision of the Supreme Court reserving to the common law tribunals the power to deal with such cases, the governing bodies at the universities have only a disciplinary control, which is exercised at the various seats of learning in various degrees: in some the practice is silently tolerated, or at most visited by reprimand; in others, again, by relegation or *carcer*—with the result that the students of one university

frequently visit another, in order to be able to fight out their battles under less rigorous surveillance. (P. A. A.)

**Dufaure, Jules Armand Stanislas** (1798–1881), French statesman, was born at Saujon (Charente-Inférieure) on 4th December 1798. He was called to the Bar at Bordeaux, where he won a great reputation by his oratorical gifts, but soon abandoned law for politics, and in 1834 was elected deputy. Two years later he was made *Conseiller d'État* by Thiers, but did not hold his office long. In 1839 he became Minister of Public Works in the Soult Ministry, and succeeded in freeing railway construction in France from the obstacles which till then had hampered it. Losing office in 1840, Dufaure became one of the leaders of the Opposition, and on the outbreak of the Revolution of 1848 frankly accepted the Republic, of which he remained throughout his life a foremost champion. On 13th October he became Minister of the Interior under Cavaignac, but retired on the latter's defeat in the Presidential election. During the Second Empire, Dufaure abstained from public life, and practised at the Paris bar with such success that he was elected *bâtonnier* in 1862. In 1863 he succeeded to Pasquier's seat in the French Academy. In 1871 he became a member of the Assembly, and it was on his motion that Thiers was elected President of the Republic. Dufaure received the Ministry of Justice, his tenure of which was distinguished by the passage of the jury-law. In 1873 he fell from office with Thiers, but in 1875 resumed his former post under Buffet, whom he succeeded on 9th March 1876 as President of the Council. In the same year he was elected a life senator. On 12th December he was defeated on the question of an amnesty for the Communists, but returned to power on 24th December 1877. Early in 1879 Dufaure took part in compelling the resignation of Marshal MacMahon, but immediately afterwards (1st February), worn out by factious opposition, himself laid down office. He died in Paris on 28th June 1881. (R. G.)

**Dufferin and Ava, Frederick Temple Hamilton-Temple-Blackwood,** 1st Marquis of (1826–1902), British diplomatist, son of the 4th Baron Dufferin, whom he succeeded in 1841, was born 21st June 1826, his mother, Helen Selina, being a granddaughter of Richard Brinsley Sheridan. He was educated at Eton and Oxford, and then devoted himself to his Irish estates at Clandeboye, near Belfast. He assisted in combating the Irish famine of 1846–47, and published an account of his experiences. As an Irish landlord he was generous and sympathetic, and in 1855 already advocated compensation for disturbance and for tenants' improvements; but while advocating reform, he insisted upon qualifying it by considerations of justice to the landowners. He quickly became a *persona grata* in Society and at Court; was a lord-in-waiting in 1849–50 (being created a peer of the United Kingdom in the latter year), and again in 1854–55, and was attached in 1855 to Lord John Russell's special mission to Vienna. In 1856 he made a voyage to Iceland, which he described with much humour and graphic power in his successful book, *Letters from High Latitudes*, a volume which made his reputation as a writer, though his only other purely literary publication was his memorial edition (1894) of his mother's *Poems and Verses.* Lord John Russell showed his recognition of Lord Dufferin's talents as a diplomatist by sending him in 1860 as British special commissioner in the Lebanon (Syria), where the massacres of Christians by the Mussulmans and Druses had precipitated a serious situation, which was complicated by the possibility of a French occupation. He did his work so successfully in carrying a scheme of reform that the trouble was permanently removed, and he was made a K.C.B. In 1862 he married Hariott, daughter of Captain Rowan Hamilton, of Killyleagh Castle, Down. In 1863 he was made a K.P.; and after holding the under-secretaryships for India (1864) and of war (1866), and the office of Chancellor of the Duchy of Lancaster (1868–1872), he was in 1872 appointed Governor-General of Canada. In 1871 he had been created Earl of Dufferin. In Canada his tact and personal charm were invaluable. He had already become known as a powerful and graceful speaker, and this quality was brilliantly displayed in dealing with the different Canadian nationalities, while his strictly constitutional methods enabled him to settle satisfactorily many of the problems of the new Federation. On his return he became successively ambassador at St Petersburg (1879) and at Constantinople (1881). From October 1882 to April 1883 he was employed as special British commissioner in Egypt, to clear matters up after Arabi's rebellion; but his Report, though its ability as a State paper was unimpeachable, hardly grasped the real problems of the subsequent reconstruction. In 1884 he was appointed Viceroy of India, and spent there four busy years, largely employed in restoring the equilibrium which had been upset by Lord Ripon's zeal for reform. The chief event of his administration was the annexation of Burma, which procured him the title of Marquis of Dufferin and Ava (1888); but Lady Dufferin's work on behalf of the better medical treatment of native women must also be mentioned. In 1888 he was sent as ambassador to Rome, and in 1891 to Paris, where he remained till 1896. He then retired from the public service to his Irish home. Lord Dufferin was one of the most admired men of his time. A man of well-nigh universal accomplishments, his special gift was a genius for diplomacy, his courteous and winning manner and great felicity in verbal expression being exceptionally marked. His last years were shadowed by the death of his eldest son, Lord Ava, at Ladysmith in 1899, and by financial troubles. He had become chairman of the "London and Globe Finance Corporation," which was entirely in the hands of the managing director, Mr Whitaker Wright; and when, after several warnings, the methods employed led to financial collapse, it was a matter of deep regret that Lord Dufferin should have been connected with such a business. He died on 12th February 1902, while the affairs of the company were still under investigation. (H. CH)

**Duffy, Sir Charles Gavan** (1816–——), Irish and colonial politician, was born in Monaghan, Ireland, on 12th April 1816. At an early age he became connected with the press, and was one of the founders of the *Dublin Nation* in 1842. The new journal was remarkable for its talent, for its seditious tendencies, and for the fire and spirit of its political poetry. In 1844 Duffy was included in the same indictment with O'Connell, and shared his conviction in Dublin and his acquittal by the House of Lords upon a point of law. His ideas, nevertheless, were too revolutionary for O'Connell; a schism took place in 1846, and Duffy united himself to the "Young Ireland" party. He was tried for treason-felony in 1848, but the jury were unable to agree. Duffy continued to agitate in the press and in Parliament, to which he was elected in 1852, but his failure to bring about an alliance between Catholics and Protestants upon the land question determined him in 1856 to emigrate to Victoria. There he became in 1857 Minister of Public Works, and after an active political career, in the course of which he was Prime Minister from 1871 to 1873, when he was knighted, he was elected Speaker of the House of Assembly in 1877, being made K.C.M.G. in the same year. In 1880 he resigned and returned to Europe, residing mostly in the south of France. He has published *The Ballad Poetry of Ireland* (1845),

several works on Irish history, *Conversations with Carlyle*, (1892), *Memoirs* (1898), &c. In 1891 he became first President of the Irish Literary Society. He was married three times, his third wife dying in 1889.

**Duisburg,** a town of Prussia, 15 miles by rail north from Dusseldorf, on the Ruhr-Rhine Canal and between these two rivers. The concert hall, law courts, Mercator fountain (1878), and war memorial are new. There are important iron industries, chemical works, saw-milling, shipbuilding, tobacco, cotton, sugar, soap, and other manufactures. There is also (in conjunction with Hochfeld) an extensive trade in coal. The harbour was, in 1898, entered and cleared by an aggregate of 2,745,400 tons. Population, (1885), 47,519; (1900), 92,729.

**Dulcigno** (Servian, *Ulcinj;* Turkish, *Olgun*), an ancient town formerly belonging to Turkish Albania, but since 1880 Montenegrin. The old walled quarter, with the strong castle, occupies a bold promontory on the Adriatic, 18 miles west-south-west of Scutari; the new town occupies a small narrow valley, and the little harbour is stopped with sand. There are about 5000 inhabitants. Dulcigno was the scene of a naval demonstration made by the British, Russian, French, and Italian fleets in August 1880, by which Turkey was compelled to hand the place over to Montenegro according to the Berlin Treaty.

**Dülken,** a town of Prussia, in the Rhine province, 11 miles by rail west-south-west from Crefeld, with manufactures of linen, cotton, silk, and velvet, &c., ironworks and foundries. It has a (Roman Catholic) Gothic parish church. Population (1900), 9517.

**Duluth,** capital of St Louis county, Minnesota, U.S.A., the third city in the state in population, in 46° 47′ N. lat. and 92° 06′ W. long., on the north shore of Lake Superior. The city is situated mainly on the slope of steep bluffs, which rise 600 feet above the lake level. It is regular in plan, one set of streets running directly up the bluffs, the others along their face, parallel with the lake shore; and it is well paved and sewered. A gravel spit, known as Minnesota Point, stretches nearly across Lake Superior, forming behind it a fine harbour, with a narrow entrance. Duluth is the terminus of no less than nine railways, making it, with its large lake commerce, a commercial city of the first magnitude. It handles large quantities of wheat from Red River Valley and Manitoba, estimated at 90,000,000 bushels annually, great amounts of lumber from the adjacent pine forests, and of iron ore from the Vermilion and Mesabi Ranges to the north. About 2000 vessels enter and clear annually. In 1890, its manufactures had an invested capital of $5,332,447, employed 3752 hands, and had a product valued at $8,811,723. The assessed valuation of real and personal property in 1900, on a basis of about one-half of the full value, was $24,600,333; the net debt of the city was $5,876,732; and the rate of taxation was $30 per $1000. Population (1880), 838; (1890), 33,115; (1900), 52,969, of whom 20,983 were foreign-born and 357 negroes. The death-rate in 1900 was 13·2. The village of West Duluth was included in the corporate limits in 1894.

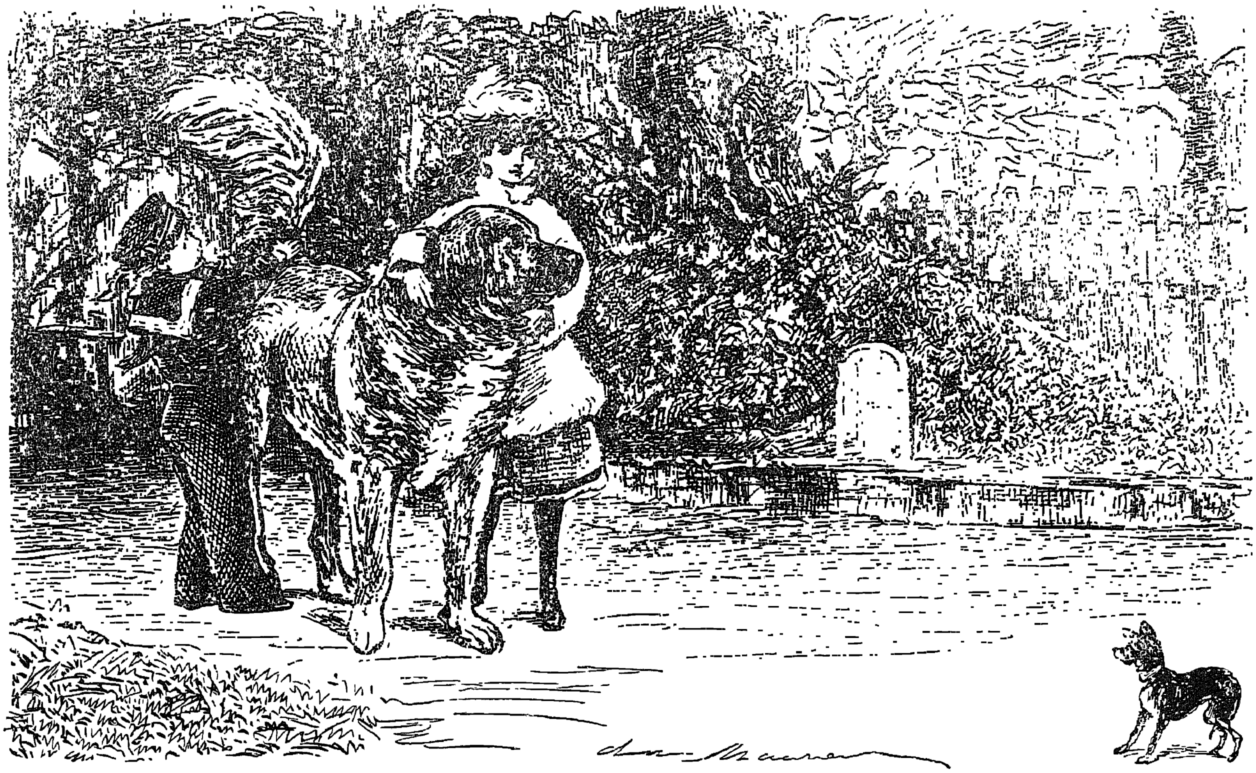
**Dulwich,** a parish of the county of London, in the metropolitan borough of Camberwell, Surrey, five miles from London Bridge, with three railway stations. The upper school, or Dulwich College, maintains its position in the front rank of English public schools. The lower, or Alleyne's school, is situated about a mile from the college, and in close proximity to it are the James Allen's school for girls and the Dulwich Presbyterian Church. There is a high school for girls within half a mile of West Dulwich station. Population (1881), 5590; (1901), 10,246.

**Dumas, Alexandre** (*fils*) (1824–1895), French dramatist and novelist, was born in Paris on the 28th July 1824. His parentage was irregular, and his father at that date still a humble clerk and not much more than a boy. "Happily," writes the son, "my mother was a good woman, and worked hard to bring me up"; while of his father he says, "by a most lucky chance he happened to be well natured," and "as soon as his first successes as a dramatist" enabled him to do so, "recognized me and gave me his name." Nevertheless the lad's earlier school-life was made bitter by his illegitimacy. The cruel taunts and malevolence of his companions rankled through life (see preface to *La Femme de Claude* and *L'Affaire Clémenceau*), and left indelible marks on his character and thoughts. Nor was his paternity, however distinguished, without peril. Alexandre the younger and elder saw life together very thoroughly, and Paris can have had few mysteries for them. Suddenly the son, who had been led to regard his prodigal father's resources as inexhaustible, was rudely undeceived. Coffers were empty, and he had accumulated debts to the amount of two thousand pounds. Thereupon he pulled himself together. To a son of Dumas the use of the pen came naturally. Like most clever young writers—and report speaks of him as specially brilliant at that time—he opened with a book of verse, *Péchés de Jeunesse* (1847). It was succeeded in 1848 by a novel, *La Dame aux Camélias*, a sort of reflection of the world in which he had been living. The book had considerable success, and was followed, in fairly quick succession, by *Le Roman d'une Femme* (1848) and *Diane de Lys* (1851). All this, however, did not deliver him from the load of debt, which, as he tells us, remained odious. In 1849 he had dramatized *La Dame aux Camélias*, but for various reasons, the rigour of the censorship being the most important, it was not till the 2nd February 1852, and then only by the intervention of Napoleon's all-powerful minister, Morny, that the play could be produced, at the Vaudeville. It succeeded then, and has held the stage ever since, less perhaps from inherent superiority to other plays which have foundered, than to the great opportunities it affords to any actress of genius. Thenceforward Dumas's career was that of a brilliant and prosperous dramatist. *Diane de Lys* (1853), *Le Demi-Monde* (1855), *La question d'argent* (1857), *Le fils naturel* (1858), *Le Père prodigue* (1859), followed rapidly. Debts became a thing of the past, and Dumas a wealthy man. The didactic habit was always strong upon him. "Alexandre loves preaching overmuch," wrote his father; and in most of his plays he assumes the attitude of a rigid and uncompromising moralist commissioned to impart to a heedless world lessons of deep import. The lessons themselves are mostly concerned with the "eternal feminine," by which Dumas was haunted, and differ in ethical value. Thus in *Les Idées de Madame Aubray* he inculcates the duty of the seducer to marry the woman he has seduced; but in *La Femme de Claude* he argues the right of the husband to take the law into his own hand and kill the wife who is unfaithful and worthless,—a thesis again defended in his novel, *L'Affaire Clémenceau*, and in his pamphlet, *L'Homme-femme;* while in *Diane de Lys* he had taught that the betrayed husband was entitled to kill—not in a duel, but summarily—the man who had taken his honour; and in *L'Etrangère* the bad husband is the victim. Nor did he preach only in his plays. He preached in voluminous introductions, and pamphlets not a few. And when, in 1870 and 1872, France was going through bitter hours of humiliation, he called her to repentance and amendment in a *Nouvelle Lettre de Junius* and two *Lettres sur les choses du jour*. As a moralist he took himself very seriously indeed. As a dramatist,

didacticism apart, he had great gifts. He knew his business thoroughly, possessed the art of situation, interest, crisis—could create characters that were real and alive. His dialogue also is admirable, the repartee rapier-like, the wit most keen. He was singularly happy, too, in his dramatic interpreters. The cast of *L'Etrangère*, for instance, comprised Sarah Bernhardt, Croizette, Madeleine Brohan, in the female characters; and Coquelin, Got, Mounet-Sully, and Fébvre in the male characters; and Desclée, whom he discovered, gave her genius to the creation of the parts of the heroine in *Une Visite de Noces*, the *Princesse Georges*, and *La Femme de Claude*. His wit has been mentioned. He possessed it in abundance, of a singularly trenchant kind. It shows itself less in his novels, which, however, do not contain his best work; but in his introductions, whether to his own books or those of his friends, and what may be called his "occasional" writings, there is an admirable brightness. At work of this kind he showed the highest literary skill. His style is that of the best French traditions. Towards his father Dumas acted a kind of brother's part, and while keeping strangely free from his literary influence, both loved and admired him. The father never belonged to the French Academy. The son was elected into that august assembly on the 30th January 1874. He died on the 27th November 1895. (F. T. M.)

**Dumas, Jean Baptiste André** (1800–1884), French chemist, was born at Alais (Gard) on 14th July 1800. Disappointed in his early hope of entering the navy, he became apprentice to an apothecary in his native town; but seeing little prospect of advancement in that calling, he soon moved to Geneva (in 1816). There he attended the lectures of such men as Pictet in physics, De la Rive in chemistry, and De Candolle in botany, and before he had reached his majority he was engaged with Prévost in original work on problems of physiological chemistry, and even of embryology. In 1823, acting on the advice of Humboldt, he left Geneva for Paris, which he made his home for the rest of his life. There he gained the acquaintance of many of the foremost scientific men of the day, and quickly made a name for himself both as a teacher and an investigator, attaining within ten years the honour of membership of the Academy of Sciences. When approaching his fiftieth year he entered political life, and became a member of the National Legislative Assembly. He acted as Minister of Agriculture and Commerce for a few months in 1850–51, and subsequently became a Senator, President of the Municipal Council of Paris, and Master of the French Mint; but his official career came to a sudden end with the fall of the Second Empire. He died at Cannes on 11th April 1884. Dumas is one of the most prominent figures in the chemical history of the middle part of the 19th century. He was one of the first to criticize the electro-chemical doctrines of Berzelius, which at the time his work began were widely accepted as the true theory of the constitution of compound bodies, and opposed a unitary view to the dualistic conception of the Swedish chemist. In a paper on the atomic theory, published so early as 1826, he anticipated to a remarkable extent some ideas which are frequently supposed to belong to a later period; and the continuation of these studies led him to the ideas about substitution ("metalepsy") which were developed about 1839 into the theory ("Older Type Theory") that in organic chemistry there are certain types which remain unchanged even when their hydrogen is replaced by an equivalent of a haloid element. Many of his well-known researches were carried out in support of these views, one of the most important being that on the action of chlorine on acetic acid to form trichloracetic acid —a derivative of essentially the same character as the acetic acid itself. In the 1826 paper he described his famous method for ascertaining vapour densities, and the redeterminations which he undertook by its aid of the atomic weights of carbon and oxygen proved the forerunners of a long series which included some thirty of the elements, the results being mostly published in 1858–60. He also devised a method of great value in the quantitative analysis of organic substances for the estimation of nitrogen, while the classification of organic compounds into homologous series was advanced as one consequence of his researches into the acids generated by the oxidation of the alcohols. Dumas was a prolific writer, and his numerous books, essays, memorial addresses, &c., show him to have been gifted with a clear and graceful style. His earliest large work was a treatise on applied chemistry in eight volumes, the first of which was published in 1828 and the last twenty years afterwards. In the *Essai de Statique Chimique des Êtres Organisés*, written jointly with Boussingault (1841), he treated the chemistry of life, both plant and animal; this book brought him into conflict with Liebig, who conceived that some of his prior work had been appropriated without due acknowledgment. In 1824, in conjunction with his friends Audouin and Adolphe Brongniart, he founded the *Annales des Sciences Naturelles*, and from 1840 he was one of the editors of the *Annales de Chimie et de Physique*. As a teacher Dumas was much sought after for his lectures at the Sorbonne and other institutions both on pure and applied science; and he was one of the first men in France to realize the importance of experimental laboratory teaching. (H. M. R.)

**Du Maurier, George Louis Palmella Busson** (1834–1896), British artist and writer, was born in Paris. His father, a naturalized British subject, was the son of *émigrés* who had left France during the Reign of Terror and settled in London. In *Peter Ibbetson*, the first of the three books which won George du Maurier late in life a reputation as novelist almost as great as he had enjoyed as artist and humorist for more than a generation, the author tells in the form of fiction the story of his singularly happy childhood. He was brought to London, indeed, when three or four years old, and spent in Devonshire Terrace and elsewhere two colourless years; but vague memories of this period were suddenly exchanged one beautiful day in June—"the first day of his conscious existence"—for the charming realities of a French garden and "an old yellow house with green shutters and mansard roofs of slate." Here, at Passy, with his "gay and jovial father" and his young English mother, the boy spent "seven years of sweet priceless home-life—seven times four changing seasons of simple genial præ-Imperial Frenchness." The second chapter of Du Maurier's life had for scene a Paris school, very much in the style of that "Institution F. Brossard" which he describes, at once so vividly and so sympathetically, in *The Martian*; and like "Barty Josselin's" schoolfellow and biographer, he left it (in 1851) to study chemistry at University College, London, actually setting up as an analytical chemist afterwards in Bucklersbury. But this was clearly not to be his *métier*, and the year 1856 found him once more in Paris, in the Quartier Latin this time, in the core of that art-world of which in *Trilby*, forty years later, he was to produce with pen and pencil so idealistic and fascinating a picture. Then, like "Barty Josselin" himself, he spent some years in Belgium and the Netherlands, experiencing at Antwerp in 1857, when he was working in the studio of Van Lerius, the one great misfortune of his life—the gradual loss of sight in his left eye, accompanied by alarming symptoms in his right. It was a period of



**CONFUSION OF CAUSE AND EFFECT.**

*Maggie.* "Oh, Tommy! ! look at that *sweet* little Thing ! ! ! I'm afraid it's afraid of *Chimborazo!* Just wag *Chimborazo's* Tail, to put him in a good Temper, there's a good Boy!"

[*By George du Maurier.*]

**FOND AND FOOLISH.**

*Edwin* (*suddenly, after a long pause*) "Darling!" *Angelina.* "Yes, Darling?"
*Edwin.* "Nothing, Darling. Only *DARLING*, Darling!" [*Bilious Old Gentleman feels quite sick.*

[*March* 17, 1883.—*Vol.* 94, *p.* 126.]

ILLUSTRATIONS BY GEORGE DU MAURIER.

(*By permission of the Proprietors of "Punch."*)

tragic anxiety, for it seemed possible that the right eye might also become affected; but this did not happen, and the dismal cloud was soon to show its silver lining, for, about Christmas time 1858, there came to the forlorn invalid a copy of *Punch's Almanac*, and with it the dawn of a new era in his career.

There can be little doubt that the study of this *Almanac*, and especially of Leech's drawings in it, fired him with the ambition of making his name as a graphic humorist; and it was not long after his return to London in 1860 that he sent in his first contribution (very much in Leech's manner) to *Punch*. Mark Lemon, then editor, appreciated his talent, and on Leech's death in 1865 appointed him his successor, counselling him with wise discrimination not to try to be "too funny," but "to undertake the light and graceful business" and be the "romantic tenor" in Mr Punch's little company, while Keene, as Du Maurier puts it, "with his magnificent highly trained basso, sang the comic songs." These respective *rôles* the two artists continued to play until the end, seldom trespassing on each other's province; the "comic songs" finding their inspiration principally in the life of the homely middle and lower middle classes, while the "light and graceful business" enacted itself almost exclusively in "good Society." To a great extent, also, Du Maurier had to leave outdoor life to Keene, his weak sight making it difficult for him to study and sketch in the open air and sunshine, thus cutting him off, as he records regretfully, from "so much that is so popular, delightful, and exhilarating in English country life"—hunting and shooting and fishing and the like. He contrived, however, to give due attention to milder forms of outdoor recreation, and turned to good account his familiarity with Hampstead Heath and Rotten Row, and his holidays with his family at Whitby and Scarborough, Boulogne and Dieppe.

Of Du Maurier's life during the thirty-six years of his connexion with *Punch* there is not, apart from his work as an artist, much to record. In the early 'sixties he lived at 85 Newman Street in lodgings, which he shared with his friend Lionel Henley, afterwards R.B.A., working hard at his *Punch* sketches and his more serious contributions to *Once a Week* and the *Cornhill Magazine*. After his marriage with Miss Emma Wightwick in 1862 he took a spacious and pleasant house near Hampstead Heath, in surroundings made familiar in his drawings. Shortly before he died he moved to a house in Oxford Square. About 1866 he struck out a new line in his admirable illustrations to Jerrold's *Story of a Feather*. In 1869 he realized a long-cherished aspiration, the illustrating of Thackeray's *Esmond*, and in 1879 he drew twelve additional vignettes for it, in the same year providing several illustrations for the *Ballads*. From time to time he sent pretty and graceful pictures to the exhibitions of the Royal Society of Painters in Water-Colour, to which he was elected in 1881. In 1885 the first exhibition of his works at the Fine Art Society took place. Thus occupied in the practice of his art, spending his leisure in social intercourse with his many friends and at home with his growing family, hearing all the new singers and musicians, seeing all the new plays, he lived the happiest of lives. He died somewhat suddenly on 8th October 1896, and was buried in the Hampstead Cemetery.

It is impossible, in considering Du Maurier's work, to avoid comparing it with that of Leech and Keene, the more so that in his little book on *Social Pictorial Satire* he himself has set forth or suggested the points both of resemblance and of difference. Like Keene, though Keene's marvellous technique was his despair, Du Maurier was a much more finished draughtsman than John Leech, but in other respects he had less in common with the younger than with the older humorist. He shows himself, in the best sense, a man of feeling in all his work. He is clearly himself in love with "his pretty woman," as he calls her—every pen-stroke in his presentment of her is a caress. How affectionate, too, are his renderings of his fond young mothers and their big, handsome, simple-minded husbands; his comely children and neat nurserymaids; even his dogs—his elongated dachshunds and magnificent St Bernards! And how he scorns the snobs and philistines—Sir Gorgius Midas and Sir Pompey Bedell, Grigsby and Cadby, Soapley and Toadson! How merciless is his ridicule of the æsthetes of the 'eighties—Maudle and Postlethwaite and Mrs Cimabue Brown! Even to Mrs Ponsonby de Tomkyns, his most conspicuous creation, his satire is scarcely tempered, despite her prettiness. He shows up unsparingly all her unscrupulous little ways, all her cynical, cunning little wiles. Like Leech, he revelled in the lighter aspects of life—the humours of the nursery, the drawing-room, the club, the gaieties of the country house and the seaside—without being blind to the tragic and dramatic. Just as Leech could rise to the height of the famous cartoon "General Février turned Traitor," so it was Du Maurier who inspired Tenniel in that impressive drawing on the eve of the Franco-Prussian War, in which the shade of the great Napoleon is seen warning back the infatuated Emperor from his ill-omened enterprise. In his tender drawings in *Once a Week*, also, and in his occasional excursions into the grotesque in *Punch*, such as his picture of "Old Nickotin stealing away the brains of his devotees," he has given ample proof of his faculty for moving and impressive art. The technique of Du Maurier's work in the 'eighties and the 'nineties, though to the average man it seems a marvel of finish and dexterity, is considered by artists a falling off from what was displayed in some of his earlier *Punch* drawings, and especially in his contributions to the *Cornhill Magazine* and *Once a Week*. His later work is undoubtedly more mannered, more "finicking," less simple, less broadly effective. But it is to his fellow-craftsmen only and to experts that this is noticeable.

A quaint tribute has been paid to the literary talent shown in Du Maurier's inscriptions to his drawings, by Mr F. Anstey, his colleague on the staff of *Punch*. "In these lines of letterpress," says Mr Anstey, "he has brought the art of précis-writing to perfection." They are indeed singularly concise and to the point. It is the more curious, therefore, to note that in his novels, and even in his critical essays, Du Maurier reveals very different qualities: the précis-writer has become an *improvisatore*, pouring out his stories and ideas in full flood, his style changing with every mood—by turn humorous, eloquent, tender, gay, sometimes merely "skittish," sometimes quite solemn, but never for long; sometimes, again, breaking into graceful and haunting verse. He writes with apparent artlessness; but, in his novels at least, on closer examination, it is found that he has in fact exerted all his ingenuity to give them—what such flagrantly untrue tales most require—verisimilitude. It is hard to say which of the three stories is the more impossible: that of Trilby, the tone-deaf artist's model who becomes a *prima donna*, that of Barty Josselin and his guardian angel from Mars, or that of the dream-existence of Peter Ibbetson and the Duchess of Towers. They are all equally preposterous, and yet plausible. The drawings are cunningly made to serve the purpose of evidence, circumstantial and direct. These books cannot be criticized by the ordinary canons of the art of fiction. They are a *genre* by themselves, a blend of unfettered day-dream and rose-coloured reminiscence.

For the dramatic version of *Trilby* by Mr Paul Potter Du Maurier would accept no credit. The play was pro-

duced in 1895 by Mr Beerbohm Tree, at the Haymarket, with immense popular success.

Some striking examples of Du Maurier's work for *Once a Week* and the *Cornhill Magazine* are included in Gleeson White's *English Illustrators of the Sixties*. The following is a list of the chief works which he illustrated: Foxe's *Book of Martyrs*, 1865; Mrs Gaskell's *Wives and Daughters*, 1866; Jerrold's *Story of a Feather*, 1867; Owen Meredith's *Lucile*, 1868; *The Book of Drawing-room Plays*, by H. Dalton, 1868; *Sooner or Later*, by C. A. G. Brooke, 1868; Thackeray's *Esmond*, 1869 and 1879, and *Ballads*, 1879; *Misunderstood*, by Florence Montgomery, 1874; *Round about the Islands*, by C. W. Scott, 1874; *Hurlock Chase*, by G. E. Sargent, 1876; *Songs of many Seasons*, by J. Browne (in collaboration), 1876; *Pegasus Re-saddled*, by H. C. Pennell, 1877; *Ingoldsby Legends* (in collaboration), by R. Barham, 1877; *Prudence*, by L. C. Lillie, 1882; *As in a Looking-glass*, by F. C. Phillips, 1889; *Luke Ashleigh*, by A. Elwes, 1891; and his own three novels, which appeared serially in *Harper's Magazine*: *Peter Ibbetson*, 1892; *Trilby*, 1894; *The Martian*, 1897, and published after his death. In 1897 also there was published, under the title *English Society*, with an introduction by W. D. Howells, a collection of full-page drawings which he had contributed regularly to *Harper's Magazine*.

Some of his *Punch* drawings have been reproduced also in *The Collections of Mr Punch*, 1880; *Society Pictures from Punch*, 1890; *A Legend of Camelot*, 1890. To his *Social Pictorial Satire* (1890) reference has been made. He contributed two essays upon book illustration to the *Magazine of Art*, 1890. See also the *Magazine of Art* for 1892, for an article upon his work by W. Delaplaine Scull, with illustrations. Other volumes containing information about his life and work are: *The History of Punch*, by M. H. Spielmann; *In Bohemia with Du Maurier*, by Felix Moscheles; Henry James's "Du Maurier and London Society," *Century Magazine*, 1883; and "Du Maurier," *Harper's Magazine*, September 1897, June 1899. See also Ruskin's *Art of England*, Lecture 5, Pennell's *Pen-Drawing and Pen-Draughtsmen*, and Muther's *Modern Painting*, vol. ii. (F. W. W.)

**Dumbarton,** a seaport, royal and parliamentary burgh (Kilmarnock group), and the county town of Dumbartonshire, on the river Leven near its confluence with the Clyde, 16 miles west by north of Glasgow by rail. A large park, Levengrove, was presented in 1885, and there is a public common and recreation ground. The burgh hall and academy were restored after a fire in 1883. There are two cottage hospitals and a philosophical and literary institute, whilst recent erections are a Congregational church, a Denny Memorial Institute, new county buildings, new municipal buildings, and a combination hospital for infectious diseases. There are two large shipbuilding yards, and numerous industries connected with shipbuilding. The output was 37,734 tons in 1889, and 52,623 tons in 1899; and in the latter year a marine engineering work turned out 16 sets of marine engines, aggregating 35,700 i.h.p. Only a few married artillerymen now occupy the ancient castle. There is an academy under the School Board. Population of parliamentary burgh (1881), 13,782; (1901), 19,864.

**Dumbartonshire,** a western county of Scotland, bounded S. by the Clyde river and firth, E. by Stirlingshire and Lanarkshire, N. by Perthshire, and W. by Loch Long and Argyllshire.

*Area and Population.*—The Stirling part of the parish of New Kilpatrick, including the town of Milngavie, was transferred to Dumbartonshire in 1891. According to the latest official estimate, the area of the county (foreshore excluded) is 170,762 acres, or 267 square miles. The population was in 1881, 75,333; in 1891, 94,495; in 1891, on the above area, 98,014, of whom 46,683 were males and 49,331 females; in 1901, 113,870. On the old area, taking land only (154,542 acres, or 241·5 square miles), the number of persons to the square mile in 1891 was 383, and the number of acres to the person 1·6. In the registration county the population increased between 1881 and 1891 by 25·4 per cent. Between 1881 and 1891 the excess of births over deaths was 13,252, and the increase of the resident population 19,832. The following table gives particulars of births, deaths, and marriages in 1880, 1890, and 1899:—

| Year. | Deaths. | Marriages. | Births. | Percentage of Illegitimate. |
|---|---|---|---|---|
| 1880 | 1500 | 475 | 2513 | 5.0 |
| 1890 | 1883 | 583 | 3065 | 4·50 |
| 1899 | 1872 | 676 | 3511 | 3·4 |

The birth-rate is above, the death-rate and marriage-rate are both below, the rates for Scotland. The following table gives the birth-rate, death-rate, and marriage-rate per thousand of the population for a series of years:—

| | 1880. | 1881–90. | 1890. | 1891–98. | 1899. |
|---|---|---|---|---|---|
| Birth-rate . . | 32·73 | 33·02 | 31·79 | 30·93 | 29·84 |
| Death-rate . . | 19·54 | 17·98 | 19·53 | 17·29 | 15·90 |
| Marriage-rate . | 6·19 | 5·91 | 6·04 | 5·46 | 5·74 |

At the census of 1891 there were 3618 persons in Dumbartonshire who spoke Gaelic, and of these 37 spoke Gaelic only; and there were 74 foreigners. Valuation in 1889–90, £459,141; in 1899–1900, £685,389.

*Administration.*—The county returns a member to Parliament. Dumbarton (19,864), the county town, is the only royal burgh, and belongs to the Kilmarnock group of parliamentary burghs. The county contains among its police burghs Helensburgh (8554), Kirkintilloch (10,502), and Clydebank (18,654), and considerable manufacturing towns are Alexandria (8392) and Renton (5227). There are 12 civil parishes, most of which belong to the Dumbarton combination, with a poorhouse at the county town. The number of paupers and dependants in September 1899 was 2155. Dumbarton forms a sheriffdom with Stirling and Clackmannan, and there is a resident sheriff-substitute at Dumbarton, who sits also at Kirkintilloch.

*Education.*—Fourteen school boards manage 47 schools, which had an average attendance of 16,100 in 1899–1900; while 9 voluntary schools, of which 7 are Roman Catholic and 1 Episcopal, had 2956. The whole of the county "residue" grant and a trifling proportion of that accruing to the burghs is spent in subsidizing science, art, and technical classes (including building and mechanical construction), in supporting agricultural lectures, and in paying the fees and travelling expenses of county students at the Glasgow Technical College.

*Agriculture.*—The percentage of cultivated area in 1898 was 30·2. In 1895 there were 8772 acres under wood. Of the 667 holdings in 1895, the date of the latest return, the average size was 76 acres. The percentage under 5 acres was 15·89, between 5 and 50 acres 35·08, and over 50 acres 49·03. The number of farms between 50 and 100 acres was 117; between 100 and 300, 198; and there were only 12 over 300. The proximity of the county to Glasgow encourages high farming. Dairying is carried on on a considerable scale. Highland cattle are bred on the upland farms. The following table gives the principal acreages at intervals of five years from 1880:—

| Year. | Area under Crops. | Corn Crops. | Green Crops. | Clover. | Permanent Pasture. | Fallow. |
|---|---|---|---|---|---|---|
| 1880 | 46,432 | 10,037 | 5000 | 13,010 | 18,269 | 98 |
| 1885 | 47,305 | 9,313 | 4249 | 15,482 | 18,113 | 148 |
| 1890 | 48,367 | 8,226 | 3994 | 18,341 | 17,632 | 114 |
| 1895 | 50,813 | 8,221 | 4050 | 14,822 | 23,522 | 127 |
| 1899 | 51,426 | 8,284 | 4164 | 16,416 | 22,432 | 67 |

The following table gives particulars of the live stock during the same years:—

| Year. | Total Horses. | Total Cattle. | Cows or Heifers in Milk or Calf. | Sheep. | Pigs. |
|---|---|---|---|---|---|
| 1880 | 1865 | 12,538 | 6676 | 73,596 | 697 |
| 1885 | 1730 | 14,112 | 7491 | 70,735 | 953 |
| 1890 | 1745 | 14,990 | 7601 | 73,946 | 1083 |
| 1895 | 2072 | 14,676 | 8203 | 75,032 | 1837 |
| 1899 | 1845 | 15,384 | 8660 | 76,287 | 1339 |

In 1891, 2491 men and 398 women were returned as being engaged in agriculture.

*Industries and Trade.*—Turkey-red dying is now the most distinctive industry; indeed, the Vale of Leven is the headquarters of this industry in Scotland. Clydebank (*q.v.*) has become an important shipbuilding and engineering centre. Among other industries of the county now of importance, noticed under Dumbarton, Kirkintilloch, Alexandria, Duntocher, &c., are distilling, the manufacture of chemicals, paper-making, and muslin-weaving. 339,559 tons of coal were raised in 1890, valued at £135,824; 511,199 tons, valued at £208,740, in 1899. Of ironstone, 107,767

tons, valued at £58,272, were obtained in 1890; 38,722 tons, valued at £20,329, in 1899. In 1899 were also obtained 29,585 tons of fireclay, 30,355 tons of sandstone, and 11,398 tons of limestone.

In 1891 the number of persons in the county engaged in industrial pursuits was 23,258 men and 7030 women, of whom 2967 men were concerned with machines and implements, 2746 men with ships, 3305 men and 2030 women with textiles, and 5782 men with minerals. Fishing is carried on on a small scale at Helensburgh and along the Gareloch, and salmon fishing at Dumbarton. About 42 miles have been added to the railway mileage during the past twenty-five years, the largest contributor being the West Highland Railway (1894).

AUTHORITIES.—J. IRVING. *History of Dumbartonshire.* Dumbarton, 1860.—*Idem. Book of Dumbartonshire.* Edinburgh, 1879.—Sir W. FRASER. *Chiefs of Colquhoun.* Edinburgh, 1869.—*Idem. The Lennox.* Edinburgh, 1874.—D. MACLEOD. *Castle and Town of Dumbarton.* Dumbarton, 1877.—*Idem. Dumbarton.* Dumbarton, 1884.—*Idem. Dumbarton: Ancient and Modern.* Glasgow, 1893.—*Idem. Ancient Records of Dumbarton.* Dumbarton, 1896.—J. GLEN. *History of Dumbarton.* Dumbarton, 1876. (W. WA.)

**Dumfries,** a royal and parliamentary burgh (Dumfries group), railway station, and county town of Dumfriesshire, Scotland, on the left bank of the river Nith. The town is half industrial, half residential. The station has been largely rebuilt, and recent erections are a new post office, St George's Hall, a volunteer drill hall, a contagious diseases hospital, a new academy (£20,000), and a Crichton Institution chapel (£30,000). The corporation purchased the gasworks in 1878, and has rebuilt and enlarged them. Public baths and wash-houses were presented to the town in 1898, and a marble statue of Burns was unveiled in 1882. A free library is under construction. The School Board controls an endowed academy. A novitiate has lately been added to the Commercial College of the Marist Brotherhood. Population of royal burgh (1881), 15,759; (1891), 16,675; of parliamentary burgh (1891), 18,049; (1901), 17,081. MAXWELLTOWN, on the other side of the river, and in Kirkcudbrightshire, but included in the parliamentary burgh of Dumfries, is a burgh of barony and a police burgh. The new bridge connecting the towns has been widened. There are in Maxwelltown 2 tweed mills, 3 hosiery factories, and dye-works. Recent erections are a Roman Catholic church and convent, an Episcopal mission church, a court house, and a new prison for Dumfries. Population (1891), 4975; (1901), 5789.

**Dumfriesshire,** a border county of Scotland, bounded S. by the Solway Firth, N. by Lanark, Peebles, and Selkirk, W. by Ayr and Kirkcudbright, and S. by Cumberland.

*Area and Population.*—In 1891 the Lanark parts of the parishes of Moffat and Kirkpatrick-Juxta were transferred to Dumfriesshire. The area of the county, according to the latest official estimate, is 688,057 acres, or 1068·8 square miles. The population was in 1881, 74,808; in 1891, 74,221; in 1891, on the above area, 72,245, of whom 34,898 were males and 39,347 females; in 1901, 72,569. On the old area, taking land only (680,217 acres or 1062·8 square miles), the number of persons to the square mile in 1891 was 70, and the number of acres to the person 9·2. In the registration county the population decreased 2·5 per cent. between 1881 and 1891. Between 1881 and 1891 the excess of births over deaths was 7053, and the decrease of the resident population 1922. The following table gives particulars of births, deaths, and marriages in 1880, 1890, and 1899:—

| Year. | Deaths. | Marriages. | Births. | Percentage of Illegitimate. |
|---|---|---|---|---|
| 1880 | 1417 | 469 | 2252 | 14·4 |
| 1890 | 1469 | 486 | 1962 | 13·46 |
| 1899 | 1255 | 482 | 1835 | 10·8 |

The following table gives the birth-rate, death-rate, and marriage-rate per thousand of the population for a series of years:—

| | 1880. | 1881-90. | 1890. | 1891-98. | 1899. |
|---|---|---|---|---|---|
| Birth-rate | 29·60 | 28·51 | 26·37 | 26·16 | 25·33 |
| Death-rate | 18·63 | 19·13 | 19·74 | 19·22 | 17·32 |
| Marriage-rate | 6·17 | 6·14 | 6·53 | 6·32 | 6·65 |

In 1891 there were 201 Gaelic-speaking persons in the county, and 75 foreigners. Valuation in 1889-90, £623,427; 1899-1900, £629,765.

*Administration.*—The county returns a member to Parliament. Royal burghs are Dumfries (17,081), Annan (5804), Lochmaben (1328), and Sanquhar (1379), which all belong to the Dumfries group of parliamentary burghs. Langholm (3142) is the largest police burgh. There are 43 civil parishes, and 2 poorhouses, besides the one at Dumfries; the number of paupers and dependants in September 1899 was 1547. Dumfries forms a sheriffdom with Kirkcudbright and Wigtownshire, and there is a resident sheriff-substitute at Dumfries, who sits also at Annan, Langholm, and Lockerbie.

*Education.*—Forty-five school boards manage 92 schools, which had an average attendance of 10,418 in 1898-99, while 13 voluntary schools (2 Roman Catholic and 1 Episcopal) had an attendance of 1624. There are academies at Dumfries, Closeburn, Annan, Langholm, and Moffat, and Dryfesdale public school and others earned grants in 1898-99 for giving higher education. The county council and most of the burgh councils hand over the bulk of the "residue" grant to the County Committee on Secondary Education, which expended in 1899 £1076 of parliamentary grant, and £1356 thus contributed on building grants, apparatus, subsidies to higher schools, bursaries, and science and technical classes, embracing agriculture, dairying (at Kilmarnock Dairy School), and practical chemistry.

*Agriculture.*—The percentage of cultivated area was 37·6 in 1898; 31,531 acres were under wood in 1895, 1311 having been planted since 1881. Wheat is a steadily diminishing crop, and the oats acreage, which was 48,292 in 1871, was 43,937 in 1898. The following table gives the principal acreages at intervals of five years from 1880:—

| Year. | Area under Crops. | Corn Crops. | Green Crops. | Clover. | Permanent Pasture. | Fallow. |
|---|---|---|---|---|---|---|
| 1880 | 231,447 | 50,406 | 25,783 | 71,450 | 83,221 | 587 |
| 1885 | 238,158 | 49,708 | 25,331 | 69,294 | 93,535 | 290 |
| 1890 | 249,168 | 48,557 | 25,978 | 76,306 | 98,145 | 130 |
| 1895 | 259,082 | 46,495 | 24,996 | 82,797 | 104,374 | 344 |
| 1899 | 259,764 | 44,414 | 23,551 | 80,838 | 110,790 | 106 |

The following table gives particulars of the live stock during the same years:—

| Year. | Total Horses. | Total Cattle. | Cows or Heifers in Milk or Calf. | Sheep. | Pigs. |
|---|---|---|---|---|---|
| 1880 | 7414 | 55,576 | 16,266 | 517,288 | 10,286 |
| 1885 | 7240 | 57,119 | 18,677 | 490,641 | 12,154 |
| 1890 | 7409 | 58,211 | 18,420 | 527,319 | 14,034 |
| 1895 | 7990 | 58,067 | 19,489 | 525,301 | 11,531 |
| 1899 | 7484 | 62,016 | 20,339 | 565,490 | 10,915 |

Pig-feeding has fallen off steadily since the value of the pork product reached £100,000 in 1867. Arable farms range from 100 to 300 acres, and pastoral from 300 to 3000. At the date of the last return, 1895, the average size of the 2785 holdings was 93 acres; 21·83 were under 5 acres, 30·41 between 5 and 50, and 47·76 over 50 acres. The number of farms between 50 and 100 acres was 384; between 100 and 300, 763; between 300 and 500, 147; between 500 and 1000, 34; and there were 2 over 1000 acres. The fortunes of agriculture of recent years have not tended to deprive the county of its general pastoral appearance. At the census of 1891 there were 7122 men and 1089 women engaged in agriculture.

*Industries and Trade.*—The following table shows the output of minerals for 1890 and 1899; the figures for coal represent the output of Dumfries and Argyll shires conjointly:—

| Year. | Coal. | | Lead Ore. | | Sandstone. | |
|---|---|---|---|---|---|---|
| | Tons. | Value. | Tons. | Value. | Tons. | Value. |
| 1890 | 106,128 | £38,471 | 1863 | £12,973 | ... | ... |
| 1899 | 154,786 | £58,690 | 1848 | £14,500 | 245,912 | £83,039 |

The number of persons engaged in industrial pursuits in 1891 was 9754 men and 3535 women, of whom 2047 men were connected with minerals, and 1192 men and 1308 women with textiles. Dumfries and Annan (*q.v.*) are the ports. Only 2 miles have been added to the railway mileage during the past twenty-

five years, but a light railway (16 miles) from Dumfries to Moniaive has been sanctioned.

AUTHORITIES.—W. M'DOWALL. *History of the Burgh of Dumfries.* Edinburgh, 1887.—*Idem. Memorials of St Michael's Churchyard.* Edinburgh, 1876.—*Idem. Chronicles of Lincluden.* Edinburgh, 1866.—Sir HERBERT MAXWELL. *Dumfries and Galloway.* Edinburgh and London, 1897.—W. DICKIE. *Dumfries and Round About.* Dumfries, 1898.—*Transactions* of the Dumfriesshire and Galloway Natural History and Antiquarian Society.—J. MACDONALD and J. BARBOUR. *Birrens and its Antiquities.* Dumfries, 1897.—R. W. WEIR. *History of the Scottish Borderers Militia.* Dumfries, 1877.—*Historical MSS. Commission.*—J. GILLESPIE. *Report on the Agriculture of Dumfriesshire.* Edinburgh, 1869.—Sir WILLIAM FRASER. *The Book of Carlaverock.* Edinburgh, 1873.—*Idem. The Douglas Book.* Edinburgh, 1885.—*Idem. The Annandale Book.* Edinburgh, 1894.—G. NEILSON. *Annandale under the Bruces.* Annan, 1887.—G. F. SCOTT-ELLIOT. *The Flora of Dumfriesshire.* Dumfries, 1896.—C. T. RAMAGE. *Drumlanrig Castle and the Douglases.* Dumfries, 1876. (W. WA.)

**Dünaburg.** See DVINSK.

**Dunbar,** a royal burgh and seaport of Haddingtonshire, Scotland, near the mouth of the Firth of Forth, 28 miles east of Edinburgh by rail. It is a sub-port of Leith, but owing to the advent of steam the shipping is now extinct. The Victoria Harbour (£20,000) is a refuge for vessels between Leith Roads and the Tyne. The fishing industry has declined. Shipbuilding and paper-making are no longer carried on, but the manufacture of agricultural implements is considerable, and there is a considerable export trade in potatoes. The town is a rising watering-place. Episcopal and Roman Catholic churches have been built. Dunbar was formerly one of the Haddington group of burghs, but its constituency was merged in that of the county in 1885. Population (1881), 3545; (1901), 3581.

**Dunblane,** a market town and police burgh of Perthshire, Scotland, on the river Allan, 5 miles north-west of Stirling by rail. A masonic hall was erected in 1886 and a town hall in 1887. The mineral springs at Cromlix are included within the beautiful grounds—18 acres in extent—of the hydropathic establishment, which cost over £60,000. The cathedral underwent restoration, 1892–95, at a cost of £26,000. Population of police burgh (1881), 2186; (1901), 2516.

**Duncker, Maximilian Wolfgang** (1811–1886), German historian and politician, eldest son of the publisher Karl Duncker, was born at Berlin on 15th October 1811. He studied at the Universities of Bonn and Berlin till 1834, was then accused of participation in the students' societies, which the Government was endeavouring to suppress, and was condemned to six years' imprisonment, afterwards reduced to six months. He had already begun his labours as a historian, but after serving his sentence in 1837, found himself debarred till 1839 from completing his course at Halle, where in 1842 he obtained a professorship. Elected to the National Assembly at Frankfort in 1848, he joined the Right Centre party, and was chosen reporter of the projected constitution. He sat in the Erfurt Assembly of 1850, and in the second Prussian Chamber from 1849 to 1852. During the crisis in Schleswig and Holstein in 1850 he endeavoured in person to aid the Duchies in their struggles. An outspoken opponent of the policy of Manteuffel, he was refused promotion by the Prussian Government, and in 1857 accepted the professorship of history at Tübingen. In 1859, however, he was recalled to Berlin as assistant in the Ministry of State in the Auerswald Cabinet, and in 1861 was appointed Councillor to the Crown Prince. In 1867 he became Director of the Prussian Archives, with which it was his task to incorporate those of Hanover, Hesse, and Nassau. He retired on 1st January 1875, and died at Ansbach on 21st July 1886. Duncker's eminent position among German historians rests mainly on his *Geschichte des Alterthums* (1st ed., 1852–57; 5th ed., in 9 vols., 1878–86; English translation by Evelyn Abbott, 1877–82). He edited, with J. G. Droysen, *Preussische Staatsschriften, Politische Correspondenz Friedrichs des Grossen,* and *Urkunden und Actenstücke zur Geschichte des Kurfursten Friedrich Wilhelm von Brandenburg.* To the period of his political activity belong, *Zur Geschichte der deutschen Reichsversammlung in Frankfurt* (1849); *Heinrich von Gagern* (1850), in the series of *Männer der Gegenwart;* and the anonymous *Vier Monate auswärtiger Politik* (1851). His other works include *Origines Germanicæ* (1840); the lectures *Die Krisis der Reformation* (1845) and *Feudalität und Aristokratie* (1858); *Aus der Zeit Friedrichs des Grossen und Friedrich Wilhelms III. Abhandlungen zur preussischen Geschichte* (1876); followed after his death by *Abhandlungen aus der griechischen Geschichte* and *Abhandlungen aus der neueren Geschichte* (1887). (H. SY)

**Dundalk,** a seaport, urban sanitary district, and formerly (until 1885) a parliamentary borough in the county of Louth, Ireland, on Dundalk Bay, 50 miles north of Dublin. It is a large railway centre, being in communication with Belfast, Dublin, Londonderry, and *viâ* Clones with the western counties. There are also branch lines to Ardee and Greenore, from which there is a service of steam packets to Holyhead. Steamers leave for Liverpool several times a week, carrying large quantities of farm produce and live stock. In all, 833 vessels of 111,374 tons entered in 1899, and 426 of 72,684 tons cleared. The number of vessels registered in the fishery district in 1899 was 191, employing 689 men and boys. Population (1881), 11,913; (1901), 13,067.

**Dundee,** a seaport, royal and parliamentary burgh (returning two members), and county of a city (1894), Forfarshire, Scotland, on the north bank of the Firth of Tay, 59 miles north-north-east of Edinburgh by rail. Its area is 4201 acres. Jute has displaced linen as the principal manufacture of the city, and gives employment to 30,000 hands, flax employing about 10,000. The total annual value of the product of jute goods is estimated at £3,800,000, and of linen goods at £450,000. The following table shows the imports of raw materials and the exports of manufactured articles for 1890, 1895, and 1899:—

<table>
<tr><th rowspan="2">Year.</th><th colspan="4">IMPORTS.</th></tr>
<tr><th>Flax.</th><th>Tow and Codilla.</th><th>Hemp.</th><th>Jute.</th></tr>
<tr><td></td><td>Tons.</td><td>Tons.</td><td>Tons.</td><td>Tons.</td></tr>
<tr><td>1890</td><td>29,896</td><td>4776</td><td>1053</td><td>206,759</td></tr>
<tr><td>1895</td><td>24,673</td><td>5175</td><td>2147</td><td>277,314</td></tr>
<tr><td>1899</td><td>15,753</td><td>6485</td><td>1826</td><td>198,718</td></tr>
<tr><td></td><th colspan="4">EXPORTS.</th></tr>
<tr><td></td><th colspan="2">Linen and Jute Cloth.</th><th>Bags and Sacks.<br>Sea.</th><th>Yarn.<br>Sea.</th></tr>
<tr><td>1890</td><td colspan="2">Tons.<br>72,371</td><td>Tons.<br>16,900</td><td>Tons.<br>21,189</td></tr>
<tr><td></td><td>Rail.</td><td>Sea.</td><td></td><td></td></tr>
<tr><td></td><td>Tons.</td><td>Tons.</td><td></td><td></td></tr>
<tr><td>1895</td><td>72,401</td><td>97,057</td><td>16,448</td><td>24,531</td></tr>
<tr><td>1899</td><td>81,107</td><td>81,500</td><td>17,910</td><td>33,808</td></tr>
</table>

The Arctic seal and whale fishing employed 6 vessels in 1898. The total expenditure on the harbour, with its $36\frac{1}{4}$ acres of wet docks and tidal basin, was £1,088,620 up to 1898, and the debt was then £386,883, including £20,000 for the Tay ferries, which were taken over by the Harbour Trust in 1890, and on which £58,465 has since been expended. In 1891 the revenue of the harbour was £62,829, and in 1898 £60,636. In 1888, 1244 vessels of 520,363

tons entered the port, and 774 vessels of 341,192 tons cleared; in 1898, 1497 vessels of 661,264 tons entered, and 1417 of 729,067 tons cleared. The registered shipping at the port at the close of 1898 was 140 vessels of 109,073 tons. In 1889, 14 vessels of 18,311 tons were launched from the shipbuilding yards; and in 1899, 19 vessels of 17,908 tons. Recent erections are the Victoria Art Galleries, the Victoria Hospital for Incurables, the Maternity Hospital and Nurses' Home, infectious diseases hospital, small-pox hospital, royal lunatic asylum, and bronze statues of Queen Victoria (1899) and Burns (1880). Lochee Park (25 acres) and Fairmuir (12 acres) were presented to the town in 1883 and 1890. Dundee Law has been acquired by the corporation, and the Barrack Park was bought in 1893 for £40,000. The esplanade on the river frontage was extended in 1893 to a total length of $2\frac{1}{2}$ miles; and about 130 acres of additional recreation ground are about to be reclaimed from the river, as a result of which the esplanade will be extended another half mile. A large part of the town has been reconstructed of late years, under an Improvement Act, at a total cost of about half a million sterling; and another scheme of reconstruction is in progress, which will cost a further sum of £350,000. There are 18 Established churches, 32 United Free, 8 Congregational, 5 Scottish Episcopal, 5 Roman Catholic, 2 Wesleyan, and 6 belonging to other denominations. Dundee University College was founded in 1881 by Dr and Miss Baxter, and has now endowments amounting to £224,027. The college has, after much litigation, been incorporated with the University of St Andrews, and has a staff of principal, 13 professors, and numerous lecturers in arts, science, medicine, and law. Evening classes form an important part of the teaching scheme, and a training college for teachers has just been inaugurated. There are also a technical institute, two endowed high schools—one for boys and the other for girls—and 35 elementary schools. The two academies and 21 of the elementary schools are managed by the School Board, and have an average attendance of 17,553; while the other 14 schools, of which 6 are Roman Catholic and 4 Episcopal, have an average attendance of 5176. On board a training-ship, which lies in the Tay, there are about 400 boys, one-fourth of whom belong to Dundee. Valuation in 1889–90, £640,225; 1899–1900, £829,388. Population (1881), 140,794; (1891), 154,118; (1901), 160,871.

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**Dunedin,** the third largest city of New Zealand, with (1901) 53,294 inhabitants, not including 2205 persons in the borough of Port Chalmers, eight miles distant, on the same harbour. The former prosperity of Dunedin has lately revived, owing in part to gold-dredging in the Otago rivers. The University College includes a School of Medicine and Medical Museum, and a School of Mines. The University library contains 5000 works of reference, well selected. The primary and secondary schools of the town are excellent. Four hundred and two pupils attend the School of Art, and there is a small training college for state teachers. Dunedin is well built and well administered. The total import and export trade was £2,721,577 in 1893; £4,423,442 in 1899; and £3,636,248 in 1900. The headquarters of the Union Steamship Company of New Zealand are in Dunedin.

**Dunfermline,** a royal, parliamentary (Stirling and Dunfermline group), and police burgh and city of Fifeshire, Scotland, $5\frac{1}{2}$ miles north of the Forth Bridge by rail. The new corporation buildings were completed in 1879 and cost £25,000; other erections have been a public hall, a Carnegie free library, and new buildings for the high school. Population of the royal and police burgh (1881), 19,915; (1901), 25,250.

**Dungannon,** an inland town and urban sanitary district in the county of Tyrone, Ireland, $94\frac{1}{2}$ miles north-north-west of Dublin by rail. It ceased to be a parliamentary borough in 1885. Population (1881), 4084; (1901), 3693.

**Dungarpur,** a native state of India, in the Rajputana Agency, in the extreme south of Rajputana. A large portion is hilly, and inhabited by Bhils. Its area is 1440 square miles. The population in 1881 was 86,429; in 1891 it was 165,400, including 66,952 Bhils, who were not enumerated in 1881, giving an average density of 115 persons per square mile. In 1901 the total population was 100,018, showing an apparent decrease of 40 per cent., due to the famine of 1899–1900. The revenue in 1896–97 was Rs.2,21,297, and the tribute was Rs.34,147. An annual fair is held at Baneswar, where goods are sold to the value of Rs.2,50,000, chiefly cloth. Kherwara is the headquarters of the Meywar Bhil corps.

**Dungarvan,** a maritime town and urban sanitary district in the county of Waterford, Ireland, 125 miles south-west of Dublin by rail. It ceased to be a parliamentary borough in 1885. The exports are chiefly agricultural. Population (1881), 6306; (1901), 4850.

**Dunkirk,** or DUNKERQUE, a seaport and chief town of arrondissement, department of Nord, France, 53 miles north-west of Lille by rail. It has a chamber of commerce, a library, two hospitals, a college, and schools of design, painting, architecture, and music. An important wool depot and market has been established here under the auspices of the Chamber of Commerce (1900). The spinning of flax, hemp, and jute, and the manufacture of artificial manures, soap, and esparto bathing shoes, have become important industries. A shipbuilding yard covering an area of 27 acres and fitted with the newest appliances has been recently established. The first ships were laid down in 1901. Direct steamship service has been arranged with Cochin China and with South America (La Plata river). The number of vessels entered and cleared in 1900 was respectively 2698, tonnage 1,613,774, and 2622, tonnage 1,613,188; of which British vessels entered numbered 1107 of 600,672 tons, and cleared 1099 of 687,412 tons. Large quantities of produce are imported from Australia, India, and North and South America. The principal imports in 1900 were grain, coal, iron ore, nitrate of soda, wool, oil-seeds, wood, raw fibres, petroleum, pitch, metals; and the principal exports sugar, coal, iron and steel, phosphates, forage, bricks, cement. The Iceland cod-fishery, employing 83 vessels manned by 1436 men, yielded 4569 tons of fish and 280 tons of oil. The harbour accommodation has been greatly increased since 1875, and now comprises seven basins, while still further extensions are projected. The entrance canal from the sea to the outer harbour has a length of 3113 feet, width between jetties 229 feet (to be increased to 425 feet), depth ordinary spring tide 27 feet. The total length of quayage is nearly 5 miles. A canal connects the docks with the inland canals. Three lighthouses now mark the approach to the port, of which one at an altitude of 193 feet is visible 42 miles. Population (1881), 34,769; (1901), 40,329.

**Dunkirk,** a city of Chautauqua county, New York, U.S.A., in 42° 29′ N. lat. and 79° 20′ W. long., on the

south shore of Lake Erie. It is regularly laid out, has a good harbour, with a fair share of the lake commerce, and is entered by no fewer than five railways, which give it a large inland trade. It is a manufacturing city, and contains locomotive works. Population (1880), 7248; (1890), 9416; (1900), 11,616, of whom 3338 were foreign-born.

**Dunmore,** a borough of Lackawanna county, Pennsylvania, U.S.A., in the anthracite coal region, at an altitude of 939 feet. It is on the Erie and Wyoming Valley Railway. The mining and handling of anthracite coal constitute its principal, almost its sole, industry. Population (1880), 5151; (1890), 8315; (1900), 12,583, of whom 3103 were foreign-born.

**Dunmow,** a town in the Epping parliamentary division of Essex, England, 12 miles north-west by north of Chelmsford by rail. It ceased to be a corporate town in 1886, and the town hall (1578) has been purchased by a company. Area of parish, 6795 acres; population (1881), 3005; (1901), 2704.

**Dunoon,** a watering-place and police burgh (1868) of Argyllshire (including Dunoon, Kirn, and Hunter's Quay), on the west shore of the Firth of Clyde, nearly opposite Greenock. Recent constructions are a combination hospital, a new pier at Dunoon, and a court house. An esplanade has been laid out, and Dunoon Castle and grounds made into a place of recreation. A statue of Burns's "Highland Mary" was erected in 1898. One of the public schools is a grammar school. Population (1881), 4692; (1901), 6772.

**Duns,** a burgh of barony, police burgh, and railway station of Berwickshire, Scotland, 44 miles east-south-east of Edinburgh by road. There are a town hall, county buildings, a corn exchange, a mechanics' institute, and a public library. Duns has become the virtual county town of Berwickshire, and the county buildings are being enlarged with a view to its being legally constituted as such. Population (1881), 2438; (1901), 2206.

**Dunstable,** a municipal borough and market town in the Luton parliamentary division of Bedfordshire, England, 37 miles north by west of London by rail. A grammar school has been founded out of the funds of the Ashton charity, and an endowed school built. Extensive printing works have been established. Area, 453 acres; population (1881), 4627; (1901), 5147.

**Dupanloup, Félix Antoine Philibert,** French ecclesiastic (1802–1878), was born in Savoy on 3rd January 1802. In his earliest years he was confided to the care of his brother, a priest in the diocese of Chambéry. In 1810 he was sent to a *pensionnat ecclésiastique* at Paris. Thence he went to the seminary of St Nicolas de Chardonnel in 1813, and was transferred to the seminary of St Sulpice at Paris in 1820. In 1825 he was ordained priest. In the same year he became vicar of the Madeleine at Paris. He became the founder of the celebrated Academy at St Hyacinthe, and received a letter from Gregory XVI. eulogizing his work there, and calling him *Apostolus juventutis*. His imposing height, his noble features, his brilliant eloquence, as well as his renown for zeal and charity, made him a prominent feature in French life for many years. Crowds of persons attended his addresses, on whom his energy, command of language, powerful voice, and impassioned gestures made a profound impression. When made bishop of Orleans in 1848, he pronounced a fervid panegyric on Joan of Arc, which attracted attention in England as well as France. Before this he had been sent by Archbishop Affre to Rome, and had been appointed Roman Prelate and Protonotary Apostolic. For thirty years he remained a notable figure in France. He instituted the celebrated catechetical method of St Sulpice, and, with Mgr. Darboy, took a prominent part in opposing the proclamation of papal infallibility in 1870. He died on 11th October 1878. (J. J. L.*)

**Düppel,** a village of Prussia, province of Schleswig-Holstein, opposite the little town of Sonderburg (on the island of Alsen), the scene of bloody contests between the Germans and the Danes. Here in 1848 the former were repelled by the latter. The Danes then constructed strong earthworks at this spot, the key of Alsen, which, however, were stormed by the Germans in the following year. At the outbreak of the war between Denmark and Austria-Prussia in 1864 the Danes had established themselves in this same position behind a dozen lines of earthworks, but their defences were stormed by the Prussians on the 18th April of the year named. After being still further strengthened and linked with similar defences at Sonderburg, the Düppel entrenchments were abandoned in 1881 in favour of the project of fortifying Kiel.

**Dupuy, Charles Alexandre** (1851——), French statesman, was born at Le Puy, 5th November 1851, his father being a local official. After being a professor of philosophy in the provinces, he was appointed a school inspector, and thus obtained a practical acquaintance with the needs of French education. In 1885 he was elected to the Chamber as an Opportunist Republican. After acting as "reporter" of the budget for public instruction, he became minister for the department, in M. Ribot's cabinet, in 1892. In April 1893 he formed a ministry himself, taking as his office that of minister of the interior, but resigned at the end of November, and on 5th December was elected president of the Chamber. During his first week of office an anarchist, Vaillant, who had managed to gain admission to the Chamber, threw a bomb at the president, and M. Dupuy's collected bearing and conduct on this occasion gained him much credit. In May 1894 he again became premier and minister of the interior; and he was by President Carnot's side when the latter was stabbed to death at Lyons in June. He then became a candidate for the presidency, but was defeated, and his cabinet remained in office till January 1895; it was under it that Captain Dreyfus was arrested and condemned (23rd December 1894). The progress of *l'affaire* then cast its shadow upon M. Dupuy, along with other French "ministrables," but in November 1898, after M. Brisson had at last remitted the case to the judgment of the Cour de Cassation, he formed a cabinet of Republican concentration. In view of the apparent likelihood that the judges of the criminal division of the Cour de Cassation —who formed the ordinary tribunal for such an appeal— would decide in favour of Dreyfus, it was thought that M. Dupuy's new cabinet would be strong enough to reconcile public opinion to such a result; but, to the surprise of outside observers, it was no sooner discovered how the judges were likely to decide than M. Dupuy proposed a law in the Chamber transferring the decision to a full court of all the divisions of the Cour de Cassation. This arbitrary act, though adopted by the Chamber, was at once construed as a fresh attempt to maintain the judgment of the first court-martial; but in the interval President Faure (an anti-Dreyfusard) died, and the accession of M. Loubet doubtless had some effect in quieting public feeling. At all events, the whole Cour de Cassation decided that there must be a new court-martial, and M. Dupuy at once resigned (June 1899).

**Dupuy de Lôme, Stanislas Charles Henri Laurent** (1816–1885), French naval architect, the son of a retired naval officer was born at Ploemeur, near

Lorient, on 15th October 1816. He entered the École Polytechnique in 1835, and in 1842 was sent to England to study and report on iron shipbuilding. Acting on his report, which was published in 1844, the Government built their first iron vessels under his supervision. He planned and built the steam line-of-battle ship *Napoleon* (1848–52), and devised the method of altering sailing ships of the line into steamers, which was afterwards extensively practised in both France and England. He also showed the practicability of armouring the sides of a ship, and the frigate *Gloire* gave a very clear demonstration of his views. It was the beginning of the great change in the construction of ships of war which has been going on ever since. In 1857 Dupuy de Lôme was appointed "chef de la direction du matériel," at Paris; and in 1861 "inspecteur général du matériel de la marine." In 1866 he was elected a member of the Académie des Sciences. At the beginning of the war with Germany in 1870 he was appointed a member of the Committee of Defence, and during the siege of Paris occupied himself with planning a steerable balloon, for carrying out which he was given a credit of 40,000 fr.; but the balloon was not ready till a few days before the capitulation. The experiments that were afterwards made with it did not prove entirely satisfactory. In 1875 he was busy over a scheme for embarking a railway train at Calais, and exhibited plans of the improved harbour and models of the "bateaux porte-trains" to the Académie des Sciences in July. In 1877 he was elected a senator for life. He received the cross of the Legion of Honour in 1845, was made a commander in 1858, and grand officer in December 1863. He died at Paris on 1st February 1885. (J. K. L.)

**Duquesne,** a borough of Allegheny county, Penn., U.S.A., on the Monongahela river, and on a line of the Pennsylvania Railway, a few miles south-east of Pittsburg. It is an iron-manufacturing place of recent growth. Population (1900), 9036, of whom 3451 were foreign-born and 192 negroes.

**Durance** (ancient *Druentia* or *Durentia*, from Celtic "dour," water), a river of South-East France, tributary to the Rhone. It rises in the department of Hautes Alpes, near the Italian frontier, at the foot of the Gondran Pass, 3 or 4 miles in direct line east of Briançon. Here, in a valley open to the north and dominated by lofty mountains, are deep ponds apparently with no outlet, but really drained by a subterranean channel which issues 2 miles to the north. The stream then flows south-west, passing Mont Genèvre, and at the hamlet of Alberts is joined by the Clairée, a mountain torrent from the north. The Durance passes Briançon through a defile between that town and the fortress of Trois-Têtes, and about 5 miles lower bends to the south and flows for 1½ miles through the deep gorge of Bessié or Baissée. Between Savine and Sisteron, in Basses Alpes, the river forms a wide western bend, separating the departments of Hautes and Basses Alpes. At Sisteron it is joined by an important tributary, the Beuch, and a little below Volonnes is joined on the left bank by the Bleône. It borders for 2½ miles the department of Var, where it is joined by its most important tributary, the Verdon. It then flows west and north-west between the departments of Vaucluse and Bouches du Rhône, and falls into the Rhone 3 miles below Avignon. Its length is 217 miles, and the area of its basin 5800 square miles. The breadth is extremely variable—sometimes very small, sometimes spreading to nearly 1½ miles. At its outfall in the Rhone the breadth is only about 130 yards. The Durance preserves throughout its whole course the character of a torrent, and it is consequently quite useless for navigation, but for irrigation purposes it is of the highest importance. Formerly reckoned one of the three great scourges of Provence, it is now a source of immense benefit. In the departments of Vaucluse and Bouches du Rhône it irrigates nearly 100,000 acres, and tracts in the Crau formerly sterile and almost worthless are now amongst the best lands in France. Its virtue as a fertilizing agent is largely due to the immense quantity of rich mud which it brings down, containing, according to M. Hervé-Mignon, as quoted by Joanne, "as much assimilable nitrogen as 100,000 tons of excellent guano, and as much carbon as would be supplied by a forest of 121,000 acres." Amongst the principal irrigation canals which the Durance supplies are those of Peyrolles, Marseille, Crapannes, Cabédan Neuf, Alpines, Chateaurenard and Eyragues, and Rognonas. Barrage reservoirs in the defile of the Upper Durance and of the Verdon augment and regulate the supply of water to the canals. The Durance is classed as flotable from the bridge of St Clement (Hautes Alpes) to the Rhone, a length of 159 miles, but the amount of traffic is small. It is believed that in a former geologic period the Durance flowed as an independent river through the valley now traversed by the Canal des Alpines to the Gulf of Fos, though probably having a subsidiary connexion with the Rhone by one or more arms.

**Durango,** a state of Mexico, bounded on the N. by that of Chihuahua, on the E. and S.E. by the state of Coahuila; Zacatecas and the Territory of Tepic on the S., and Sinaloa on the W. It has an area of 38,020 square miles. The population in 1879 was 190,846, and in 1900 was 371,274. It is one of the richest states of the Republic as to agriculture, mining, and stock-raising, and is divided into 13 *partidos* and 49 municipalities. The capital, Durango, 574 miles from the city of Mexico, has a population of 26,425, and contains many fine buildings, notably the cathedral, one of the handsomest in the Republic, besides a mint, city and suburban railways, electric lights, cotton and woollen mills, foundries, flour and sugar mills. Amongst other cities are Villa Lerdo, Guanacevi (6859), San Juan de Guadalupe, Nombre de Dios, San Dimas, and El Oro.

**Durazzo,** a Turkish seaport on the Adriatic, and the chief town of the sanjak of Durazzo, in Albania. The chief exports are olive oil—largely manufactured in the district—wheat, oats, barley, pottery, and skins. The population is about 5000.

**Durban,** seaport town of Natal, South Africa. It has a population within the township of 39,245 (1898), namely, 17,705 Europeans, 10,924 natives, and 10,616 Indians. It is well laid out, has many good public buildings, including a very fine town hall, central railway station, and public baths. It has an extensive system of electric lighting and an efficient drainage scheme. A tram service connects the Point, the town proper, and the Berea, which is the residential suburb. The rateable value of the borough in 1899 was £5,626,695. The harbour, which used to be impeded by a bar, has been much improved of late years, and this change, besides leading to a large increase of shipping business, was of material service in connexion with the Boer war.

**Düren,** a town of Prussia, in the Rhine province, on the river Roer, 19 miles by rail east from Aix-la-Chapelle. It is the seat of cloth, paper, carpet, flax-spinning, artificial wool, sugar, iron-wares, and other manufactures. Here are several new buildings and monuments—the former embracing the provincial lunatic asylum and the church of St Joachim; the latter, monuments to the Emperors William I. and II., Bismarck, and the war of 1870–71.

The town hall contains a collection of antiquities. There are also a synagogue, technical school, library, and hospital. Population (1885), 19,802; (1901), 27,171.

**Durham,** a north-eastern county of England, bounded S.E. and S. by Yorkshire, W. by Westmoreland and Cumberland, N.W. and N. by Northumberland, and E. by the North Sea.

*Area and Population.*—The area of the ancient and administrative county, as given in the census tables of 1891, was 647,281 acres or 1011 square miles, with a population in 1881 of 867,576 and in 1891 of 1,016,559, of whom 517,942 were males and 498,617 females, the number of persons per square mile being 1005, and of acres to a person 0·64. In 1895 the area of the administrative county was slightly enlarged, by the transference from the North Riding of Yorkshire of the area which, prior to the passing of the Local Government Act, 1894, constituted the part of the township of Linthorpe in the borough of Stockton. The area of the registration county is 764,788 acres, with a population in 1891 of 1,024,369, of whom 668,782 were urban and 355,587 rural. Within the registration area the population between 1881 and 1891 increased 26·28 per cent. The excess of births over deaths between 1881 and 1891 was 169,257, and the actual increase of the resident population was 148,885. In 1901 the population was 1,187,324.

The following table gives the number of marriages, births, and deaths, with the number of illegitimate births, for 1880, 1890, and 1898:—

| Year. | Marriages. | Births. | Deaths. | Illegitimate Births. | |
|---|---|---|---|---|---|
| | | | | Males. | Females. |
| 1880 | 6419 | 33,197 | 19,796 | 704 | 681 |
| 1890 | 8534 | 36,955 | 20,767 | 668 | 663 |
| 1898 | 9977 | 40,240 | 22,169 | 718 | 723 |

The number of marriages in 1899 was 10,101; of births, 40,991; and of deaths, 22,530.

The following table shows the marriage-, birth-, and death-rates per 1000 of the population, with the percentage of illegitimate births, for a series of years:—

| | 1870-79. | 1880. | 1889. | 1888-97. | 1898. |
|---|---|---|---|---|---|
| Marriage-rate | 17·3 | 14·9 | 16·9 | 15·7 | 17·5 |
| Birth-rate | 44·3 | 38·5 | 36·5 | 36·0 | 35·2 |
| Death-rate | 24·0 | 22·9 | 20·5 | 19·3 | 19·4 |
| Percentage of illegitimate births | 4·2 | 4·2 | 3·6 | 3·8 | 3·6 |

The birth-rate is much above the average, and the death-rate is also above it, but the percentage of illegitimate births is considerably below it.

In 1891 the number of Scots in the county was 26,857, of Irish 27,663, and of foreigners 5366.

*Constitution and Government.*—The county is divided into eight parliamentary divisions, and it also includes the parliamentary borough of Sunderland, returning two members; and the boroughs of Darlington, Durham, Gateshead, Hartlepool, South Shields, and Stockton-on-Tees, each returning one member. There are nine municipal boroughs: Darlington (44,496 in 1901), Durham (14,641), Gateshead (109,887), Hartlepool (22,737), Jarrow (34,294), South Shields (97,267), Stockton-on-Tees (51,476), Sunderland (146,565), and West Hartlepool (62,614); Gateshead, South Shields, and Sunderland are county boroughs. The following are urban districts: Hebburn (20,901), Hetton (13,673), Houghton-le-Spring (7858), Leadgate (4658), Ryton (8448), Seaham Harbour (10,163), Shildon and East Thickley (11,759), Southwick (12,643), Spennymoor (16,661), Stanhope (1964), Stanley (13,553), Tanfield (8178), Tow Law (4371), Whickham (12,851), and Willington (7887).

Durham is in the north-eastern circuit, and assizes are held at Durham. The boroughs of Darlington, Durham, Gateshead, Hartlepool, Jarrow, South Shields, Stockton-on-Tees, and Sunderland have separate commissions of the peace. The ancient county, which is in the diocese of Durham, contains 238 ecclesiastical parishes, and parts of two others.

*Education.*—The city of Durham (*q.v.*) is the seat of a university, and it has also a residential training college (diocesan) for schoolmasters and schoolmistresses. At Ushaw, near Durham, there is a Roman Catholic college. The number of elementary schools on 31st August 1899 was 519, of which 187 were board and 332 voluntary; the latter including 218 National Church of England schools, 19 Wesleyan, 54 Roman Catholic, and 51 "British and other." At South Shields there is a board school for blind children; there is another at Sunderland; Darlington and Stockton-on-Tees have each a board school for deaf children. The average attendance at board schools in 1899 was 93,095, and at voluntary schools 91,713. The total school board receipts for the year ended 29th September 1899 were over £356,360. The income under the Technical Instruction Act was over £1289; that under the Agricultural Rates Act was over £2343.

*Agriculture.*—Nearly two-thirds of the total area of the county are under cultivation, but nearly two-thirds of this are in permanent pasture. There are also about 49,000 acres of hill-pasture, and 29,000 acres under woods. Of the area under corn crops, which has greatly diminished, oats occupy about one-half, and wheat and barley each about a fourth. Nearly two-thirds of the acreage under green crops are occupied by turnips, many cattle being raised. The following table gives the acreages of the larger main divisions of the cultivated area at intervals of five years from 1880:—

| Year. | Total Area under Cultivation. | Corn Crops. | Green Crops. | Clover. | Permanent Pasture. | Fallow. |
|---|---|---|---|---|---|---|
| 1880 | 415,626 | 90,771 | 34,835 | 44,582 | 226,867 | 19,155 |
| 1885 | 423,421 | 81,645 | 35,267 | 48,265 | 241.900 | 16,332 |
| 1890 | 435,084 | 73,065 | 32,285 | 56,518 | 260,064 | 12,886 |
| 1895 | 439,144 | 65,038 | 33,023 | 53,907 | 277,355 | 9,425 |
| 1900 | 438,713 | 65,726 | 33,488 | 51,780 | 280,190 | 7,186 |

The following table gives particulars regarding the live stock for the same years:—

| Year. | Horses. | Total Cattle. | Cows or Heifers in Milk or in Calf. | Sheep. | Pigs. |
|---|---|---|---|---|---|
| 1880 | 16,839 | 62,395 | 21,124 | 214,427 | 7,732 |
| 1885 | 16,586 | 69,427 | 25,202 | 198,471 | 11,913 |
| 1890 | 17,925 | 69,037 | 26,004 | 224,504 | 14,758 |
| 1895 | 20,425 | 71,968 | 26,190 | 225,041 | 12,894 |
| 1900 | 20,167 | 78,183 | 28,822 | 258,257 | 10,024 |

*Industries and Trade.*—According to the annual report for 1898 of the chief inspector of factories (1900), the total number of persons employed in factories and workshops in 1897 was 99,219, as compared with 95,115 in 1896. Only 1760 were employed in textile factories. As many as 90,039 were employed in non-textile factories, there being an increase between 1895 and 1896 of 7·3 per cent., and between 1896 and 1897 of 4·1 per cent. More than half (46,376) were employed in the manufacture of machines, appliances, conveyances, tools, &c. This includes those employed in the iron and steel shipbuilding yards of the Tyne, Stockton-on-Tees, and the Hartlepools. The Tyne shipbuilding industry is second only to that of the Clyde, and the greater portion of it is carried on within the Durham boundaries. The total number of ships built in the Tyne ports and at the Hartlepools, Stockton, and Sunderland in 1895 was 174, with a tonnage of 229,868; in 1898 it was 224, with a tonnage of 319,705. Next to shipbuilding the most important industry is the founding and conversion of metal, which in 1897 employed 17,980 persons, the extraction of metal employing 3148. Other industries are the manufacture of paper, &c., employing 3211 persons; of chemicals (chiefly on the Tyne), employing 3289; and of glass (at Gateshead and Sunderland), employing 3264; and of clay, stone, &c. (chiefly earthenware at Gateshead and Sunderland), 3195. In workshops, 7240 persons were employed—4403 in clothing industries. The total number of persons employed in mines and quarries in 1899 was 111,720. Of limestone 1,944,207 tons were raised in 1899, the largest amount of any county in the United Kingdom, of clays 744,453 tons, of which 498,011 were mainly fireclay, of sandstone 82,048 tons, of igneous rocks 73,644 tons, and of gravel and sand 20,471 tons. But the most important mineral is coal. The coalfield of Durham is at present by far the most productive of England; and although the county's output of iron is inconsiderable, its proximity to the great Cleveland iron region of North Yorkshire enables it now to produce over 1,000,000 tons of pig iron annually. There is also a very large production of salt from brine. The following table gives particulars regarding the more valuable minerals in 1890 and 1899:—

| Year. | Coal. | | Ironstone. | | Lead. | | Salt. | |
|---|---|---|---|---|---|---|---|---|
| | Tons. | Value. | Tons. | Value. | Tons. | Value. | Tons. | Value. |
| 1890 | 30,265,241 | £11,034,202 | 11,488 | £3591 | 9781 | £81,422 | 119,971 | £64,990 |
| 1899 | 34,870,675 | 12,065,153 | 16,960 | 6360 | 3361 | 32,958 | 197,610 | 93,868 |

The only fishing stations mentioned in the annual return relating to the sea fisheries of the United Kingdom are Sunderland and East Hartlepool, the total quantity of fish landed in 1898 being 118,884 cwt., valued at £95,826.

AUTHORITIES.—HUTCHINSON. *History and Antiquities of the County Palatine of Durham*, 3 vols. Newcastle, 1785–94.—

SURTEES. *History and Antiquities of the County Palatine of Durham*, 4 vols. London, 1816–40.—RAINE. *History and Antiquities of North Durham.* London, 1852.—D. M. A. *A Collection of Rhymes, Proverbs, and Sayings.* C. W. Dunelm, 1859.—PERRY and HERMAN. *Illustrations of the Mediæval Antiquities of the County of Durham.* Oxford, 1867.—LEBOUR. *Outlines of the Geology of Durham.* Newcastle, 1886. See also the *Surtees Society's Publications* and *Transactions of the Architectural Society of Durham and Northumberland.* (T. F. H.)

**Durham,** a city, municipal and parliamentary borough (since 1885 returning only one member), and county town of Durham, England, on the Wear, 256 miles from London by rail. The cathedral has undergone extensive repairs and the chapter-house been restored. The grammar school, the diocesan training colleges for schoolmasters and schoolmistresses, and the County Hospital have been enlarged. A mission church, a high school for girls, and the Shire Hall and County Buildings have been erected. Manufactures of hosiery and iron-works have been introduced. Area of municipal borough, 880 acres; population (1881), 14,932; (1901), 14,641. (See UNIVERSITIES.)

**Durham,** capital of Durham county, North Carolina, U.S.A., on the Southern, the Norfolk and Western, and the Sea Board Air Line Railways, at an altitude of 392 feet. It is the seat of Trinity College, a Methodist Episcopal institution. The surrender of General J. E. Johnston, at the close of the Civil War, took place in this neighbourhood on 25th April 1865. The growth and prosperity which have come to the city since the Civil War are due to the development of its tobacco manufactures. Population (1880), 2041; (1890), 5485; (1900), 6679, of whom 108 were foreign-born and 2241 negroes.

**Durlach,** a town of Germany, grand-duchy of Baden, $2\frac{1}{2}$ miles by rail east from Carlsruhe. A funicular railway runs to the top of the Turmberg. Gardening, iron-founding, and the manufacture of sewing and other machines, starch, chicory, and pottery are carried on. Population (1885), 7656; (1901), 11,353.

**Duruy, Jean Victor** (1811–1894), French historian and statesman, was born in Paris on 11th September 1811. The son of an artisan, he was at first intended for his father's trade, but succeeded in passing brilliantly through the École Normale Supérieure, and then held a succession of professorships and educational inspectorships. He assisted Napoleon III. in his life of Julius Cæsar, and his abilities being thus brought under the emperor's notice, he was in 1863 appointed Minister of Education. In this position he displayed incessant activity, and a desire for broad and liberal reform which aroused the bitter hostility of the clerical party. Among his measures may be cited his organization of higher education ("enseignement spécial"), his foundation of the "conférences publiques," which have now become universal throughout France, and of a course of secondary education for girls by lay teachers, and his introduction of modern history and modern languages into the curriculum both of the *lycées* and of the colleges. He greatly improved the state of primary education in France, and proposed to make it compulsory and gratuitous, but was not supported in this project by the emperor. In the new cabinet that followed the elections of 1869, Duruy was replaced by Bourbeau, and was made a senator. After the fall of the Empire he took no part in politics, except for an unsuccessful candidature for the Senate in 1876. From 1881 to 1886 he served as a member of the Conseil Supérieur de l'Instruction Publique. In 1884 he was elected to the Académie Française in succession to Mignet. He died in Paris on 25th November 1894. Duruy's fame as a historian rests mainly on the revised edition of his Roman history. First published in 2 vols. under the title of *Histoire des Romains et des peuples soumis à leur domination* (1843–44), it appeared in a greatly enlarged form in 7 vols. under the title of *Histoire des Romains depuis les temps les plus reculés jusqu'à la mort de Théodose* (1876–85); a magnificent illustrated edition was published from 1879 to 1885 (English translation by W. J. Clarke, in 6 vols., 1883–86). His *Histoire des Grecs*, similarly illustrated, appeared in 3 vols. from 1887 to 1889 (English translation in 4 vols., 1892). He was the editor, from its commencement in 1846, of the *Histoire universelle, publiée par une société de professeurs et de savants*, for which he himself wrote a "Histoire sainte d'après la Bible," "Histoire grecque," "Histoire romaine," "Histoire du moyen âge," "Histoire des temps modernes," and "Abrégé de l'histoire de France." His other works include *Atlas historique de la France accompagné d'un volume de texte* (1849); *Histoire de France de 1453 à 1815* (1856), of which an expanded and illustrated edition appeared as *Histoire de France depuis l'invasion des barbares dans la Gaule romaine jusqu'à nos jours* (1892); *Histoire populaire de la France* (1862–63); *Histoire populaire contemporaine de la France* (1864–66); *Causeries de voyage* (1864); and *Introduction générale à l'histoire de France* (1865). A memoir by Ernest Lavisse appeared in 1895 under the title of *Un Ministre: Victor Duruy.* (H. SY.)

**Düsseldorf,** a town of Prussia, in the Rhine province, on the right bank of the Rhine, 24 miles by rail north by west from Cologne. Düsseldorf is one of the handsomest cities of Western Germany. Its situation on the great mid-European waterway and as the junction of several main lines of railway has largely favoured its rapid growth and industrial development. It is the principal banking centre of the Westphalian coal and iron trade, and the favourite residence of the leading merchants of the lower Rhine. Of late the city has been much extended and improved. New quays, with a magnificent harbour, affording accommodation for vessels of deep draught, have been built, and the trade with the Dutch ports and with London thereby greatly enhanced. On the south side the town has been of late completely metamorphosed by the removal of Köln-Mindner and Bergisch Maerkisch stations to a new central station lying to the east. The site gained has been converted into new boulevards, while the railway to Neuss and Aix-la-Chapelle has been diverted through the suburb of Bilk and thence across the Rhine by a new iron bridge. A new road bridge (completed 1898, 2087 feet long), replacing the old bridge of boats, carries the electric tram-line to Crefeld. Düsseldorf ranks as one of the art centres of Europe, and is especially famous for its school of painting, which is largely attended. Many handsome modern buildings have been recently erected. The west wing of the town hall was rebuilt in 1885. The building of the academy of art, in the Renaissance style, was erected in 1879–81. The art exhibition (1881), with a mosaic façade, contains the municipal picture gallery and a permanent exhibition of pictures. In front of it stands a bronze statue of Bismarck (1899). In the old town there are, further, the industrial art museum (1896), the historical museum, and the industrial art school (1882). In the quarters which lie east and north of the old town the most noteworthy of the newer buildings are the Johannes (1875–81), St Rochus, and the Heil Empfàngniss Kirchen (1896); the law courts; the Roman Catholic hospital of St Mary; the state archives; the bronze statue of Cornelius, by Donndorf (1879); the bronze equestrian statue of the Emperor William I. (1896); and the war memorial in the botanical gardens. To the south of the old town lie the assembly hall of the Rhenish provincial diet, an Italian

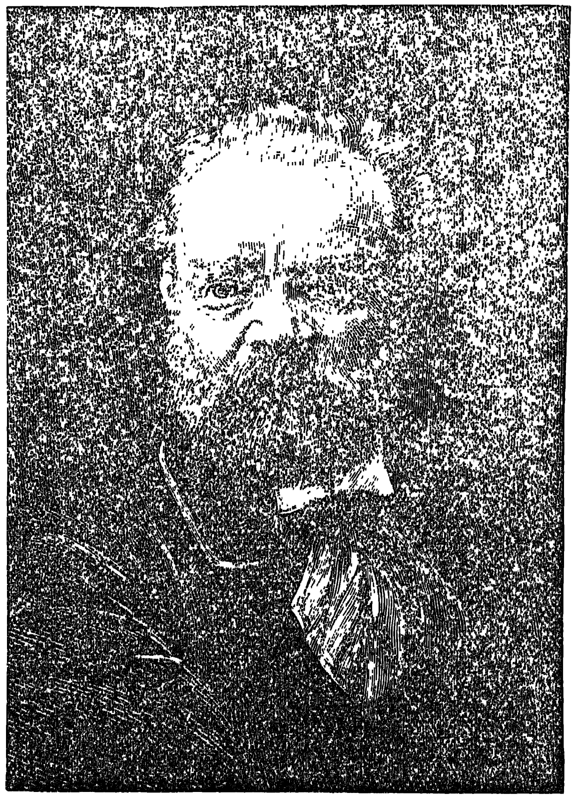
Renaissance edifice (1879), and in front of it a large bronze group representing the river Rhine and its chief tributaries, by Tüshaus and C. Janssen (1897); Petri Kirche; and the house in which the poet Freiligrath (1810–76) lived. Farther south, in the suburb of Bilk, there are the Flora Garten and the Volks Garten, the astronomical observatory (51° 12′ 25″ N. lat., 6° 46′ 13″ E. long.), and the harbour. Towards the extreme north-east lie the zoological gardens. Within quite recent years Dusseldorf has made remarkable progress as an industrial centre. The first place is occupied by the iron industries, embracing foundries, furnaces, engineering and machine shops, &c. Next come cotton spinning and weaving, calico printing, yarn-spinning, dyeing, and similar textile branches, besides a variety of other industries. Population (1885), 115,190; (1890), 144,642; (1895), 175,985; (1900), 212,949.

**Dutch East Indies.** See MALAY ARCHIPELAGO.

**Dux** (Czech, *Duchovcov*), a town in the government district of the same name in Bohemia, Austria; the centre of an extensive lignite or brown coal deposit, which is worked in sixteen different pits. It has also a steam corn-mill and a sugar refinery, and manufactures glass, porcelain, earthenware, and hosiery. There are numerous memorials of Wallenstein in the château of Count Waldstein, which also contains a collection of arms and armour, a picture gallery, and a library of about 24,000 volumes. Population in 1890, 10,141; in 1900, 11,921, the majority German and Catholic (Czechs, estimated at 29 per cent.; Protestants and Jews, 1 per cent. each).

**Dvinsk,** the official name (since 1893) of DÜNABURG, a fortress of Western Russia, and district town of the government, 183 miles by rail north-west of Vitebsk, on the right bank of the Düna, and at the crossing of two main lines—Riga-Smolensk and Wilno-St Petersburg. It is the chief strategic position for the defence of the Düna. The population of Dvinsk rapidly increased from 25,764 in 1860, to 72,230 in 1897. It consists chiefly of Jews (about 30,000), Lithuanians, and Letts.

**Dvořák, Anton** (1841–——), Bohemian musical composer, born at Nelahozeves (otherwise Mühlhausen) in Bohemia on 8th September 1841, was the son of Frantisek Dvořák, a small publican and village butcher. At the door of his father's inn Dvořák first imbibed the "concord of sweet sounds" uttered by peripatetic musicians, and there he first appeared as a practical musician, taking his place among the fiddlers who scraped out their "furiants" and other wild dances for the benefit of the holiday-making local beaux and belles. At the village school he learnt from Josef Spitz both to sing and to play the violin with so much effect that soon he was able to assist in the parish church services. But the seriousness of life came home soon to the youth, who at twelve years old was sent by his father to Zlonic, near Schlan, to an uncle, with whom he lived while passing through the higher-grade classes at school. Here, too, he was fortunate enough to find a valuable friend in A. Liehmann, organist and chief musician of the little town, a competent musician, who instructed the boy in elementary theory, organ and pianoforte playing. The theory studies, however, could not long be continued, since Liehmann soon acknowledged in his own dialect that "Aus Tonda, dem Sapperments-buben 'mal 'was werden könnte," at the same time realizing that he could not do much to assist. But Dvořák soon left Zlonic for Böhmisch-Kamnitz, where he learnt German and advanced his musical studies under Hancke. A year later he was summoned to return to Zlonic to assist his father, who had set up in business there. But his craving for a musical career was not to be denied, and after considerable trouble with Dvořák senior, consent was obtained to his settling in Prague in order to devote himself entirely to music. In October 1857 Dvořák entered the organ-school of the "Gesellschaft der Kirchenmusik," where he worked for three years. The small financial aid his father was at first able to lend soon ceased, and after being in Prague but a few months Dvořák found himself practically thrown on his own resources to obtain a livelihood. This he obtained precariously by playing the viola in a private orchestra and by making music in various inns of the town. On the opening in 1862 of the Bohemian Interimstheater, Dvořák, with part of this band, formed the nucleus of the theatrical orchestra, and remained connected with it for eleven years, when he became organist of the church of St Adalbert. At this time his small stipend was augmented slightly by the fees of a few pupils, though the privations



ANTON DVOŘÁK.
*(From a photograph by Draycott, London.)*

suffered by him and his wife—whom he had recently married—must have been great. But in spite of financial worry and of the amount of time he had to devote to his professional duties and private pupils, Dvořák found leisure not only for his own studies of the classics, but also to compose. His work, like his daily life, was beset with difficulties, for he had not the means to provide himself with sufficient music-paper, much less to hire a pianoforte; and it is possible that several of his important early works would never have been written had it not been for the generosity of Karel Bendl, the distinguished composer, who helped him in many ways.

Dvořák himself has said since that he retained no recollection of much that he then composed. In and about 1864 two symphonies, a host of songs, some chamber-music, and an entire opera, *Alfred*, lay unheard in his desk. The libretto of this opera was made up from

materials found in an old almanack. Most of these works were burnt long ago. In 1873 he made his first bid for popularity by his patriotic hymn *Die Erben des weissen Berges* (published many years later as Op. 30). Its reception was enthusiastic, and Dvořák's subsequent works were eagerly awaited and warmly received on production. In 1874 his opera *König und Köhler* resulted in a fiasco at Prague, owing to its mixture of styles. Nothing daunted, Dvořák recomposed the whole work in three months. In 1875 he obtained a stipend from the Kultus-Ministerium at Vienna on the recommendation of Brahms and Hanslick, which freed him from care and enabled him to indulge in composition to his heart's content. Following on this success came a commission in 1877 from Simrock in Berlin for a series of Slavic dances, which took the public by storm. Immediately compositions, old and new, began to pour from the publisher. English sympathy was entirely won by the *Stabat Mater* in 1883, and increased by the symphonies in D, D mi., and F, G, and E mi. (*The American*), and the cantata *The Spectre's Bride*, but somewhat chilled by the oratorio *St Ludmila*, a comparatively feeble work written "to suit English taste" for the Leeds Festival of 1886. The three overtures Opp. 91, 92, 93, failed to hold their place, but the pseudo-American symphony has become one of Dvořák's most popular works, and much of his chamber-music, of which there is abundance, seems quite permanent in its place in concert programmes. In 1892, after having frequently visited England, Dvořák took up the duties of head of the principal American school of music in New York. There he remained till 1895, when he returned to Prague.

Dvořák's music is characteristically national, though less purely so than that of Smetana. His industry is monumental; but in spite of his dramatic talent, none of his operas has been really successful. A past master of the orchestra and a composer of real individuality, he has earned and deserved his place among the elect, not only by his great gifts, but by his abnormal energy in their development.

**Dyeing.**—Dyeing is the art of colouring textile and other materials in such a manner that the colours will not be readily removed by those influences to which they are likely to be submitted—*e.g.*, washing, rubbing, light, &c.

***Historical sketch.***

The materials usually dyed are those made from the textile fibres, silk, wool, cotton, &c., and intended for clothing or decoration; but in addition to these may be mentioned straw, fur, leather, paper, &c. The art of dyeing dates from prehistoric times, and its practice probably began with the first dawn of civilization. Although we cannot trace the successive stages of its development from the beginning, we may suppose they were somewhat similar to those witnessed among certain uncivilized tribes to-day—*e.g.*, the Maoris of New Zealand. At first the dyes were probably mere fugitive stains obtained by means of the juices of fruits, and the decoctions of flowers, leaves, barks, and roots; but in course of time methods were discovered, with the aid of certain kinds of earth and mud containing alumina or iron, whereby the stains could be rendered permanent, and then it was that the true art of dyeing began. There is no doubt that dyeing was, in the early period of its history, a home industry practised by the women of the household, along with the sister arts of spinning and weaving, for the purpose of embellishing the materials manufactured for clothing.

Historical evidence shows that already at a remote period a high state of civilization existed in Persia, India, and China, and the belief is well founded that the arts of dyeing and printing have been practised in these countries during a long succession of ages. In early times the products and manufactures of India were highly prized throughout Southern Asia, and in due course they were introduced by Arabian merchants to Phœnicia and Egypt, with which countries commercial intercourse, by way of the Persian and Arabian Gulfs, seems to have existed from time immemorial. Eventually the Egyptians themselves began to practise the arts of dyeing and printing, utilizing no doubt both the knowledge and the materials derived from India. Pliny the historian has left us a brief record of the methods employed in Egypt during the first century, as well as of the Tyrian purple dye celebrated already 1000 B.C., while the chemical examination of mummy cloths by Thomson and Schunck testifies to the use by the Egyptian dyers of indigo and madder. The Phœnician and Alexandrian merchants imported drugs and dyestuffs into Greece, but we know little or nothing of the methods of dyeing pursued by the Greeks and Romans, and such knowledge as they possessed seems to have been almost entirely lost during the stormy period of barbarism reigning in Europe during the 5th and succeeding centuries. In Italy, however, some remnants of the art fortunately survived these troublous times, and the importation of Oriental products by the Venetian merchants about the beginning of the 13th century helped to revive the industry. From this time rapid progress was made, and the dyers formed important guilds in Florence, Venice, and other cities. It was about this time, too, that a Florentine named Rucellai rediscovered the method of making the purple dye orchil from certain lichens of Asia Minor. In 1429 there was published at Venice, under the title of *Mariegola dell' Arte de Tentori*, the first European book on dyeing, which contained a collection of the various processes in use at the time. From Italy a knowledge of dyeing gradually extended to Germany, France, and Flanders, and it was from the latter country that the English king Edward III. procured dyers for England, a Dyers' Company being incorporated in 1472 in the City of London. A new impetus was given to the industry of dyeing by the discovery of America in 1492, as well as by the opening up of the way to the East Indies round the Cape of Good Hope in 1498 by Vasco de Gama. A number of new dyestuffs were now introduced, and the dyewood trade was transferred from Italy to Spain and Portugal, for the East Indian products now came direct to Europe round the Cape instead of by the old trade routes through Persia and Asia Minor. Eastern art-fabrics were introduced in increasing quantity, and with them came also information as to the methods of their production. In Europe itself the cultivation of dye-plants gradually received more and more attention, and both woad and madder began to be cultivated, about 1507, in France, Germany, and Holland. Under the influence of Spain the Dutch largely developed their industries and made considerable progress in dyeing. The Spaniards, on their first arrival in Mexico (1518), noticed the employment of the red dyestuff cochineal by the natives, and at once imported it to Europe, where an increasing demand for the new colouring matter gradually developed in the course of the century. A further impetus was given to the trade by the Dutch chemist Drebbel's accidental discovery, in 1630, of the method of dyeing a brilliant scarlet on wool by means of cochineal and tin solutions. The secret was soon communicated to other dyers, and the new scarlet was dyed as a speciality at the Gobelin dye-works in Paris, and some time later (1643) at a dyeworks in Bow, near London. In 1662 the Royal Society of London gave some attention to the art of dyeing, and in order to inform and assist practical dyers, caused the

publication of the first original account, in the English language, of the methods employed in dyeing, entitled "An apparatus to the history of the common practices of Dyeing." Ten years later the French Minister Colbert sought to improve as well as control the operations of dyeing, by publishing a code of instructions for the use of the woollen dyers and manufacturers in France. From this time, too, a succession of eminent chemists were appointed by the French Government to devote some of their attention to the study of the industrial arts, including dyeing, with a view to their progress and improvement. Dufay, Hellot, Macquer, Berthollet, Roard, and Chevreul (1700–1825) all rendered excellent service to the art, by investigating the chemical principles of dyeing, by publishing accounts of the various processes in vogue, by examining the nature and properties of the dyestuffs employed, and by explaining the cause of the several phenomena connected with dyeing. With the advent of the 18th century, certain old prejudices against the use of foreign dyewoods gradually disappeared, and very rapid progress was made owing to the birth of the modern chemistry and the discovery of several useful chemical products and processes—*e.g.*, Prussian Blue (1710), Saxony Blue or Indigo Extract (1740), sulphuric acid (1774), Murexide (1776), picric acid (1788), carbonate of soda (1793), bleaching powder (1798). Experiments on the practical side of bleaching and dyeing were made during this period, in England by Thomas Henry, Home, and Bancroft, and in France by Dambourney, Gonfreville, and others, each of whom has left interesting records of his work.

Down to the middle of the 19th century natural dyestuffs alone, with but few exceptions, were at the command of the dyer. But already in the year 1834 the German chemist Runge noticed that one of the products obtained by distilling coal-tar, namely, aniline, gave a bright blue coloration under the influence of bleaching powder. No useful colouring matter, however, was obtained from this product, and it was reserved for the English chemist Perkin to prepare the first aniline dyestuff, namely, the purple colouring matter Mauve (1856). The discovery of other brilliant aniline dyestuffs followed in rapid succession, and the dyer was in the course of a few years furnished with Magenta, Aniline Blue, Hofmann's Violet, Iodine Green, Bismarck Brown, Aniline Black, &c. Investigation has shown that the products of the distillation of coal-tar are very numerous, and some of them are found to be specially suitable for the preparation of colouring matters. Such, for example, are benzene, naphthalene, and anthracene, from each of which distinct series of colouring matters are derived. In 1869 the German chemists Graebe and Liebermann succeeded in preparing Alizarin, the colouring matter of the madder-root, from the coal-tar product anthracene, a discovery which is of the greatest historical interest, since it is the first instance of the artificial production of a vegetable dyestuff. Another notable discovery is that of artificial Indigo by Baeyer in 1878. Since 1856, indeed, an ever-increasing number of chemists has been busily engaged in pursuing scientific investigations with the view of preparing new colouring matters from coal-tar products, and of these a few typical colours, with the dates of their discovery, may be mentioned: Cachou de Laval, (1873); Eosin (1874); Alizarin Blue (1877); Xylidine Scarlet (1878); Biebrich Scarlet (1879); Congo Red (1884); Primuline Red (1887); Rhodamine (1887); Paranitraniline Red (1889); Alizarin Bordeaux (1890); Alizarin Green (1895). At the present time (1901) it may truly be said that the dyer is furnished with quite an embarrassing number of coal-tar dyestuffs which are capable of producing every variety of colour possessing the most diverse properties. Many of the dyes produced are fugitive, but a considerable number are permanent and withstand various influences, so that the general result for some years has been the gradual displacement of the older dyewoods by the newer coal-tar colours.

*Mechanical improvements.*

During this period of discovery on the part of the chemist, the mechanician has been actively engaged in devising machines suitable for carrying out, with a minimum of manual labour, all the various operations connected with dyeing—*e.g.*, washing, squeezing, dyeing, drying, &c. At the present time the several textile fabrics may be dyed in each stage of their manufacture, *e.g.*, as loose unspun fibres, slubbing, tops, yarn, cops, and cloth, each requiring special forms of machine. Loose wool, which was formerly stirred about in the dye solution, is now enclosed in perforated cylinders, &c., and remains stationary, while the dye-liquor is circulated through the material by means of a pump. Wool tops and cotton cops are dyed in a similar manner. Yarn is still suspended on wooden rods and turned in the dye-liquor by hand, or the rods of yarn are suspended on revolving reels. Cloth is dyed by circulating it as an endless band over a reel placed above the dye-vessel and through the dye solution. This introduction of machinery into the dyeing trade has resulted in the production of better work, it has effected considerable economy, and may be regarded as an important feature in modern dyeing.

*General principles.*

The art of dyeing is a branch of applied chemistry in which the dyer is continually making use of chemical and physical principles in order to bring about a permanent union between the material to be dyed and the colouring matter applied. If cotton or wool is boiled in water containing finely powdered charcoal, or other insoluble coloured powder, the material is not dyed, but merely soiled or stained. This staining is entirely due to the entanglement of the coloured powder by the rough surface of the fibre, and a vigorous washing and rubbing suffices to remove all but mere traces of the colour. True dyeing can only result when the colouring matter is presented to the fibre in a soluble condition, and is then, by some means or other, rendered insoluble while it is absorbed by, or is in direct contact with, the fibre. There must always be some marked physical or chemical affinity existing between fibre and colouring matter, and this depends upon the physical and chemical properties of both. It is well known that the typical fibres, wool, silk, and cotton, behave very differently towards the solution of any given colouring matter, and that the method of dyeing employed varies with each fibre. As a general rule wool has the greatest attraction for colouring matters, and dyes most readily, cotton has the least attraction, while silk occupies in this respect an intermediate position. These differences are no doubt partly due to differences of physical structure in the fibres, but they are also in great measure owing to their different chemical composition.

On the other hand, a given fibre, *e.g.*, cotton, behaves quite differently in dyeing towards various colouring matters. Some of these are not at all attracted by it, and are incapable of being used as dyestuffs for cotton. For others cotton exhibits a marked attraction, so that it is readily dyed by mere steeping in a hot solution of the colouring matter. Again, for other colouring matters cotton has little or no attraction, and cannot be dyed with them until it has been previously impregnated or prepared with a metallic salt, tannic acid, or some other agent which is capable of combining with the colouring matter and precipitating it as an insoluble coloured compound within or upon the fibre. Such differences of behaviour are to be ascribed to differences in the chemical constitution or atomic arrangement of the various colouring matters.

In the case of the coal-tar colours we are, for the most part, well acquainted with their chemical constitution, and in accordance with this knowledge the chemist has arranged them in the following groups:—1. Nitro Colours. 2. Azo Colours, including Amido-azo, Oxy-azo, Tetrazo, and Polyazo Colours. 3. Hydrazone Colours. 4. Oxy-quinone Colours, including Quinone-oxime Colours. 5. Diphenyl methane and Triphenylmethane Colours, including Rosaniline, Rosolic acid, and Phthaleïne Colours. 6. Quinoneimide Colours, including Indamine, Indophenol, Thiazime, Thiazone, Oxazime, Oxazone, Azine, Induline, Quinoxaline, and Fluorindine Colours. 7. Aniline Black. 8. Quinoline and Acridine Colours. 9. Thiazol Colours. 10. Oxy-ketone, Xanthone, Flavone, and Cumarine Colours. 11. Indigo. 12. Colours of unknown constitution.

*Classification of colouring matters.*

This arrangement of the colouring matters in natural chemical groups is well suited for the requirements of the chemist, but another classification is that based on the mode of their application in dyeing. This is much simpler than the previous one, and being better adapted for the practical purposes of the dyer, as well as for explaining the various methods of dyeing, it is preferred for this article. According to this arrangement colouring matters are classified under the following groups:—1. *Acid Colours*. 2. *Basic Colours*. 3. *Direct Colours*. 4. *Developed Colours*. 5. *Mordant Colours*. 6. *Miscellaneous Colours*. 7. *Mineral Colours*. It is well to state that there is no sharp line of division between some of these groups, for many colours are applicable by more than one method, and might quite well be placed in two, or even three, of the above groups. This may be due either to the kind of fibre to which the colouring matter is to be applied, or to certain details in the chemical constitution of the latter which give it a twofold character.

**Acid Colours.**—These dyestuffs are so called because they dye the animal fibres wool and silk in an acid bath; they do not dye cotton. From a chemical point of view the colouring matters themselves are of an acid character, this being due to the presence in the molecule of nitro ($NO_2$) or sulphonic acid ($HSO_3$) groups. According to their origin and constitution they may be distinguished as nitro compounds, sulphonated azo compounds, and sulphonated basic colours. The Acid Colours are usually sold in the form of their alkali salts, as variously coloured powders soluble in water. For the alkali salts in neutral or alkaline solution wool and silk have little or no affinity, but dyeing rapidly occurs if the solution is acidified with sulphuric acid whereby the colour-acid is liberated. This addition of acid, however, is necessary not only to set free the colour-acid of the dyestuff, but also to alter partially the chemical composition of the fibre, and thus render it capable of uniting more readily with the free colour-acid. It has been shown, namely, that if wool is boiled with dilute sulphuric acid, and then thoroughly washed with boiling water till free from acid, it acquires the property of being dyed with Acid Colours even in neutral solution. By this treatment a portion of the wool substance is converted into so-called *lanuginic acid*, which has a strong attraction for the colour-acid of the dyestuff, with which it forms an insoluble coloured compound. For dyeing *wool*, the general rule is to charge the dyebath with the amount of dyestuff necessary to give the required colour, say from ½ to 2 or 6 per cent. on the weight of wool employed, along with 10 per cent. sodium sulphate (Glauber's salt) and 4 per cent. sulphuric acid (1·84° sp. gr.). The woollen material is then introduced and continually handled or moved about in the solution, while the temperature of the latter is gradually raised to the boiling-point in the course of ¾ to 1 hour; after boiling for ¼ to ½ hour longer, the operation is complete, and the material is washed and dried.

In practice, modifications of this normal process may be introduced, in order to ensure the dyeing of an even colour, *i.e.*, free from such irregularities as cloudiness, streaks, &c., which may be due to the quality of the material or to the special properties of the Acid Colour employed. Materials of a firm, close texture, also the existence of a strong affinity between fibre and colouring matter, are not conducive to the dyeing of even colours, or to a satisfactory penetration of the material. Some Acid Colours dye even colours without any difficulty; others, however, do not. The addition of sodium sulphate to the dyebath acts beneficially by causing less sulphuric acid to be attracted by the wool, so that its action is moderated; the dyeing therefore proceeds more slowly and regularly, and a more equal distribution and better absorption of the colouring matter takes place. Other devices to obtain even colours are: the use of old dye-liquors, a diminished amount of acid, the employment of weaker acids, *e.g.*, acetic acid or ammonium acetate, and the entering of the material at a low temperature.

In the application of so-called Alkali Blue the process of dyeing in an acid bath is impossible, owing to the insolubility of the colour-acid in an acid solution. Wool and silk, however, possess an affinity for the alkali salt of the colouring matter in neutral or alkaline solution, hence these fibres are dyed with the addition of about 5 per cent. borax; the material acquires only a pale colour, that of the alkali salt, in this dyebath, but by passing the washed material into a cold or tepid dilute solution of sulphuric acid a full bright blue colour is developed, due to the liberation of the colour-acid within the fibre. In the case of other Acid Colours, *e.g.*, Chromotrope, Chrome Brown, Chromogen, Alizarin Yellow, &c., the dyeing in an acid bath is followed by a treatment with a boiling solution of bichromate of potash, alum, or chromium fluoride, whereby the colouring matter on the fibre is changed into insoluble oxidation products or colour-lakes. This operation of developing or fixing the colour is effected either in the same bath at the end of the dyeing operation, or in a separate bath. See also *Artificial Mordant Colours*.

When dyeing with certain Acid Colours, *e.g.*, Eosine, Phloxine, and other allied bright pink colouring matters derived from resorcinol, the use of sulphuric acid as an assistant must be avoided, since the colours would thereby be rendered paler and duller, and only acetic acid must be employed.

The properties of the dyes obtained with the Acid Colours are extremely varied. Many are fugitive to light; on the other hand, many are satisfactorily fast, some even being very fast in this respect. As a rule, they do not withstand the operations of milling and scouring very well, hence Acid Colours are generally unsuitable for tweed yarns, or for loose wool. They are largely employed, however, in dyeing other varieties of woollen yarn, silk yarn, union fabrics, dress materials, leather, &c. Previous to the discovery of the coal-tar colours, very few Acid Colours were known, the most important one being Indigo Extract. Prussian Blue as applied to wool may also be regarded as belonging to this class, also the purple dyestuff known as Orchil or Cudbear.

The following list includes some of the more important Acid Colours now in use, arranged according to the colour they yield in dyeing:—

*Red.*—Wool Scarlet, Brilliant Scarlet, Erythrine, Brilliant Croceïn, Violamine G, Scarlet 3 R, Crystal Scarlet, New Coccine, Chromotrope 2 R, Azo Acid Magenta, Victoria Scarlet, Xylidine Scarlet, Palatine Scarlet, Biebrich Scarlet, Pyrotine, Orchil Red, Milling Red, Azo Carmine, Acid Magenta, Fast Acid Violet A 2 R, Naphthylamine Red, Fast Red, Claret Red, Eosine, Erythrosine, Rose Bengal, Phloxine, Cyanosine.

*Orange.*—Diphenylamine Orange, Methyl Orange, Naphthol Orange, Croceïn Orange, Brilliant Orange, Orange G, Orange N, Mandarin G R.

*Yellow.*—Picric acid, Naphthol Yellow S, Fast Yellow, Brilliant Yellow S, Azoflavine, Metanil Yellow, Resorcine Yellow, Tartrazine, Quinoline Yellow, Milling Yellow, Azo Yellow, Victoria Yellow, Brilliant Yellow S.

*Green.*—Acid Green, Guinea Green, Fast Green, Patent Green.

*Blue.*—Alkali Blue, Soluble Blue, Opal Blue, Hoechst New Blue, Patent Blue, Ketone Blue, Cyanine, Thiocarmine, Fast Blue, Induline, Violamine 3 B, Azo Acid Blue, Wool Blue, Indigo Extract.

*Violet.*—Acid Violet, Red Violet, Regina Violet, Formyl Violet, Violamine B, Fast Violet.

*Brown.*—Fast Brown, Naphthylamine Brown, Acid Brown, Resorcine Brown, Azo Brown, Chrome Brown, Chromogen.

*Black.*—Naphthol Black, Azo Black, Wool Black, Naphthylamine Black, Jet Black, Anthracite Black, Victoria Black, Azo Acid Black, Brilliant Black.

**Basic Colours.**—These colouring matters are the salts of organic colour-bases, their name being derived from the fact that their dyeing power entirely resides in the basic part of the salt. In the free state the bases are colourless and insoluble, but in combination with acids they form salts which are coloured and for the most part soluble in water. They are usually sold in the form of powder or crystals, the latter exhibiting frequently a beautiful metallic lustre. *Wool* and *silk* are dyed in a neutral bath, *i.e.*, without any addition, the material not requiring any previous preparation. During the dyeing operation the animal fibres appear to play the part of an acid, for they decompose the colouring matter and unite with the colour-base to form an insoluble coloured salt or lake, while the acid of the colouring matter is liberated and remains in solution. Although, as a rule, a neutral dyebath is employed in dyeing wool, a slight addition (2 per cent.) of soap is sometimes made in order to give a brighter colour, while in other cases, *e.g.*, with Victoria Blue, the dyebath must of necessity be

made distinctly acid with acetic or sulphuric acid. Silk is usually dyed in a bath containing "boiled-off liquor" (*i.e.*, the spent soap-liquor from the operation of scouring) neutralized or slightly acidified with acetic or tartaric acid. For a full colour use 2 or 3 per cent. colouring matter, enter the wool at a low temperature, heat gradually to near the boiling-point in the course of $\frac{3}{4}$ hour, and continue dyeing for $\frac{1}{4}$ hour. Owing to the slight solubility of many Basic Colours, it is important to take the precaution of filtering the colour solution into the dyebath through a flannel filter, also to neutralize the alkalinity of calcareous water with a little acetic acid, to prevent decomposition of the colouring matter and precipitation of the colour-base.

Unlike the animal fibres, *cotton* has little or no affinity for the Basic Colours; hence the cotton dyer makes use of the fact that cotton has a natural attraction for tannic acid, and that the latter forms insoluble lakes with the bases of Basic Colours. Previous to dyeing, the cotton is prepared with tannic acid by steeping in a cold solution of the latter for one or two hours; it is then worked for half to one hour in a cold solution of tartar-emetic or stannic chloride, so that the tannic acid absorbed by the fibre may be fixed upon it as insoluble tannate of antimony or tin. Although the tannic acid is thus united with metallic oxide, it still has the power of attracting the base of the colouring matter, and there is fixed upon the fibre an insoluble colour-lake, namely, a tannate of antimony and colour-base, which constitutes the dye. In this process the tannic acid is called the *mordant*, the tartar-emetic acts as the *fixing-agent* for the tannic acid, and the cotton as finally prepared for dyeing is said to be *mordanted*. The proportions employed, reckoned on the weight of cotton, may vary from 2 to 10 per cent. tannic acid, or the equivalent in a decoction of sumach, myrabolams, or other tannin matter, and $\frac{1}{2}$ to 3 per cent. tartar emetic. After mordanting and fixing of the mordant, the cotton is well washed and dyed in the cold or at 60° C. for $\frac{1}{2}$ to 1 hour with the necessary colouring matter. Applied in this manner, Basic Colours are moderately fast to soap, but not to the action of light.

Another method of mordanting cotton for dyeing with the Basic Colours is to impregnate the fibre for a few minutes with a warm solution of soap, or of so-called sulphated-oil (1 ℔ per gallon), then dry and work for $\frac{1}{2}$ hour in a cold solution of aluminium acetate ($\frac{1}{10}$ gallon at 1·045° sp. gr. to 20 gallons water), and finally rinse in water. The cotton is thus mordanted or prepared with a substance analogous to oleate of alumina, in which the oleic acid acts as the real mordant and combines with the base of the colouring matter subsequently applied, while the alumina acts as the fixing-agent for the oleic acid. The ultimate compound fixed upon the dyed fibre is an oleate of alumina and colour-base. The dyes thus obtained are brighter than the colours dyed on tannin mordant, but they are not so fast to soap, and are also fugitive to light.

*Linen* is dyed in the same manner as cotton. Jute is dyed without any previous preparation, since it behaves like a tannin-mordanted fibre, attracting the Basic Colours direct.

The Basic Colours, to which class most of the earlier coal-tar colours belonged, are remarkable for their great colouring power, and in most cases for the brilliancy of the colours they yield. With the exception of certain dark colours, they are fugitive to light. It is interesting to note that only one vegetable colouring matter is at present recognized as belonging to this class, namely, the yellow dyestuff Barberry bark and root (*Berberis vulgaris*), which contains the organic base berberine.

The following is a list of the more important Basic Colours derived from coal-tar:—

*Red.*—Magenta, Safranine, Rhodamine, Pyronine Red, Magdala Red.

*Orange.*—Chrysoïdine, Phosphine, Acridine Orange, Tannin Orange.

*Yellow.*—Auramine, Benzoflavine, Thioflavine T.

*Green.*—Malachite Green, Emerald Green, Imperial Green, China Green, Brilliant Green, Victoria Green, Diamond Green, Methylene Green, Azine Green.

*Blue.*—Methylene Blue, Toluidine Blue, Thionine Blue, Indamine Blue, Victoria Blue, Night Blue, Nile Blue, Turquoise Blue, Marine Blue, Indoïne Blue, Induline, Nigrosine, Meldola Blue, Metamine Blue, Muscarine, Capri Blue, Basle Blue, Indazine, Metaphenylene Blue, Paraphenylene Blue, Toluylene Blue, Indigene, Indol Blue, Diphene Blue.

*Violet.*—Methyl Violet, Crystal Violet, Ethyl Purple, Methylene Violet, Mauve, Paraphenylene Violet, Rhoduline Violet.

*Brown.*—Bismarck Brown.

*Black.*—Fast Black.

*Grey.*—Methylene Grey, Nigrisine, New Grey.

**Direct Colours.**—The characteristic feature of the dyestuffs belonging to this class is that they dye cotton "direct"—*i.e.*, without the aid of mordants. Three distinct series of colouring matters of this group may be distinguished—namely, *Benzidine Colours, Janus Colours*, and *Sulphide Colours.*

(*a*) BENZIDINE COLOURS.—The colours of this class are frequently called the Substantive Cotton Colours, Direct Cotton Colours, Benzo Colours, Diamine Colours, Congo Colours. Considered from the chemical point of view, they are alkali salts of sulphonated tetrazo colours obtained by azotizing certain diamido compounds, *e.g.*, benzidine, diamido-stilbene, &c., and uniting the product thus obtained with various amines or phenols. The first colouring matter of this class was the so-called Congo Red, discovered in 1884, and since that time a very great number have been introduced which yield almost every variety of colour. The method of dyeing *cotton* consists in merely boiling the material in a suitably concentrated solution of the dyestuff, when the cotton absorbs and retains the colouring matter by reason of a special natural affinity. The addition of 1 to 3 oz. sodium sulphate and $\frac{1}{12}$ to $\frac{1}{3}$ oz. carbonate of soda per gallon gives deeper colours, since it diminishes the solubility of the colouring matter in the water and increases the affinity of the cotton for the colouring matter. An excess of sodium sulphate is to be avoided, otherwise precipitation of the colouring matter and imperfect dyeing result. With many dyestuffs it is preferable to use $\frac{1}{6}$ to $\frac{1}{3}$ oz. soap instead of soda. On cotton the dyed colours are usually not very fast to light, and some are sensitive to alkali or to acid, but their most serious defect is that they are not fast to washing, the colour tending to run and stain neighbouring fibres. Their fastness to light and washing is, however, greatly improved by a short ($\frac{1}{2}$ hour) after-treatment with a boiling solution of copper sulphate (3 per cent.), with or without the addition of bichromate of potash (1 per cent.). *Wool* and *silk* are dyed with the Direct Colours in the same manner as cotton, or as with the Acid Colours, adding acetic acid to the dyebath. On these fibres the dyed colours are usually faster than on cotton to washing, milling, and light; some are very fast even to light—*e.g.*, Diamine Fast Red, Chrysophenine, Hessian Yellow, &c. Many of the Direct Colours are very useful for dyeing plain shades on union fabrics composed of wool and cotton, silk and cotton, or wool and silk. Owing to the facility of their application, they are also very suitable for use as household dyes.

A few vegetable dyestuffs belong to this class, notably Turmeric, Saffron, Annatto, and Safflower, but they all yield colours which are fugitive to light, and they are now of little importance. *Turmeric* is the underground stem or tuber of *Curcuma tinctoria*, a plant growing abundantly in the East Indies. It dyes cotton, wool, and silk in a bath acidified with acetic acid or alum, yielding a bright yellow colour which is turned brown by alkalis. *Saffron* consists of the stigmata of the flower of *Crocus sativus*, which is grown in Austria, France, and Spain. It dyes a bright orange-yellow colour. *Annatto* is the pulpy mass surrounding the seeds of *Bixa orellana*, a plant which grows in South America—*e.g.*, Brazil, Cayenne, &c. It dyes cotton and silk in an alkaline or soap bath an orange colour, which is turned red by acids. *Safflower* consists of the dried florets of *Carthamus tinctorius*, which is grown in the East Indies, Egypt, and Southern Europe. Cotton is dyed a brilliant pink colour by working it in a cold alkaline (sodium carbonate) extract of the colouring matter, while gradually acidifying the solution with citric acid (lime-juice).

The Direct Colours which are derived from coal-tar products are very numerous indeed; they are largely employed, and occupy a very important position among dyestuffs. The following list includes the principal coal-tar colours of this group:—

*Red.*—Congo Red, Brilliant Congo, Benzopurpurine, Brilliant Purpurine, Deltapurpurine, Diamine Scarlet, Diamine Fast Red, Rosazurine, Salmon Red, Erica, Titan Pink, St Denis Red, Columbia Red, Naphthylene Red, Congo Rubine, Geranine, Brilliant Geranine.

*Orange.*—Congo Orange, Benzo Orange, Toluylene Orange, Mikado Orange, Brilliant Orange, Columbia Orange, Diamine Orange.

*Yellow.*—Chrysamine, Cresotin Yellow, Diamine Yellow, Carbazol Yellow, Chrysophenine, Hessian Yellow, Curcumine Yellow, Thiazol Yellow, Thioflavine S, Oriol, Mimosa Yellow, Columbia Yellow, Cotton Yellow, Chloramine Yellow, Direct Yellow, Diamine Fast Yellow, Diamine Gold.

*Green.*—Benzo Olive, Columbia Green, Benzo Green, Diamine Green.

*Blue.*—Azo Blue, Benzoazurine, Brilliant Azurine, Sulphonazurine, Diamine Blue, Benzo Indigo Blue, Benzo Black Blue, Chicago Blue, Columbia Blue, Erie Blue, Zambesi Blue, Benzo Cyanine, Congo Blue, Diamine Sky Blue, Brilliant Benzo Blue, Benzo Chrome Black Blue.

*Violet.*—Hessian Purple, Congo Corinth, Heliotrope, Congo Violet, Diamine Violet, Hessian Violet, Azo Violet, Benzo Violet, Violet Black, Diamine Bordeaux.

*Brown.*—Benzo Brown, Congo Brown, Toluylene Brown, Diamine Brown, Cotton Brown, Hessian Brown, Terra Cotta, Mikado Brown, Catechu Brown, Wool Brown, Columbia Brown, Zambesi Brown, Benzo Chrome Brown, Direct Fast Brown, Direct Bronze Brown, Chloramine Brown.

*Black.*—Diamine Black, Columbia Black, Nyanza Black, Tabora Black, Zambesi Black, Chromanil Black, Benzo Black, Benzo Fast Black, Direct Blue Black, Pluto Black, Oxy Diamine Black, Diamine Jet Black.

*Grey.*—Benzo Grey, Benzo Black, Azo Mauve, Diaminogene, Neutral Grey.

(*b*) Janus Colours.—These comprise a small series of azo colours of a strongly basic character, which possess the unusual property of dyeing cotton in an acid bath. Since they also dye wool and silk under the same conditions, they may be employed for dyeing plain shades on wool, silk, and cotton union fabrics. The material is entered into the dyebath at a low temperature, which is gradually raised to the boiling-point. The necessary additions to the dyebath are 1 to 3 per cent. colouring matter, 2 per cent. sulphuric acid, and 5 to 20 per cent. sodium sulphate. The colours include Janus Red, Janus Yellow, Janus Green, Janus Blue, Janus Brown, Janus Bordeaux, Janus Grey, and Janus Black.

(*c*) Sulphide Colours.—These dyestuffs, which are also called Sulphine Colours and Thiosulphate Colours, are only suitable for dyeing the vegetable fibres. The dyestuff Cachou de Laval, discovered in 1873, was the first member of this group, and was obtained by melting a mixture of sodium sulphide and various organic substances—*e.g.*, bran, sawdust, &c. In recent years several other dyestuffs have been added to the list, namely, grey, blue, green, brown, and especially black colours, by submitting certain definite amido compounds to a similar treatment with sodium sulphide or sodium thiosulphate, and subsequent oxidation. The mode of dyeing with these colours is based on the fact that they are soluble in an alkaline reducing agent, and if the cotton is impregnated with the solution, subsequent oxidation develops the colour and fixes it upon the fibre in an insoluble condition. The material is boiled for about one hour in a solution of the colour (10 to 15 per cent.), with the addition of sodium carbonate (1 to 10 per cent.), common salt (10 to 20 per cent.), and sodium sulphide (2 to 20 per cent.); it is then washed quickly in water, and developed for half an hour in a boiling bath containing 2 to 5 per cent. of some metallic salt—*e.g.*, bichromate of potash, copper sulphate, chrome alum, &c. A final washing with water containing a little caustic soda to remove acidity is important. The sulphide colours are remarkable for their fastness to light, alkalis, acids, and washing, but unless proper care is exercised the cotton is apt to be tendered.

The following list includes most of the colours of this class:—

*Green.*—Pyrogene Green, Italian Green.

*Brown.*—Pyrogene Brown, Pyrogene Yellow, Cachou de Laval, Thiocatechine, Katigene Black Brown.

*Grey and Black.*—Pyrogene Grey, Vidal Black, Immedial Black, Katigene Black, Anthraquinone Black, St Denis Black, Amidazol Black, Cross Dye Black, Clayton Fast Black, Eclipse Black, Carbide Black, Thiogene Black, Sulphaniline Black, Sulfogene Black, Pyrogene Black.

At the present time (1902) this class of colours is continually increasing in number, and for certain purposes in cotton dyeing the group is already becoming important.

**Developed Colours.**—This group includes certain azo colours which are developed or produced upon the fibre itself (usually *cotton*) by the successive application of their constituent elements. It may be conveniently divided into the following sub-groups:—Insoluble Azo Colours, Primuline Colours, Developed Direct Colours, Benzo Nitrol Colours.

(*a*) The Insoluble Azo Colours are produced as insoluble coloured precipitates by adding a solution of a so-called diazo compound to an alkaline solution of a phenol, or to an acid solution of an amido compound. The necessary diazo compound is prepared by allowing a solution containing nitrous acid to act upon a solution of an amido-base—*e.g.*, aniline. It is desirable to keep the solutions cool with ice, owing to the very unstable nature of the diazo compounds produced. The colour obtained varies according to the particular diazo compound, as well as the amine or phenol employed, beta-naphthol being the most useful among the latter. The same coloured precipitates are produced upon the *cotton* fibre if the material is first impregnated with an alkaline solution of the phenol, then dried and passed into a cold solution of the diazo solution. Three operations are therefore necessary when dyeing with these colours: (1) *diazotizing* of the base; (2) *impregnation* of the cotton with the phenol solution; (3) *developing.* As an example, the method of dyeing an orange-yellow colour derived from aniline and beta-naphthol is here given.—*Diazotizing.* Aniline (93 parts) is dissolved in hydrochloric acid (sp. gr. 1·14) (390 parts) and water (200 parts). The solution is cooled with the addition of ice, and a solution of sodium nitrite (75 parts) in water (500 parts) is slowly added with continual stirring. Each base requires a slightly different treatment to ensure the best results.—*Impregnation.* A stock solution of beta-naphthol is prepared by dissolving 14 parts by weight of this substance in 4 parts caustic soda and 50 parts water. This solution is diluted 5 to 10 times with water, according to the depth of colour required, and 1 part soda-ash (sodium carbonate) is then dissolved in 15 to 30 parts of the dilute solution; in order to give a brighter colour, a small amount of sulphated oil is sometimes added. The cotton is well impregnated with this solution, then wrung out and dried quickly.—*Developing.* The naphthol-prepared cotton should be passed as soon as possible into the diazo or developing solution, in order to prevent the cotton from acquiring a brownish hue through oxidation. The orange-yellow colour desired is developed almost immediately, but it is well to continue working the cotton about in the solution for a few minutes. The dyed cotton is squeezed, washed, soaped slightly, and finally rinsed in water and dried. The colours obtained by this method vary according to the particular diazo compound employed. If the aniline used in the foregoing process is replaced by meta-nitraniline, a yellowish-orange colour is obtained; with para-nitraniline, a bright red; with alpha-naphthylamine, a claret-red; with amido-azo-toluene, a brownish red; with benzidine, a dark chocolate; with dianisidine, a dark blue; and so on. The dyed colours are fast to washing and are much used in practice, particularly the Para-nitraniline Red, which serves as a substitute for Turkey-red, although it is not so fast to light as the latter.

(*b*) The Primuline Colours are derived from the yellow dyestuff known as Primuline, which dyes cotton in the same manner as the Direct Colours. The Primuline yellow is fugitive to light and of no practical value, but since the colouring matter is an amido base, the dyed fibre can be diazotized and then developed in solutions of phenols or amines, whereby azo dyes of various hues may be obtained, according to the developer employed; *e.g.*, beta-naphthol develops a bright red colour (Primuline Red), resorcinol develops an orange, phenol a yellow, naphthylamine a brown, &c. The *dyeing* of the Primuline yellow is effected by boiling the cotton for one hour in a solution of Primuline (5 per cent.) and common salt (10 to 20 per cent.). The *diazotizing* operation consists in passing the dyed and rinsed cotton for 5 to 10 minutes into a cold solution of nitrous acid—*i.e.*, a solution of ¾ oz. sodium nitrite per gallon of water, slightly acidified with sulphuric acid. The diazotized material should not be exposed to light, but at once washed in cold water and passed into the developer. The *developing* process consists in working the diazotized material for 5 to 10 minutes in a cold solution of the necessary phenol or amine, and finally washing with water. If the developer employed is an amido compound, the dyed colour will contain a free amido group, and hence the operations of diazotizing and developing may be repeated again and again with the object of obtaining darker shades. The Primuline colours are best adapted for *cotton* dyeing, and the colours obtained are fast to washing and to moderate soaping, but they are not very fast to light.

(*c*) Developed Direct Colours.—If *cotton* is dyed with such Direct Colours as contain free amido groups, the colour can be diazotized on the dyed fibre exactly in the same manner as in the case of Primuline-dyed cotton, and then developed by passing into the solution of an amine or phenol, or by treating it with a warm solution of sodium carbonate. In this manner a new azo dye is produced upon the fibre, which differs from the original one not only in colour, but also by being faster to washing and other influences. A treatment with copper sulphate solution after development is frequently beneficial in rendering the colour faster to light. Some Direct Colours, indeed, are of little value, owing, for example, to their sensibility to acids, until they have been diazotized and developed, the usual developers being beta-naphthol, resorcinol, phenol, and phenylene-diamine.

The following Direct Colours, after being applied to cotton, may be submitted to the above treatment, the colours produced being chiefly blue, brown, and black:—

*Blue.*—Diazurine, Diazo Blue, Diamine Blue, Diaminogene.

*Brown.*—Diazo Brown, Diamine Cutch, Diamine Brown, Cotton Brown.

*Grey and Black.*—Benzo Blue, Diazo Blue Black, Diazo Black, Diamine Black, Diazo Brilliant Black.

(*d*) Benzo Nitrol Colours.—These are certain Direct Colours dyed on *cotton* in the ordinary manner, which are then developed by passing into a diazo solution—*e.g.*, diazotized para-nitraniline, &c. The dyed colour here plays the part of a phenol or amine, and reacts with the diazo compound to produce a new colour. The process is similar to the production of the Insoluble Azo Colours, the beta-naphthol which is there applied to the fibre being here replaced by a Direct Colour. The colour of the latter is rendered much deeper by the process, and also faster to washing and to the action of acids. The dyestuffs recommended for application in the manner described are: Benzo Nitrol Brown, Toluylene Brown, Direct Fast Brown, Pluto Black, Direct Blue Black.

**Mordant Colours.**—The colouring matters of this class include some of the most important dyestuffs employed, since they furnish many colours remarkable for their fastness to light, washing, and other influences. Employed by themselves, Mordant Colours are usually of little or no value as dyestuffs, because, with some exceptions, either they are not attracted by the fibre, particularly in the case of cotton, or they only yield a more or less fugitive stain. Their importance and value as dyestuffs are due to the fact that they act like weak acids and have the property of combining with metallic oxides to form insoluble coloured compounds termed

"lakes," which vary in colour according to the metallic oxide or salt employed. The most stable lakes are those in which the colouring matter is combined with two metallic oxides, a sesqui-oxide and a monoxide—*e.g.*, alumina and lime. In applying colouring matters of this class the object of the dyer is to precipitate and fix these coloured lakes upon and within the fibre, for which purpose two operations are necessary, namely, *mordanting* and *dyeing*.

The *mordanting operation* aims at fixing upon the fibre the necessary metallic oxide or insoluble basic salt, which is called the *mordant*, although the term is also applied to the original metallic salt employed. In the subsequent dyeing operation the mordanted material is boiled with a solution of the colouring matter, during which the metallic oxide attracts and chemically combines with the colouring matter, producing the coloured lake *in situ* on the fibre, which thus becomes dyed. The mode of applying the mordants varies according to the nature of the fibre and the metallic salt employed, the chief mordants at present in use being salts of chromium, aluminium, tin, copper, and iron. The method of mordanting *wool* depends upon its property of decomposing metallic salts, and fixing upon itself an insoluble metallic compound, when boiled in their solutions. This decomposition is facilitated by the heating and by the dilution of the solution, but it is chiefly due to the action of the fibre itself. The exact nature of the substance fixed upon the fibre has not in all cases been determined; probably it is a compound of the metallic oxide with the wool-substance itself, which has the character of an amido-acid. The mordant most largely employed for wool is bichromate of potash, since, besides being simply applied, and leaving the wool with a soft feel, it yields with the various mordant-dyestuffs a large variety of fast colours. The wool is boiled for 1 to 1½ hour in a solution containing 2 to 3 per cent. bichromate of potash on the weight of the wool employed. During this operation the wool at first attracts chromic acid, which is gradually reduced to chromium chromate, so that the mordanted fibre has finally a pale olive-yellow tint. In the dyebath, under the influence of a portion of the dyestuff, further complete reduction to chromic hydrate occurs before it combines with the colouring matter. Not unfrequently certain so-called "assistants" are employed in small amount along with the bichromate of potash—*e.g.*, sulphuric acid, cream of tartar, tartaric acid, lactic acid, &c. The use of the organic acids here mentioned ensures the complete reduction of the chromic acid on the wool to chromic hydrate already in the mordant bath, and the pale greenish mordanted wool is better adapted for dyeing with colours which are susceptible to oxidation—*e.g.*, Alizarin Blue. For special purposes chromium fluoride, chrome alum, &c., are employed. Alum or aluminium sulphate (8 per cent.), along with acid potassium tartrate (cream of tartar) (7 per cent.), is used for brighter colours—*e.g.*, reds, yellows, &c. The object of the tartar is to retard the mordanting process and ensure the penetration of the wool by the mordant, by preventing superficial precipitation through the action of ammonia liberated from the wool; it ensures the ultimate production of clear, bright, full colours. For still brighter colours, notably yellow and red, stannous chloride was at one time largely employed, now it is used less frequently; and the same may be said of copper and ferrous sulphate, which were used for dark colours. *Silk* may be often mordanted in the same manner as wool, but as a rule it is treated like cotton. The silk is steeped for several hours in cold neutral or basic solutions of chromium chloride, alum, ferric sulphate, &c., then rinsed in water slightly, and passed into a cold dilute solution of silicate of soda, in order to fix the mordants on the fibre as insoluble silicates. *Cotton* does not, like wool and silk, possess the property of decomposing metallic salts, hence the methods of mordanting this fibre are more complex, and vary according to the metallic salts and colouring matters employed, as well as the particular effects to be obtained. One method is to impregnate the cotton with a solution of so-called "sulphated oil" or "Turkey-red oil"; the oil-prepared material is then dried and passed into a cold solution of some metallic salt—*e.g.*, aluminium acetate, basic chromium chloride, &c. The mordant is thus fixed on the fibre as a metallic oleate, and after a passage through water containing a little chalk or silicate of soda to remove acidity, and a final rinsing, the cotton is ready for dyeing. Another method of mordanting cotton is to fix the metallic salt on the fibre as a tannate instead of an oleate. This is effected by first steeping the cotton in a cold solution of tannic acid or in a cold decoction of some tannin matter, *e.g.*, sumach, in which operation the cotton attracts a considerable amount of tannic acid; after squeezing, the material is steeped for an hour or more in a solution of the metallic salt, and finally washed. The mordants employed in this case are various—*e.g.*, basic aluminium or ferric sulphate, basic chromium chloride, stannic chloride (cotton spirits), &c. There are other methods of mordanting cotton besides those mentioned, but the main object in all cases is to fix an insoluble metallic compound on the fibre. It is interesting to note that whether the metallic oxide is united with the substance of the fibre, as in the case of wool and silk, or precipitated as a tannate, oleate, silicate, &c., as in the case of cotton or silk, it still has the power of combining with the colouring matter in the dyebath to form the coloured "lake" or dye on the material.

The *dyeing operation* consists in working the mordanted material in a solution of the necessary colouring matter, the dyebath being gradually raised to the boiling-point. With many colouring matters, *e.g.*, with Alizarin, it is necessary to add a small percentage of calcium acetate to the dyebath, and also acetic acid if wool is being dyed. In wool-dyeing, also, the mordanting operation may follow that of dyeing instead of preceding it, in which case the boiling of the wool with dyestuff is termed "stuffing," and the subsequent developing of the colour by applying the mordant is termed "saddening," because this method has in the past been usually carried out with iron and copper mordants, which give dull or sad colours. The method of "stuffing and saddening" may, however, be carried out with other mordants, even for the production of bright colours, and it is now frequently employed with certain alizarin dyestuffs for the production of pale shades which require to be very even and regular in colour. There is still another method of applying Mordant Colours in wool-dyeing, in which the dyestuff and the mordant are applied simultaneously from the beginning; it is known as the "single-bath method." It is only successful, however, in the case of certain colouring matters and mordants, to some of which reference will be made in the following paragraphs.

The Natural Mordant Colours.—It is interesting to note that nearly all the natural or vegetable dyestuffs employed belong to the class of Mordant Colours, the most important of these being included in the following list:—*Madder, Cochineal, Peachwood, Sapanwood, Limawood, Camwood, Barwood, Sanderswood, Old Fustic, Young Fustic, Quercitron Bark, Persian Berries, Weld, Logwood.*

Madder consists of the dried ground roots of *Rubia tinctorum*, a plant of Indian origin. Formerly cultivated largely in France and Holland, it was long one of the most important dyestuffs employed, chiefly in the production of Turkey-red and in calico-printing, also in wool-dyeing. With the different mordants it yields very distinct colours, all fast to light and soap, namely, red with aluminium, orange with tin, reddish brown with chromium, purple and black with iron. Madder contains two closely allied colouring matters, namely, purpurin and alizarin. The latter, which is by far the most important, is now prepared artificially from the coal-tar product anthracene, and has almost entirely superseded madder.

Cochineal is the dried scale-insect *Coccus-cacti*, which lives on certain of the cactus plants of Mexico and elsewhere. The rearing of cochineal was once a large and important industry, and although still pursued, it has seriously declined, in consequence of the discovery of the Azo Scarlets derived from coal-tar. The colouring matter of cochineal, carminic acid, is believed by chemists to be a derivative of naphthalene, but its artificial production has not yet been accomplished. Cochineal dyes a purple colour with chromium mordant, crimson with aluminium, scarlet with tin, and grey or slate with iron. Its chief employment is for the purpose of dyeing crimson, and more especially scarlet, on wool. Crimson is dyed by mordanting the wool with alum and tartar and dyeing in a separate bath with ground cochineal. Scarlet on wool is obtained by the single-bath method, namely, by dyeing the wool with a mixture of stannous chloride (or nitrate of tin), oxalic acid, and cochineal. It is usual to add also a small amount of the yellow dyestuff Flavine in order to obtain a yellower shade of scarlet. The cochineal colours are very fast to light, but somewhat susceptible to the action of alkalis.

Peachwood, Sapanwood, and Limawood are usually referred to as the "soluble red-woods," because of the solubility in water of the colouring principle they contain. They consist of the ground wood of various species of *Cæsalpinia* found in Central America, the East Indies, and Peru. They all yield more or less similar colours with the different mordants—claret-brown with chromium, red with aluminium, bright red with tin, dark slate with iron. Owing to the fugitive character of all the colours to light, these dyewoods are now comparatively little employed in dyeing, being replaced by the Alizarin Colours. All these dyewoods seem to contain the same colouring principle, namely, brazilin, which, either before or during its union with the mordant, is converted by oxidation into the colouring matter brazileïn. The chemical constitution of this substance has recently been definitely established, and it appears to be a member of the $\gamma$-pyrone group of colouring matters, to which several of the natural yellow dyestuffs also belong.

Camwood, Barwood, and Sanderswood represent the so-called "insoluble red-woods," their colouring principles being sparingly soluble even in boiling water. They are obtained from certain species of *Pterocarpus* and *Baphia*, large trees growing in the interior of West Africa. Their general dyeing properties are similar, a claret-brown being obtained with chromium mordant, a brownish red with aluminium, a brighter red with tin, and

purplish brown with iron. Their chief employment is in wool-dyeing, for the production of various shades of brown, being best applied by the "stuffing and saddening" method above described; but since the colours are fugitive to light, they are now very largely replaced by Alizarin. A brown on wool is obtained by first boiling for one to two hours in a decoction of the ground wood (50 per cent.), and then boiling in a separate bath in solution of bichromate of potash (2 per cent.) for half an hour. These dye-woods are also employed by the indigo-dyer, in order to give a brownish ground colour to the wool previous to dyeing in the indigo vat, and thus obtain a deeper, fuller blue. The colouring matters contained in these dyewoods have not been exhaustively examined.

Old Fustic is a yellow dyestuff, and consists of the wood of the dyer's mulberry tree, *Morus tinctoria*, which grows in Cuba, Jamaica, &c. It is still an important and largely used dyestuff, being cheap, and the colours obtained from it being satisfactorily fast to light and other influences. With chromium mordant it yields an olive-yellow or "old-gold" shade; with aluminium, yellow; with tin, a brighter yellow; with iron, an olive-green. It is chiefly employed in wool-dyeing along with other dyestuffs, and furnishes the yellow in compound shades. Two colouring principles exist in Old Fustic, namely, morin and maclurin, the former being the most important, and generally regarded as the true colouring matter.

Young Fustic consists of the wood of the sumach tree, *Rhus cotinus*, which grows in Italy and Southern Europe. Its general dyeing properties are similar to those of Old Fustic, although the various mordants give somewhat different colours, notably the tin mordant, which gives a brilliant orange-yellow. All the colours obtained are very fugitive to light, hence this dyestuff is now of little importance. The colouring matter of Young Fustic is called fisetin.

Quercitron Bark consists of the inner bark of an oak-tree, *Quercus tinctoria*, which grows in the North American States. It dyes somewhat like Old Fustic, but gives with aluminium and tin mordants brighter yellows, for which colours it is chiefly used. The colouring principle of Quercitron Bark is called quercitrin, which by the action of boiling mineral acid solutions is decomposed, with the production of the true colouring matter termed quercetin.

So-called Flavine is a commercial preparation of Quercitron Bark consisting of quercitrin or of quercetin; it is much used by wool-dyers for the production of bright yellow and orange colours. Wool is dyed in single bath by boiling with a mixture of Flavine (8 per cent.), stannous chloride (4 per cent.), and oxalic acid (2 per cent.). Flavine is used in small quantity along with cochineal for dyeing scarlet on wool.

Persian Berries are the dried unripe fruit of various species of *Rhamnus* growing in the Levant. The general dyeing properties are similar to those of Quercitron Bark, the orange colour given with tin mordant being particularly brilliant. The high price of this dyestuff causes its employment to be somewhat limited. The colouring matter of Persian Berries is called xanthorhamnin, which by the action of fermentation and acids yields the true dyestuff rhamnetin.

Weld is the dried plant *Reseda luteola*, a species of wild mignonette, formerly largely cultivated in Europe. Its dyeing properties resemble those of Quercitron Bark, but the yellows with aluminium and tin mordants are much brighter and purer, and also faster to light. It is still used to a limited extent for dyeing a bright yellow on woollen cloth and braid for the decoration of military uniforms. Quite recently the colouring matter of Weld, namely, luteolin, has been prepared artificially, but the process is too expensive to be of practical use.

Logwood is the heart-wood of *Hæmatoxylon campechianum*, a tree growing in Central America. It is the most important natural dyewood at present employed, being largely used for dyeing dark blues and black on silk, wool, and cotton. With chromium and aluminium mordants logwood dyes a dark blue, and even black; with tin, a dark purple; and with iron, black. The colours are only moderately fast to light. On wool the mordant is bichromate of potash, on cotton and silk an iron mordant is employed. Before use by the dyer the logwood is ground and aged or oxidized, by allowing moistened heaps of the ground wood to ferment slightly, and by frequently turning it over to expose it freely to the air. By this means the colouring principle hæmatoxylin which logwood contains is changed into the true colouring matter hæmateïn. The constitution of this colouring matter has been recently discovered; it is very closely allied to the brazilin of Peachwood, Sapanwood, and Limawood, and is also a member of the $\gamma$-pyrone group of colouring matters.

The importance of the above-mentioned natural dyestuffs is gradually diminishing in favour of mordant dyestuffs and others derived from coal-tar. Old Fustic and Logwood are perhaps the most largely used, and may continue to be employed for many years, owing to their comparatively low price.

The Artificial Mordant Colours are well represented by Alizarin, the colouring matter of the Madder root, which was the first natural dyestuff prepared artificially in 1868 from the coal-tar product anthracene. For this reason many of these colours are frequently referred to as the Alizarin Colours. At the present time, however, there are numerous Mordant Colours which are prepared from other initial materials than anthracene; they are not chemically related to Alizarin, and for these the term Alizarin Colours is therefore inappropriate. The property, which Mordant Colours possess in common, of combining with metals and producing lakes, which readily adhere to the fibre, depends upon their chemical constitution, more particularly upon the general and relative position in the molecule of certain side atomic groups. In Alizarin there are, for example, two characteristic hydroxyl groups (OH) occupying a special (ortho) position in the molecule—*i.e.*, they are next to each other, and also next to one of the so-called ketone groups (C : O). In other Mordant Colours there are carboxyl (COOH) as well as hydroxyl groups, which are all-important in this respect. In addition to this, the general dyeing property is influenced by the constitution of the molecule itself, and by the presence of other side-groups, *e.g.*, $NH_2$, $HSO_3$, &c., which modify the colour as to solubility or hue. Hence it is that the members of this group, while possessing the mordant-dyeing property in common, differ materially in other points. Some, like Alizarin, are not in themselves to be regarded as colouring matters, but rather as colouring principles, because they only yield useful dyes in combination with metallic oxides. According to their constitution, these may yield one or many colours with the various metallic oxides employed, and they are used for cotton as well as for wool and silk. Other Mordant Colours, *e.g.*, many of the Direct Colours and others, are capable of dyeing either the vegetable or animal fibres without the aid of a mordant; they are fully developed colouring matters in themselves, and possess the mordant dyeing property as an additional feature, in consequence of the details of their chemical constitution, to which reference has been made in the foregoing paragraphs. As a rule these yield, at most, various shades of one colour with the different oxides, and are only suitable for the animal fibres, particularly wool.

In the following list, the most important artificial Mordant Colours are arranged according to the colour they give in conjunction with the aluminium mordant, unless otherwise indicated. Those which dye the animal fibres, even without mordants, are given in italics; some are Direct Colours possessing mordant-dyeing properties, others are sulphonic acid derivatives of Alizarin Colours, suitable for wool but not for cotton.

*Red.*—Alizarin, Anthrapurpurin, Flavopurpurin, Purpurin, Alizarin Bordeaux, Alizarin Garnet R, Alizarin Maroon, Alizarin S, *Cloth Red*, *Diamine Fast Red*, *Anthracene Red.*

*Orange and Yellow.*—Alizarin Orange, Alizarin Orange G, Alizarin Yellow paste, Alizarin Yellow A, Alizarin Yellow C, Anthracene Yellow, Galloflavin, *Fustin*, *Alizarin Yellow GG*, *Alizarin Yellow R*, *Diamond Flavin G*, *Chrome Yellow D*, *Crumpsall Yellow*, *Fast Yellow*, *Diamond Yellow*, *Benzo Orange R*, *Cloth Orange*, *Carbazol Yellow*, *Chrysamine.*

*Green.*—Cœruleïn, Cœruleïn S, Alizarin Green S, Fast Green (Fe), Naphthol Green (Fe), Dioxin (Fe), Gambine (Fe), *Azo Green*, *Gallanil Green*, *Alizarin Green G and B*, *Acid Alizarin Green*, *Alizarin Cyanine Green*, *Diamond Green.*

*Blue.*—Alizarin Blue, Alizarin Blue S, Alizarin Cyanine, Anthracene Blue, Brilliant Alizarin Blue, Alizarin Indigo Blue S, *Acid Alizarin Blue*, *Brilliant Alizarin Cyanine*, *Alizarin Saphirole*, *Gallanilide Blue*, *Delphine Blue*, *Gallamine Blue*, *Celestine Blue*, *Chrome Blue*, *Gallazine A*, *Phenocyanine*, *Coreïne.*

*Purple and Violet.*—Galleïn, *Gallocyanine*, *Chrome Violet.*

*Brown.*—Anthracene Brown, Chromogen, *Cloth Brown*, *Diamond Brown*, *Alizarin Brown*, *Fast Brown.*

*Black.*—Alizarin Black, *Diamond Black*, *Alizarin Blue Black*, *Alizarin Cyanine Black*, *Alizarin Fast Grey*, *Chromotrope.*

A brief description of the application of a few of the more important of the above colouring matters will suffice.

Alizarin, Anthrapurpurin, and Flavopurpurin give somewhat similar shades with the different mordants, namely, brown with chromium, red with aluminium, orange with tin, and purple with iron mordant.

In *wool*-dyeing they are applied along with other Mordant Colours on chromium mordant for the production of a large variety of compound shades, browns, drabs, greys, &c., the presence of acetic acid in the dyebath being advantageous. When alum and tartar mordant is employed, for the production of reds, it is necessary to add a small amount (4 per cent.) of calcium acetate to the dyebath, in order to neutralize the strong acidity of the mordanted wool, and to furnish the calcium of the colour-lake fixed upon the fibre, which is regarded as an aluminium-calcium compound of the colouring matter.

In *cotton*-dyeing the above colouring matters are chiefly used for the production of so-called Turkey-red, a colour remarkable for its brilliancy and its fastness to light and soap. These properties are due to the preparation of the cotton with oil, in addition to the ordinary mordanting and dyeing, whereby there is fixed on the fibre a permanent and stable lake, in which aluminium and calcium are combined with Alizarin and some form of oxy-fatty acid. In the older processes employed, the preparation of the cotton with oil was effected by passing the material several times through emulsions of olive-oil and potassium carbonate solution; at a later date, and even now in the case of cloth, the cotton is first impregnated with hot oil (Steiner's process), then passed through solutions of alkali carbonate. After the preparation with oil or oil-emulsions, the cotton is "stoved," *i.e.*, heated for several hours in special chambers or stoves to a temperature of about 70° C., during which operation the oil is decomposed and oxidized and becomes indelibly attached to the fibre. The oil-prepared cotton is steeped in cold solutions of basic aluminium sulphate or acetate, washed, dyed with Alizarin, and finally boiled for several hours with soap solution under pressure in order to brighten the colour. In the more recent and much more expeditious "sulphated-oil process," castor-oil is employed instead of olive-oil, and before use it is submitted to a treatment with sulphuric acid, the sulphated oil thus obtained being finally more or less neutralized with alkali. The cotton is impregnated with this sulphated-oil solution, dried, mordanted with aluminium acetate, dyed, dried, steamed, and soaped. The operation of steaming plays an important part in brightening and fixing the colour-lake on the fibre. In these and all other Turkey-red processes, the oil, probably in the form of an oxy-fatty acid, acts as a fixing agent for the aluminium and enters into the composition of the red lake, imparting to it both brilliancy and permanency.

Alizarin S is a sulphonic acid derivative of Alizarin, and since it is much more soluble, it readily yields level colours. Silk is dyed in a similar manner to wool, the fibre being mordanted by the ordinary methods and then dyed in a separate bath.

Diamine Fast Red is applied to cotton as a Direct Colour, with the addition of soda or soap to the dyebath. By treating the dyed colour with a solution of fluoride of chromium, its fastness to washing is materially increased. Wool is dyed in a similar manner, sodium sulphate being added to the dyebath, and the dyed colour treated with fluoride of chromium or bichromate of potash. The colour is so extremely fast to light and to milling on wool that it may well serve as a substitute for Alizarin.

Alizarin Orange is employed in the same manner as Alizarin. In wool-dyeing it is usually applied on chromium mordant for browns and a variety of compound shades in combination with other Alizarin Colours and dyewood extracts, less frequently on aluminium mordant.

Galloflavin is used in wool and silk dyeing on chromium mordant as a substitute for Fustic and other yellow dyewoods, to furnish the yellow part of compound shades.

The Alizarin Yellows, R and GG, Anthracene Yellow, Diamond Flavine, Chrome Yellow, Diamond Yellow, Carbazol Yellow, Chrysamine, &c., are Direct Colours with mordant-dyeing properties. They also serve as substitutes for Fustic in wool or silk dyeing, and are dyed either on a chromium mordant, or first in an acid bath and afterwards saddened with bichromate of potash.

Cœruleïn is employed in dyeing wool, silk, or cotton with aluminium or chromium mordants, either as a self-colour or for compound shades. With aluminium mordant the colour is a moderately bright green, more particularly on silk; with chromium mordant, an olive-green. Cœruleïn S is the more soluble bisulphite compound of the ordinary Cœruleïn. It is applied in the same manner, care being taken, however, to dye for some time (one hour) at a temperature not exceeding 60° C. until the bath is nearly exhausted, and then only raising the temperature to the boiling-point. Without this precaution Cœruleïn S is decomposed, and the ordinary insoluble Cœruleïn is precipitated. The colours obtained are very fast to light.

Fast Green, Dioxine, and Gambine are chiefly of use in calico-printing and in wool-dyeing. With iron mordant they yield olive-greens, which on wool are extremely fast to light. Cotton is impregnated with ferrous acetate, dried, aged, and fixed with silicate of soda, then dyed in a neutral bath. Wool is mordanted with ferrous sulphate and tartar (3 per cent. of each) and dyed in a neutral bath.

Acid Alizarin Green, Alizarin Cyanine Green, and Diamond Green, all dye wool direct in a bath acidified with acetic or sulphuric acid, and the dyed colour may be afterwards fixed or saddened with bichromate of potash, or they may be dyed on chromium-mordanted wool. The first method is very useful for pale shades, since the colours are very level or regular.

Alizarin Blue is a dark blue dyestuff which, owing to the fastness of the colours it yields, has for many years been regarded as a worthy substitute for Indigo in wool-dyeing. It is applied in the same manner as Alizarin, the chromium mordant being alone employed. Alizarin Blue S is the soluble sodium bisulphite compound of Alizarin Blue; it corresponds, therefore, to the above-mentioned Cœruleïn S, and in its application the same precautions as to the temperature of the dyebath are necessary. The fastness of the dyed colours to light, milling, and acid satisfy the highest requirements.

Alizarin Cyanine, Anthracene Blue, and Brilliant Alizarin Blue were discovered later than the above-mentioned Alizarin Blues, and, owing to their greater solubility and other advantages, they have largely replaced them as substitutes for Indigo. They are dyed on chromium-mordanted wool, silk, or cotton, and yield dark purplish or greenish blues, according to the particular brand employed. The fastness of the dyed colours to light, and general durability, are very satisfactory, but in fastness to milling and acids they are to some extent inferior to Alizarin Blue.

Celestine Blue and Chrome Blue dye purplish blue and bright blue respectively, and are dyed in the ordinary way upon a chromium mordant. The colours they yield are inferior to the Alizarin Colours in fastness to light, but on account of their clear shades they are often used for brightening other colours.

Brilliant Alizarin Cyanine and Alizarin Saphirole are true Alizarin Colours, and possess the same fastness to light as other colours of this class. Unlike most of the Alizarin Colours, they are capable of dyeing wool satisfactorily without the aid of a metallic mordant—namely, with the addition of sulphuric acid to the dyebath, in the same manner as the Acid Colours. If necessary, the dyed colours may be treated with bichromate of potash. The colours thus produced are very fast to light and very level, hence these dyestuffs are valuable in the production of the most delicate compound shades, such as drabs, slates, greys, &c., which are desired to be fast to light. Alizarin Saphirole dyes clear blue, the colour produced being much more brilliant even than those of Brilliant Alizarin Cyanine.

Galleïn, Gallocyanine, and especially Chrome Violet, dye somewhat bright purple shades, and are hence frequently employed for brightening other colours, but they are only moderately fast to light. They are applied in the usual manner on a chromium mordant.

Anthracene Brown is largely employed in the production of compound shades. It dyes a dark, somewhat reddish, brown on chromium mordant, the colour being very even and extremely fast to light.

Chromogen is a greyish white powder, readily soluble in water, with a pale brown colour. It is attracted and absorbed by wool in a boiling acid bath; at this stage the wool remains colourless, but by subsequently boiling it with a little bichromate of potash in the same or in a separate bath the absorbed chromogen is oxidized and the brown colour is developed.

Alizarin Black is dyed on chromium mordant in the same manner as Alizarin, and is used as a self-colour or in combination with other Alizarin Colours.

Diamond Black and the following three colours mentioned in the list are very useful for dyeing good blacks on wool, fast to light and acids. The wool is first dyed with the addition of acetic and finally sulphuric acid. When the dyebath is exhausted, bichromate of potash (2 per cent.) is added, and boiling is continued for half an hour longer.

Chromotrope, of which there are several brands, is an Acid Colour which is applied to wool in an acid bath in the usual manner. The red or purple colours thus obtained are saddened in the same bath with bichromate of potash and changed into black, the colouring matter being oxidized and simultaneously combined with chromium.

**Miscellaneous Colours.**—Under this head there may be arranged a few dyestuffs which, although capable of inclusion under one or other of the foregoing groups, it is more convenient to treat of separately. Indigo, Aniline Black, and Catechu, for example, might be placed in the class of Developed Colours, since they are all developed on the fibre, and indeed by the same method—namely, by oxidation.

Indigo is one of our most important blue dyestuffs, which has been employed from the earliest times. It may be obtained from various plants, the chief of which are the European woad-plant *Isatis tinctoria*, the Chinese and Japanese indigo-plant *Polygonum tinctorium*, and the indigo-plant of India, *Indigofera tinctoria*, &c., but the chief supply is obtained from the last-mentioned plant, which is largely cultivated in India. Curiously enough, the living plant contains no indigo, but an indigo-yielding substance called indican, which is converted into indigo during the process of extraction by the joint influence of fermentation and oxidation, there being simultaneously separated a sugar product called Indiglucine. In India the fresh plants are steeped in large tanks containing water; fermentation soon begins, and lasts for about fifteen hours, when it subsides; at this stage a clear yellow liquor is drawn off into shallow tanks, and there agitated in contact with the air, whereby the indigo is produced and precipitated as

a dark blue powder. After drawing off the supernatant liquid, the sediment of indigo is boiled with water to prevent further destructive fermentation, and then collected on filtering frames, the drained pasty indigo being finally pressed; the press-cakes are cut into the form of cubes, which are finally dried in open-air sheds. In 1878 Professor Baeyer succeeded in preparing indigo by artificial means from the coal-tar product toluene. Two years later he devised another method, the initial substance being cinnamic acid. This process, known as the "propiolic-acid" method, was for a brief period carried out on a commercial scale, the product "propiolic acid" being employed by calico-printers and only converted by them into indigo-blue during the process of application. Since then, chemists have found it possible to prepare artificial indigo by various methods, but few of these have given any great promise of commercial success. In 1890, however, Heumann astonished the chemical world by preparing indigo from such simple materials as aniline, acetic acid, chlorine, and alkali, the immediate mother-substance, prepared from the first three, being so-called phenyl-glycocoll, which requires simply to be melted with alkali and dissolved in water to yield the indigo. Difficulties as to the yield of indigo obtained soon caused this process to be abandoned in favour of one closely akin to it, in which the carboxylic acid derivative of phenyl-glycocoll is similarly melted with alkali. This substance is derived by successive stages from anthranilic acid, phthalimide, phthalic acid, and finally naphthalene. This last-mentioned substance, which has now therefore become the initial material, is obtained in large quantity by the direct distillation of coal-tar. Since 1897 the manufacture of indigo from naphthalene on a commercial scale has been carried on by one of the large German colour-manufacturing firms (Badische Anilin and Soda Fabrik) with every appearance of success, so much so that the indigo-planters of India have been compelled to adopt improved methods in order to reduce the cost of production. At the present time natural and synthetic indigo are entering upon a period of commercial competition with each other, and time alone can show which can be produced at the lowest price and be ultimately successful in the conflict. It is well to emphasize the fact that the colouring matter indigotin is identical in both the artificial and natural products, but in the latter it is accompanied by other substances, notably indigo-red (indirubin), indigo-brown, and indigo-gluten. The first is a dyestuff similar in general properties to indigo-blue, but yielding purple shades instead of blue; the rest may be regarded as impurities. An exaggerated importance has been attached by some dyers to the presence of these accompanying substances in natural indigo, as giving fulness and depth to the dyed colour, but these effects may also be obtained with artificial indigo by employing suitable means; and in the case of indigo-red this, too, can be made artificially if required.

As to the methods of application in dyeing, they are the same with both dyestuffs, and these may be now briefly described. Indigo, being insoluble in water, would be of no use in dyeing if it were not capable of being rendered soluble. This is effected in two ways, corresponding to which there are two methods of dyeing with indigo. One method consists in dissolving the indigo in very strong sulphuric acid, whereby it is converted into indigotin-disulphonic acid (Indigo Extract), which is readily soluble in water. This substance belongs to the group of Acid Colours; hence it is applied to the animal fibres, wool and silk, by boiling in a solution of the colouring matter slightly acidified with sulphuric acid. The second and most important method is based on the fact that under the influence of reducing agents (*i.e.*, substances capable of yielding nascent hydrogen) indigo-blue is changed into indigo-white, which is soluble in alkali, the solution thus obtained being called a "vat." If textile materials are steeped in a clear yellow solution of the reduced indigo and then exposed to air, the indigo-white absorbed by the fibre is oxidized and reconverted into indigo-blue within and upon the fibre, which thus becomes dyed blue; this is the so-called "indigo-vat" method of dyeing. Comparing the two methods, the "indigo-extract method" is only applicable to the animal fibres, and although it gives brighter colours, they are fugitive to light and are decolorized by washing with alkaline solutions; the "vat method" is applicable to all fibres, and gives somewhat dull blues, which are very fast to light, washing, &c.

*Cotton* is dyed by means of the "*lime and copperas vat*," the "*zinc powder vat*," or the "*hydrosulphite vat*." In the first-mentioned vat the ingredients are quicklime, ferrous sulphate, and indigo; the lime decomposes the ferrous sulphate and precipitates ferrous hydrate; this quickly absorbs oxygen from the water present, with the liberation of hydrogen, which at once combines with the indigo to form indigo-white, this in turn dissolving in the excess of lime present. The ingredients of the zinc powder vat are zinc powder, lime, and indigo; in the presence of the lime and indigo the zinc takes up oxygen from the water, liberating the hydrogen necessary to reduce the indigo, as in the previous vat. The constituents of the hydrosulphite vat are hydrosulphite, or more correctly hyposulphite of soda, lime, and indigo. The requisite hyposulphite of soda is prepared by allowing zinc powder (13 lb) to act upon a cold concentrated solution of bisulphite of soda (17 gallons of sp. gr. 1·225), taking care to avoid, as much as possible, access of air and any heating of the mixture, to prevent decomposition. The solution thus obtained is thoroughly neutralized by the addition of lime; and after settling, the clear liquor is used for the vat, along with indigo and lime. Here again the hyposulphite takes up oxygen from the water and liberates the necessary hydrogen. It is found convenient to prepare, in the first instance, a very concentrated standard of reduced indigo, and to add as much of this to the dye-vat as may be required, along with lime and a little hyposulphite of soda. The advantages of this vat are that it is easily prepared and that there is very little sediment; moreover, it can be employed in dyeing wool as well as cotton, and it is now very generally in use. The vat usually employed for dyeing *wool* is the so-called "woad vat," which differs from the foregoing in that the hydrogen necessary to reduce the indigo and bring it into solution is furnished, not by the action of chemical agents, but by means of fermentation. The ingredients of the woad-vat are indigo, woad, bran, madder, and lime. The woad here employed is prepared by grinding the leaves of the woad plant (*Isatis tinctoria*) to a paste, which is allowed to ferment and then partially dried. It serves as the ferment to excite lactic and butyric fermentation with the aid of the bran and madder, the necessary hydrogen being thus evolved. Excessive fermentation is avoided by making timely additions of lime; sluggish fermentation is accelerated by additions of bran and slightly raising the temperature. When the reduction and complete solution of the indigo is effected, the vat is allowed to settle, and the woollen material is immersed and moved about in the clear liquor for half an hour to two hours, according to the shade required, then squeezed and exposed to the air in order to develop the blue colour on the fibre.

Aniline Black differs from other dyes in that it is not sold as a ready-made dyestuff, but is produced *in situ* upon the fibre by the oxidation of aniline. It is chiefly used for cotton, also for silk and cotton-silk union fabrics, but seldom or not at all for wool. Properly applied, this colour is one of the most permanent to light and other influences with which we are acquainted. One method of dyeing cotton is to work the material for about two hours in a cold solution containing aniline (10 parts), hydrochloric acid (20 parts), bichromate of potash (20 parts), sulphuric acid (20 parts), and ferrous sulphate (10 parts). The ferrous sulphate here employed is oxidized by the chromic acid to a ferric salt, which serves as a carrier of oxygen to the aniline. This method of dyeing is easily carried out, and it gives a good black; but since much of the colouring matter is precipitated on the fibre superficially as well as in the bath itself, the colour has the defect of rubbing off. Another method is to impregnate the cotton with a solution containing aniline hydrochlorate (35 parts), neutralized with addition of a little aniline oil, sodium chlorate (10 parts), ammonium chloride (10 parts). Another mixture is 1·8 part aniline salt, 12 parts potassium ferrocyanide, water (200 parts), (3·5) potassium chlorate dissolved in water. After squeezing, the material is passed through a special oxidation chamber, the air of which is heated to about 50° C. and also supplied with moisture. This oxidizing or ageing is continuous, the material passing into the chamber at one end in a colourless condition, and after about 20 minutes passing out again with the black fully developed, a final treatment with hot chromic acid solution and soaping being necessary to complete the process. In this method, employing the first-mentioned solution, chlorate of copper is formed, and this being a very unstable compound, readily decomposes, and the aniline is oxidized by the liberated chlor-oxygen compounds. The presence in the mixture of a metallic salt is very important in aiding the development of the black, and for this purpose salts of vanadium, cerium, and copper have proved to be specially useful. The chemistry of aniline black is still incomplete, but it would appear that there are several oxidation products of aniline. The first product is so-called emeraldine, a dark green substance of the nature of a salt, which by treatment with alkali yields a dark blue base called azurine. The further oxidation of emeraldine yields nigraniline, also a dark green salt, but the free base of which has a violet black colour. The latter becomes greenish under the influence of acids, especially sulphuric acid, and explains the defect known as "greening" which is developed in ordinary aniline blacks during exposure to air. By a supplementary oxidation with chromic acid such a black is rendered ungreenable, the nigraniline being probably changed into the more stable chromate of nigraniline.

Catechu is a valuable brown dyestuff, obtained from various species of *Acacia*, *Areca*, and *Uncaria* growing in India. The wood, leaves, and fruit of these plants are extracted with boiling water; the decoction is then evaporated to dryness or to a pasty consistency. Catechu is largely used by the cotton dyer for the production of brown, drab, and similar colours. It is seldom employed for wool. Cotton is usually dyed by boiling it for about one hour in a decoction of catechu (100 per cent.) containing

copper sulphate (5 per cent.). After squeezing, the material is boiled for about fifteen minutes in a solution of bichromate of potash (¼ oz. per gal.), then washed and dried. By repeating the operations two or three times, deeper shades are obtained. During the boiling with catechu the cotton attracts the active principles catechin and catechu-tannic acid, but it thus acquires only a pale brown colour; in the bichromate of potash, however, these are oxidized to form insoluble japonic acid, which permeates the fibre, and a deep brown colour is thus developed. Catechu browns are fast to a variety of influences, *e.g.*, washing, alkalis, acids, &c., but less so to light. Catechu has been recently much employed, in conjunction with copper sulphate, for dyeing the so-called khaki-brown on woollen material for military clothing. On silk, catechu is much used for weighting purposes in dyeing black.

**Mineral Colours.**—These include Chrome Yellow, Iron Buff, Prussian Blue, and Manganese Brown.

CHROME YELLOW is only useful in cotton-dyeing as a self-colour, or for conversion into Chrome Orange, or, in conjunction with Indigo, for the production of fast green colours. The cotton is first impregnated with a solution of lead acetate or nitrate, squeezed, and then passed through a solution of sodium sulphate or lime water to fix the lead on the fibre, as sulphate or oxide of lead. The material is then passed through a solution of bichromate of potash. The colour is changed to a rich orange by a short, rapid passage through boiling milk of lime, and at once washing with water, a basic chromate of lead being thus produced. The colour is fast to light, but has the defect of being blackened by sulphuretted hydrogen.

IRON BUFF is produced by impregnating the cotton with a solution of ferrous sulphate, squeezing, passing into sodium hydrate or carbonate solution, and finally exposing to air, or passing through a dilute solution of bleaching powder. The colour obtained, which is virtually oxide of iron, or iron-rust, is fast to light, but readily removed by acids.

PRUSSIAN BLUE is applicable to wool, cotton, and silk, but since the introduction of coal-tar blues its employment has been very restricted. The colour is readily obtained on cotton by first dyeing an iron-buff, according to the method just described, and then passing the dyed cotton into an acidified solution of potassium ferrocyanide, when the blue is at once developed. A similar method is employed for silk. Wool is dyed by heating it in a solution containing potassium ferricyanide and sulphuric acid. The colour is developed gradually as the temperature rises; it may be rendered brighter by the addition of stannous chloride. On wool and silk, Prussian blue is very fast to light, but alkalis turn it brown (ferric oxide).

MANGANESE BROWN is applied in wool, silk, and cotton dyeing. The animal fibres are readily dyed by boiling with a solution of potassium permanganate, which, being at first absorbed by the fibre, is readily reduced to insoluble brown manganic hydrate. Imitation furs are dyed in this manner on wool-plush, the tips or other parts of the fibres being bleached by the application of sulphurous acid. Cotton is dyed by first impregnating it with a solution of manganous chloride, then dyeing and passing into a hot solution of caustic soda. There is thus precipitated on the fibre manganous hydrate, which by a short passage into a cold dilute solution of bleaching powder is oxidized and converted into the brown manganic hydrate. This manganese bronze or brown colour is very susceptible to, and readily bleached by, reducing agents; hence by the application of these, in conjunction with various dyestuffs, the calico-printer is able to produce a pleasing variety of so-called coloured discharge patterns.

**Theory of dyeing.**

With respect to the question of colour, we meet with two kinds of substances in nature, those which possess colour and those which do not. Why this difference? The physicist says the former are bodies which reflect all the coloured rays of the spectrum composing white light—if opaque, they appear white; if transparent, they are colourless. The latter are bodies which absorb some of the spectrum rays only, reflecting the remainder, and these together produce the impression of colour. A black substance is one which absorbs all the spectrum rays. The fundamental reason, however, of this difference of action on the part of substances towards light remains still unknown. All substances which possess colour are not necessarily dyestuffs, and the question may be again asked, Why? It is a remarkable circumstance that most of the dyestuffs at present employed occur among the so-called aromatic or benzene compounds derived from coal-tar, and a careful study of these has furnished a general explanation of the point in question, which briefly is, that the dyeing property of a substance depends upon its chemical constitution. Speaking generally, those colouring matters which have the simplest constitution are yellow, and as the molecular weight increases, their colour passes into orange, red, violet, and blue. In recent years chemists have begun to regard the constitution of nearly all dyestuffs as similar to that of Quinone, and some even believe that all coloured organic compounds have a quinonoid structure. According to O. N. Witt, a colourless hydrocarbon, *e.g.*, benzene, becomes coloured by the introduction of one or more special groups of atoms, which he terms the colour-bearing or *chromophorous groups*—*e.g.*, $NO_2$, $-N:N-$, &c. Benzene, for example, is colourless, whereas nitro-benzene and azo-benzene are yellow. Such compounds containing chromophorous groups are termed chromogens, because, although not dyestuffs themselves, they are capable of generating such by the further introduction of salt-forming atomic groups—*e.g.*, OH, $NH_2$. These Witt terms *auxochromous* groups. In this way the chromogen *tri-nitro-benzene* $C_6H_3(NO_2)_3$ becomes the dyestuff, *tri-nitro-phenol* (picric acid) $C_6H_2(NO_2)_3(OH)$, and the chromogen *azo-benzene* $C_6H_5 \cdot N:N \cdot C_6H_5$ is changed into the dyestuff *amido-azo-benzene* (Fast Yellow) $C_6H_5 \cdot N:N \cdot C_6H_4(NH_2)$. These two dyestuffs are typical of a large number which possess either an acid or a basic character according as they contain an hydroxyl (OH) or an amido ($NH_2$) group, and correspond to the Acid Colours and Basic Colours to which reference has already been made. Other important atomic groups which frequently occur, in addition to the above, are the carboxyl (COOH) and the sulphonic acid ($HSO_3$) groups; these either increase the solubility of the colouring matter or assist in causing it to be attracted by the fibre, &c. In many cases the free colour-acid or free colour-base has little colour, this being only developed in the salt. The free base rosaniline, for example, is colourless, whereas the salt magenta (rosaniline hydrochloride) has a deep crimson colour in solution. The free-acid Alizarine is orange, while its alumina-salt is bright red. It may be here stated that the scientific classification of colouring matters into Nitro-colours, Azo-colours, &c., already alluded to, is based on their chemical constitution, or the chromophorous groups they contain, whereas the classification according to their mode of application is dependent upon the character and arrangement of the auxochromous groups. The question of the mordant-dyeing property of certain colouring matters containing (OH) and (COOH) groups has already been explained under the head of *Artificial Mordant Colours*.

The peculiar property characteristic of dyestuffs, as distinguished from mere colouring matters, namely, that of being readily attracted by the textile fibres, notably the animal fibres, appears then to be due to their more or less marked acid or basic character. Intimately connected with this is the fact that these fibres also exhibit partly basic and partly acid characters, due to the presence of carboxyl and amido groups. The behaviour of magenta is typical of the Basic Colours. As already indicated, rosaniline, the base of magenta, is colourless, and only becomes coloured by its union with an acid, and yet wool and silk can be as readily dyed with the colourless rosaniline (base) as with the magenta (salt). The explanation is that the base rosaniline has united with the fibre, which here plays the part of an acid, to form a coloured salt. It has also been proved that in dyeing the animal fibres with magenta (rosaniline hydrochloride), the fibre unites with the rosaniline only, and liberates the hydrochloric acid. Further, in dyeing cotton with magenta it is necessary to prepare the cotton previously with the mordant tannic acid, with which the base rosaniline unites to form an insoluble salt.

In dyeing wool it is the fibre itself which acts as the mordant. In the case of the Acid Colours the explanation is similar. In many of these the free colour-acid has quite a different colour (purple) from that of the alkali-salt (yellow), and yet on dyeing wool or silk with the free colour-acid, the fibre exhibits the colour of the alkali-salt and not of the colour-acid. In this case the fibre evidently plays the part of a base. Another fact in favour of the view that the union between fibre and colouring matter is of a chemical nature, is that by altering the chemical constitution of the fibre its dyeing properties are also altered; oxycellulose and nitrocellulose, for example, have a greater attraction for Basic Colours than cellulose. Such facts and considerations as these have helped to establish the view that in the case of dyeing animal fibres with many colouring matters the operation is a *chemical* process, and not merely a mechanical absorption of the dyestuff. A similar explanation does not suffice, however, in the case of dyeing cotton with the Direct Colours; also in some cases of dyeing wool and silk—*e.g.*, with Orchil. These are attracted by cotton from their solutions as alkali salts, apparently without decomposition. The affinity existing between the fibre and colouring matter is somewhat feeble, for the latter can readily be removed from the dyed fibre by merely boiling with water. The depth of colour obtained in dyeing varies with the concentration of the colour solution, or with the amount of some neutral salt—*e.g.*, sodium chloride, added as an assistant to the dyebath; moreover, the dyebath is never completely exhausted. The colouring matter is submitted to the action of two forces, the solvent power of the water and the affinity of the fibre, and divides itself between the fibre and the water. After dyeing for some time, a state of equilibrium is attained in which the colouring matter is divided between the fibre and the water in a given ratio, and prolonged dyeing does not intensify the dyed colour. An interesting fact bearing on this question is that some basic colouring matters are capable of dyeing—amorphous sulphur, gelatin, silicic acid, infusorial earth, &c.

These and other similar facts have led to the adoption by various investigators of the view that in some cases the fibres exert a purely physical attraction towards colouring matters, and that the latter are held in an unchanged state by the fibre. The phenomenon is regarded as one of purely mechanical surface-attraction, very similar to that exercised by animal charcoal when employed in decolorizing a solution of some colouring matter. Some consider such direct dyeing as mere diffusion of the colouring matter into the fibre, and others that the colouring matter is in a state of "solid solution" in the fibre, similar to the solution of a metallic oxide in coloured glass. According to this latter view, the cause of the dyeing of textile fibres is similar to the attraction or solvent action exerted by ether when it withdraws colouring matter from an aqueous solution by agitation.

In the case of colours which are dyed on mordants, the question is merely transferred to the nature of the attraction which exists between the fibre and the mordant, for it has been conclusively established that the union between the colouring matter and the mordant is essentially chemical in character.

From our present knowledge it will be seen that we are unable to give a final answer to the question of whether the dyeing process is to be regarded as a chemical or a mechanical process. There are arguments and facts which favour both views; but in the case of wool and silk dyeing, the prevailing opinion in most cases is in favour of the chemical theory, whereas in cotton-dyeing the mechanical theory is widely accepted. Probably no single theory can explain satisfactorily the fundamental cause of attraction in all cases of dyeing, and further investigation is needed to answer fully this very difficult and abstruse question.

**Conclusion.**

The poisonous nature or otherwise of the coal-tar dyes has been frequently discussed, and the popular opinion, no doubt dating from the time when magenta and its derivatives were contaminated with arsenic, seems to be that they are for the most part really poisonous, and ought to be avoided for colouring materials worn next the skin, for articles of food, &c. It is satisfactory to know that most of the colours are not poisonous, but some few are—namely, Picric acid, Victoria Orange, Aurantia, Coralline, Metanil Yellow, Orange II., and Safranine. Many coal-tar colours have, indeed, been recommended as antiseptics or as medicinal remedies, *e.g.*, Methyl Violet, Auramine, and Methylene Blue, because of their special physiological action. In histology and bacteriology many coal-tar colours have rendered excellent service in staining microscopic preparations, and have enabled the investigator to detect differences of structure, &c., previously unsuspected. In photography many of the more fugitive colouring matters, *e.g.*, Cyanine, Eosine, Quinoline Red, &c., are employed in the manufacture of ortho-chromatic plates, by means of which the colours of natural objects can be photographed in the same degrees of light and shade as they appear to the eye—blue, for example, appearing a darker grey, yellow a lighter grey, in the printed photograph.

Since the year 1856, in which the first coal-tar colour, mauve, was discovered, the art of dyeing has made enormous advances, mainly in consequence of the continued introduction of coal-tar colours having the most varied properties and suitable for nearly every requirement. The old idea that the vegetable dyestuffs are superior in fastness to light is gradually being given up, and, if one may judge from the past, it seems evident that in the future there will come a time when all our dyestuffs will be prepared by artificial means.

Those who desire further information on the subject of dyeing may consult the following works of reference:—

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**Dynamics, Analytical.**—The fundamental principles of Dynamics, and their application to special problems, are explained under MECHANICS (*Ency. Brit.* vol. xv.), where brief indications are also given of the more general methods of investigating the properties of a dynamical system, independently of the accidents of its particular constitution, which were inaugurated by Lagrange. These methods, in addition to the unity and breadth which they have introduced into the treatment of pure dynamics, have a peculiar interest in relation to modern physical speculation, which finds itself confronted in various directions with the problem of explaining on dynamical principles the properties of systems whose ultimate mechanism can at present only be vaguely conjectured. This article is devoted to an outline of such portions of general dynamical theory as seem to be most important from this latter point of view.

*General Equations of Impulsive Motion.*

§ 1. The systems contemplated by Lagrange are composed of discrete particles, or of rigid bodies, in finite number, connected (it may be) in various ways by invariable geometrical relations, the fundamental postulate being that the position of every particle of the system at any time can be completely specified by means of the instantaneous values of a finite number of independent variables $q_1, q_2, \dots q_n$, each of which admits of continuous variation over a certain range, so that if $x, y, z$ be the Cartesian co-ordinates of any one particle, we have for example

$$x=f(q_1, q_2, \dots q_n), \quad y=\&c., \quad z=\&c., \qquad (1)$$

where the functions $f$ differ (of course) from particle to particle. In modern language, the variables $q_1, q_2, \dots q_n$ are *generalized co-ordinates* serving to specify the *configuration* of the system; their derivatives with respect to the time are denoted by $\dot{q}_1, \dot{q}_2, \dots \dot{q}_n$, and are called the *generalized components of velocity*. The continuous sequence of configurations assumed by the system in any actual or imagined motion (subject to the given connexions) is called the *path*.

For the purposes of a connected outline of the whole subject it is convenient to deviate somewhat from the historical order of development, and to begin with the consideration of *impulsive* motion. Whatever the actual motion of the system at any instant, we may conceive it to be generated instantaneously from rest by the application of proper impulses. On this view we have, if $x, y, z$ be the rectangular co-ordinates of any particle $m$,

**Impulsive motion.**

$$m\dot{x}=X', \quad m\dot{y}=Y', \quad m\dot{z}=Z', \qquad (2)$$

where $X', Y', Z'$ are the components of the impulse on $m$. Now let $\delta x, \delta y, \delta z$ be any infinitesimal variations of $x, y, z$ which are consistent with the connexions of the system, and let us form the equation

$$\Sigma m(\dot{x}\delta x+\dot{y}\delta y+\dot{z}\delta z)=\Sigma(X'\delta x+Y'\delta y+Z'\delta z), \qquad (3)$$

where the sign $\Sigma$ indicates (as throughout this article) a summation extending over all the particles of the system. To transform (3) into an equation involving the variations $\delta q_1, \delta q_2, \dots$ of the generalized co-ordinates, we have

$$\dot{x}=\frac{\partial x}{\partial q_1}\dot{q}_1+\frac{\partial x}{\partial q_2}\dot{q}_2+\dots, \ \&c., \&c., \qquad (4)$$

$$\delta x=\frac{\partial x}{\partial q_1}\delta q_1+\frac{\partial x}{\partial q_2}\delta q_2+\dots, \ \&c., \&c., \qquad (5)$$

and therefore

$$\Sigma m(\dot{x}\delta x+\dot{y}\delta y+\dot{z}\delta z)=(A_{11}\dot{q}_1+A_{12}\dot{q}_2+\dots)\delta q_1 + (A_{21}\dot{q}_1+A_{22}\dot{q}_2+\dots)\delta q_2+\dots, \qquad (6)$$

where

$$\left.\begin{aligned} A_{rr}&=\Sigma m\left\{\left(\frac{\partial x}{\partial q_r}\right)^2+\left(\frac{\partial y}{\partial q_r}\right)^2+\left(\frac{\partial z}{\partial q_r}\right)^2\right\}, \\ A_{rs}&=\Sigma m\left\{\frac{\partial x}{\partial q_r}\frac{\partial x}{\partial q_s}+\frac{\partial y}{\partial q_r}\frac{\partial y}{\partial q_s}+\frac{\partial z}{\partial q_r}\frac{\partial z}{\partial q_s}\right\}=A_{sr}. \end{aligned}\right\} \qquad (7)$$

If we form the expression for the kinetic energy T of the system, we find

$$2T=\Sigma m(\dot{x}^2+\dot{y}^2+\dot{z}^2)=A_{11}\dot{q}_1^2+A_{22}\dot{q}_2^2+\dots+2A_{12}\dot{q}_1\dot{q}_2+\dots \qquad (8)$$

The coefficients $A_{11}, A_{22}, \dots A_{12}, \dots$ are by an obvious analogy called the *coefficients of inertia* of the system; they are in general functions of the co-ordinates $q_1, q_2, \dots$. The equation (6) may now be written

$$\Sigma m(\dot{x}\delta x+\dot{y}\delta y+\dot{z}\delta z)=\frac{\partial T}{\partial \dot{q}_1}\delta q_1+\frac{\partial T}{\partial \dot{q}_2}\delta q_2+\dots. \qquad (9)$$

This may be regarded as the cardinal formula in Lagrange's method. For the right-hand side of (3) we may write

$$\Sigma(X'\delta x+Y'\delta y+Z'\delta z)=Q'_1\delta q_1+Q'_2\delta q_2+\dots, \qquad (10)$$

where

$$Q'_r=\Sigma\left(X'\frac{\partial x}{\partial q_r}+Y'\frac{\partial y}{\partial q_r}+Z'\frac{\partial z}{\partial q_r}\right). \qquad (11)$$

The quantities $Q_1, Q_2, \dots$ are called the *generalized components of impulse*. Comparing (9) and (10), we have, since the variations $\delta q_1, \delta q_2, \dots$ are independent,

$$\frac{\partial T}{\partial \dot{q}_1}=Q'_1, \quad \frac{\partial T}{\partial \dot{q}_2}=Q'_2, \ \dots \qquad (12)$$

These are the general equations of impulsive motion.

It is now usual to write

$$p_r=\frac{\partial T}{\partial \dot{q}_r}. \qquad (13)$$

The quantities $p_1, p_2, \dots$ represent the effects of the several component impulses on the system, and are therefore called the *generalized components of momentum.* In terms of them we have

$$\Sigma m(\dot{x}\delta x+\dot{y}\delta y+\dot{z}\delta z)=p_1\delta q_1+p_2\delta q_2+\dots \qquad (14)$$

Also, since T is a homogeneous quadratic function of the velocities $\dot{q}_1, \dot{q}_2, \dots$,

$$2T=p_1\dot{q}_1+p_2\dot{q}_2+\dots. \qquad (15)$$

This follows independently from (14), assuming the special variations $\delta x=\dot{x}dt$, &c., and therefore $\delta q_1=\dot{q}_1 dt$, $\delta q_2=\dot{q}_2 dt, \dots$.

Again, if the values of the velocities and the momenta in any other motion of the system through the same configuration be distinguished by accents, we have the identity

**Reciprocal Theorems.**

$$p_1\dot{q}'_1+p_2\dot{q}'_2+\dots=p'_1\dot{q}_1+p'_2\dot{q}_2+\dots, \qquad (16)$$

each side being equal to the symmetrical expression

$$A_{11}\dot{q}_1\dot{q}'_1+A_{22}\dot{q}_2\dot{q}'_2+\dots+A_{12}(\dot{q}_1\dot{q}'_2+\dot{q}'_1\dot{q}_2)+\dots. \qquad (17)$$

The theorem (16) leads to some important reciprocal relations. Thus, let us suppose that the momenta $p_1, p_2, \dots$ all vanish with the exception of $p_1$, and similarly that the momenta $p'_1, p'_2, \dots$ all vanish except $p'_2$. We have then $p_1\dot{q}'_1=p'_2\dot{q}_2$, or

$$\dot{q}_2 : p_1=\dot{q}'_1 : p'_2. \qquad (18)$$

The interpretation is simplest when the co-ordinates $q_1, q_2$ are both of the same kind, *e.g.*, both lines, or both angles. We may then conveniently put $p_1=p'_2$, and assert that the velocity of the first type due to an impulse of the second type is equal to the velocity of the second type due to an equal impulse of the first type. As an example, suppose we have a chain of straight links hinged each to the next, extended in a straight line, and free to move. A blow at right angles to the chain, at any point P, will produce a certain velocity at any other point Q; the theorem asserts that an equal velocity will be produced at P by an equal blow at Q. Again, an impulsive couple acting on any link A will produce a certain angular velocity in any other link B; an equal couple applied to B will produce an equal angular velocity in A. Also if an impulse F applied at P produce an angular velocity $\omega$ in a link A, a couple F$a$ applied to A will produce a linear velocity $\omega a$ at P. Historically, we may note that reciprocal relations in

dynamics were first recognized by Helmholtz in the domain of acoustics; their use has been greatly extended by Lord Rayleigh.

The equations (13) determine the momenta $p_1, p_2, \ldots$ as linear functions of the velocities $\dot{q}_1, \dot{q}_2, \ldots$. Solving these, we can express $\dot{q}_1, \dot{q}_2, \ldots$ as linear functions of $p_1, p_2, \ldots$. The resulting equations give us the velocities produced by any given system of impulses. Further, by substitution in (8), we can express the kinetic energy as a homogeneous quadratic function of the momenta $p_1, p_2, \ldots$. The kinetic energy, *as so expressed*, will be denoted by $T'$; thus

***Velocities in terms of momenta.***

$$2T' = A'_{11}p_1^2 + A'_{22}p_2^2 + \ldots + 2A'_{12}p_1p_2 + \ldots \quad . \quad (19)$$

where $A'_{11}, A'_{22}, \ldots A'_{12}, \ldots$ are certain coefficients depending on the configuration. They have been called by Maxwell the *coefficients of mobility* of the system. When the form (19) is given, the values of the velocities in terms of the momenta can be expressed in a remarkable form due to Hamilton. The formula (15) may be written

$$p_1\dot{q}_1 + p_2\dot{q}_2 + \ldots = T + T', \quad . \quad . \quad . \quad (20)$$

where T is supposed expressed as in (8), and $T'$ as in (19). Hence if, for the moment, we denote by $\delta$ a variation affecting the velocities, and therefore the momenta, but not the configuration, we have

$$p_1\delta\dot{q}_1 + \dot{q}_1\delta p + p_2\delta\dot{q}_2 + \dot{q}_2\delta p_2 + \ldots = \delta T + \delta T'$$

$$= \frac{\partial T}{\partial \dot{q}_1}\delta\dot{q}_1 + \frac{\partial T}{\partial \dot{q}_2}\delta\dot{q}_2 + \ldots + \frac{\partial T'}{\partial p_1}\delta p_1 + \frac{\partial T'}{\partial p_2}\delta p_2 + \ldots \quad . \quad (21)$$

In virtue of (13) this reduces to

$$\dot{q}_1\delta p_1 + \dot{q}_2\delta p_2 + \ldots = \frac{\partial T'}{\partial p_1}\delta p_1 + \frac{\partial T'}{\partial p_2}\delta p_2 + \ldots \quad . \quad (22)$$

Since $\delta p_1, \delta p_2, \ldots$ may be taken to be independent, we infer that

$$\dot{q}_1 = \frac{\partial T'}{\partial p_1}, \quad \dot{q}_2 = \frac{\partial T'}{\partial p_2}, \quad \ldots \quad . \quad (23)$$

In the very remarkable exposition of the matter given by Maxwell in his *Electricity and Magnetism*, the Hamiltonian expressions (23) for the velocities in terms of the impulses are obtained directly from first principles, and the formulæ (13) are then deduced by an inversion of the above argument.

An important modification of the above process has been introduced in recent times by Routh and Thomson and Tait. Instead of expressing the kinetic energy in terms of the velocities alone, or in terms of the momenta alone, we may express it in terms of the velocities corresponding to some of the co-ordinates, say $q_1, q_2, \ldots q_m$, and of the momenta corresponding to the remaining co-ordinates, which (for the sake of distinction) we may denote by $\chi, \chi', \chi'', \ldots$. Thus, T being expressed as a homogeneous quadratic function of $\dot{q}_1, \dot{q}_2, \ldots \dot{q}_m, \dot{\chi}, \dot{\chi}', \dot{\chi}'', \ldots$, the momenta corresponding to the co-ordinates $\chi, \chi', \chi'', \ldots$ may be written

***Routh's modification.***

$$\kappa = \frac{\partial T}{\partial \dot{\chi}}, \quad \kappa' = \frac{\partial T}{\partial \dot{\chi}'}, \quad \kappa'' = \frac{\partial T}{\partial \dot{\chi}''}, \quad \ldots \quad . \quad (24)$$

These equations, when written out in full, determine $\dot{\chi}, \dot{\chi}', \dot{\chi}'', \ldots$ as linear functions of $\dot{q}_1, \dot{q}_2, \ldots \dot{q}_m, \kappa, \kappa', \kappa'', \ldots$. We now consider the function

$$\Theta = T - \kappa\dot{\chi} - \kappa'\dot{\chi}' - \kappa''\dot{\chi}'' - \ldots, \quad . \quad . \quad (25)$$

supposed expressed, by means of the above relations, in terms of $\dot{q}_1, \dot{q}_2, \ldots \dot{q}_m, \kappa, \kappa', \kappa'', \ldots$. Performing the operation $\delta$ on both sides of (25), we have

$$\frac{\partial\Theta}{\partial \dot{q}_1}\delta\dot{q}_1 + \ldots + \frac{\partial\Theta}{\partial\kappa}\delta\kappa + \ldots = \frac{\partial T}{\partial \dot{q}_1}\delta\dot{q}_1 + \ldots + \frac{\partial T}{\partial\dot{\chi}}\delta\dot{\chi} + \ldots$$
$$- \kappa\delta\dot{\chi} - \dot{\chi}\delta\kappa - \ldots, \quad . \quad . \quad (26)$$

where, for brevity, only one term of each type has been exhibited. Omitting the terms which cancel in virtue of (24), we have

$$\frac{\partial\Theta}{\partial \dot{q}_1}\delta\dot{q}_1 + \ldots + \frac{\partial\Theta}{\partial\kappa}\delta\kappa + \ldots = \frac{\partial T}{\partial \dot{q}_1}\delta\dot{q}_1 + \ldots - \dot{\chi}\delta\kappa - \ldots \quad . \quad (27)$$

Since the variations $\delta q_1, \delta q_2, \ldots \delta q_m, \delta\kappa, \delta\kappa', \delta\kappa'', \ldots$ may be taken to be independent, we have

$$p_1 = \frac{\partial T}{\partial \dot{q}_1} = \frac{\partial\Theta}{\partial \dot{q}_1}, \quad p_2 = \frac{\partial T}{\partial \dot{q}_2} = \frac{\partial\Theta}{\partial \dot{q}_2}, \quad \ldots \quad . \quad (28)$$

and

$$\dot{\chi} = -\frac{\partial\Theta}{\partial\kappa}, \quad \dot{\chi}' = -\frac{\partial\Theta}{\partial\kappa'}, \quad \dot{\chi}'' = -\frac{\partial\Theta}{\partial\kappa''} \quad \ldots \quad . \quad (29)$$

An important property of the present transformation is that, when expressed in terms of the new variables, the kinetic energy is the sum of two homogeneous quadratic functions, thus

$$T = \mathfrak{T} + K, \quad . \quad . \quad . \quad . \quad (30)$$

where $\mathfrak{T}$ involves the velocities $\dot{q}_1, \dot{q}_2, \ldots \dot{q}_m$ alone, and K the momenta $\kappa, \kappa', \kappa'', \ldots$ alone. For in virtue of (29) we have, from (25),

$$T = \Theta - \left(\kappa\frac{\partial\Theta}{\partial\kappa} + \kappa'\frac{\partial\Theta}{\partial\kappa'} + \kappa''\frac{\partial\Theta}{\partial\kappa''} + \ldots\right), \quad . \quad . \quad (31)$$

and it is evident that the terms in $\Theta$ which are bilinear in respect of the two sets of variables $\dot{q}_1, \dot{q}_2, \ldots \dot{q}_m$ and $\kappa, \kappa', \kappa'', \ldots$ will disappear from the right-hand side.

It may be noted that the formula (30) gives immediate proof of two important theorems due to Bertrand and to Lord Kelvin respectively. Let us suppose, in the first place, that the system is started by given impulses of certain types, but is otherwise free. Bertrand's theorem is to the effect that the kinetic energy is *greater* than if by impulses of the remaining types the system were constrained to take any other course. We may suppose the co-ordinates to be so chosen that the constraint is expressed by the vanishing of the velocities $\dot{q}_1, \dot{q}_2, \ldots \dot{q}_m$, whilst the given impulses are $\kappa, \kappa', \kappa'', \ldots$. Hence the energy in the actual motion is greater than in the constrained motion by the amount $\mathfrak{T}$.

***Maximum and minimum energy.***

Again, suppose that the system is started with prescribed velocity components $\dot{q}_1, \dot{q}_2, \ldots \dot{q}_m$, by means of proper impulses of the corresponding types, but is otherwise free, so that in the motion actually generated we have $\kappa = 0, \kappa' = 0, \kappa'' = 0, \ldots$ and therefore $K = 0$. The kinetic energy is therefore *less* than in any other motion consistent with the prescribed velocity-conditions by the value which K assumes when $\kappa, \kappa', \kappa'', \ldots$ represent the impulses due to the constraints.

Simple illustrations of these theorems are afforded by the chain of straight links already employed. Thus if a point of the chain be held fixed, or if one or more of the joints be made rigid, the energy generated by any given impulses is less than if the chain had possessed its former freedom.

*Continuous Motion of a System.*

§ 2. We may proceed to the continuous motion of a system. The equations of motion of any particle of the system are of the form

$$m\ddot{x} = X, \quad m\ddot{y} = Y, \quad m\ddot{z} = Z. \quad . \quad . \quad (1)$$

Now let $x + \delta x$, $y + \delta y$, $z + \delta z$ be the co-ordinates of $m$ in any arbitrary motion of the system differing infinitely little from the actual motion, and let us form the equation

***Lagrange's equations.***

$$\Sigma m(\ddot{x}\delta x + \ddot{y}\delta y + \ddot{z}\delta z) = \Sigma(X\delta x + Y\delta y + Z\delta z). \quad . \quad (2)$$

Lagrange's investigation consists in the transformation of (2) into an equation involving the independent variations $\delta q_1, \delta q_2, \ldots \delta q_n$.

It is important to notice that the symbols $\delta$ and $d/dt$ are commutative, since

$$\delta\dot{x} = \frac{d}{dt}(x + \delta x) - \frac{dx}{dt} = \frac{d}{dt}\delta x, \text{ \&c.} \quad . \quad . \quad (3)$$

Hence

$$\Sigma m(\ddot{x}\delta x + \ddot{y}\delta y + \ddot{z}dz) = \frac{d}{dt}\Sigma m(\dot{x}\delta x + \dot{y}\delta y + \dot{z}\delta z)$$
$$- \Sigma m(\dot{x}\delta\dot{x} + \dot{y}\delta\dot{y} + \dot{z}\delta\dot{z})$$
$$= \frac{d}{dt}(p_1\delta q_1 + p_2\delta q_2 + \ldots) - \delta T, \quad . \quad . \quad . \quad (4)$$

by § 1 (14). The last member may be written

$$\dot{p}_1\delta q_1 + p_1\delta\dot{q}_1 + \dot{p}_2\delta q_2 + p_2\delta\dot{q}_2 + \ldots$$
$$- \frac{\partial T}{\partial \dot{q}_1}\delta\dot{q}_1 - \frac{\partial T}{\partial q}\delta q_1 - \frac{\partial T}{\partial \dot{q}_2}\delta\dot{q}_2 - \frac{\partial T}{\partial q_2}\delta q_2 - \ldots \quad . \quad (5)$$

Hence, omitting the terms which cancel in virtue of § 1 (13), we find

$$\Sigma m(\ddot{x}\delta x + \ddot{y}\delta y + \ddot{z}\delta z) = \left(\dot{p}_1 - \frac{\partial T}{\partial q_1}\right)\delta q_1 + \left(\dot{p}_2 - \frac{\partial T}{\partial q_2}\right)\delta q_2 + \ldots \quad . \quad (6)$$

For the right-hand side of (2) we have

$$\Sigma(X\delta x + Y\delta y + Z\delta z) = Q_1\delta q_1 + Q_2\delta q_2 + \ldots, \quad . \quad (7)$$

$$Q_r = \Sigma\left(X\frac{\partial x}{\partial q_r} + Y\frac{\partial y}{\partial q_r} + Z\frac{\partial z}{\partial q_r}\right). \quad . \quad . \quad (8)$$

The quantities $Q_1, Q_2, \ldots$ are called the *generalized components of force* acting on the system.

Comparing (6) and (7) we find

$$\dot{p}_1 - \frac{\partial T}{\partial q_1} = Q_1, \quad \dot{p}_2 - \frac{\partial T}{\partial q_2} = Q_2, \quad \ldots, \quad . \quad . \quad (9)$$

or, restoring the values of $p_1, p_2, \ldots$,

$$\frac{d}{dt}\left(\frac{\partial T}{\partial \dot{q}_1}\right) - \frac{\partial T}{\partial q_1} = Q_1, \quad \frac{d}{dt}\left(\frac{\partial T}{\partial \dot{q}_2}\right) - \frac{\partial T}{\partial q_2} = Q_2, \quad \ldots \quad . \quad (10)$$

These are Lagrange's general equations of motion. Their number is of course equal to that of the co-ordinates $q_1, q_2, \ldots$ to be determined.

Analytically, the above proof is that given by Lagrange, but the terminology employed is of much more recent date, having been first introduced by Thomson and Tait; it has greatly promoted the physical application of the subject. Another proof of the equations (10), by direct transformation of co-ordinates, has

been given by Hamilton and other writers, but the variational method of Lagrange is that which stands in closest relation to the subsequent developments of the subject. The chapter of Maxwell, already referred to, is a most instructive commentary on the subject from the physical point of view, although the proof there attempted of the equations (10) is fallacious.

In a "conservative system" the work which would have to be done by extraneous forces to bring the system from rest in some standard configuration to rest in the configuration $(q_1, q_2, \dots q_n)$ is independent of the path, and may therefore be regarded as a definite function of $q_1, q_2, \dots q_n$. Denoting this function (the *potential energy*) by V, we have, if there be no extraneous force on the system,

$$\Sigma(X\delta x + Y\delta y + Z\delta z) = -\delta V, \qquad (11)$$

and therefore

$$Q_1 = -\frac{\partial V}{\partial q_1},\ \ Q_2 = -\frac{\partial V}{\partial q_2},\ \dots \qquad (12)$$

Hence the typical Lagrange's equation may be now written in the form

$$\frac{d}{dt}\left(\frac{\partial T}{\partial \dot q_r}\right) - \frac{\partial T}{\partial q_r} = -\frac{\partial V}{\partial q_r}, \qquad (13)$$

or, again,

$$\dot p_r = -\frac{\partial}{\partial q_r}(V - T). \qquad (14)$$

It has been proposed by Helmholtz to give the name *kinetic potential* to the combination V − T.

To calculate the rate at which the kinetic energy varies in the actual motion we have

$$2\frac{dT}{dt} = \frac{d}{dt}(p_1\dot q_1 + p_2\dot q_2 + \dots) = \dot p_1\dot q_1 + p_1\ddot q_1 + \dot p_2\dot q_2 + p_2\ddot q_2 + \dots$$
$$= \left(\frac{\partial T}{\partial q_1} + Q_1\right)\dot q_1 + \left(\frac{\partial T}{\partial q_2} + Q_2\right)\dot q_2 + \dots + \frac{\partial T}{\partial \dot q_1}\ddot q_1 + \frac{\partial T}{\partial \dot q_2}\ddot q_2 + \dots, \qquad (15)$$

by (9). This may be written

$$2\frac{dT}{dt} = \frac{dT}{dt} + Q_1\dot q_1 + Q_2\dot q_2 + \dots \qquad (16)$$

or

$$\frac{dT}{dt} = Q_1\dot q_1 + Q_2\dot q_2 + \dots \qquad (17)$$

This expresses that the kinetic energy is increasing at a rate equal to that at which work is being done by the forces. In the case of a conservative system free from extraneous force, we have, substituting the values of $Q_1, Q_2, \dots$ from (12),

$$\frac{d}{dt}(T + V) = 0 \quad \text{or} \quad T + V = \text{const.}, \qquad (18)$$

which is the equation of energy.

A classical example of the application of Lagrange's equations is to the motion of a top. A rigid body, symmetrical about an axis, is supposed free to turn about a fixed point O in this axis, at a distance $h$ (say) from the centre of mass. Let $\theta$ be the angle which OG makes with the vertical OZ, $\psi$ the azimuth of the plane ZOG relative to a fixed vertical plane ZOX, and $\phi$ the angle which a meridian plane fixed in the solid makes with the plane ZOG, the notation being in fact that of MECHANICS, § 81. Denoting the principal moments of inertia by A, A, C, we have

***Application to the top.***

$$2T = A(\omega_1^2 + \omega_2^2) + C\omega_3^2$$
$$= A(\dot\theta^2 + \sin^2\theta\dot\psi^2) + C(\dot\phi + \dot\psi\cos\theta)^2 \dots \qquad (19)$$

If $\lambda$, $\mu$, $\nu$ be the corresponding components of momentum, we have

$$\left.\begin{aligned} \lambda = \frac{\partial T}{\partial \dot\theta} = A\dot\theta \quad \mu = \frac{\partial T}{\partial \dot\psi} = A\sin^2\theta\dot\psi + C(\dot\phi + \dot\psi\cos\theta)\cos\theta,\\ \nu = \frac{\partial T}{\partial \dot\phi} = C(\dot\phi + \dot\psi\cos\theta)\dots \end{aligned}\right\} (20)$$

The geometrical meaning of these quantities is recognized at once from the expression for the virtual moment of the impulses,

$$\lambda\delta\theta + \mu\delta\psi + \nu\delta\phi, \qquad (21)$$

viz., $\lambda$ is the angular momentum about an axis normal to the plane of $\theta$, $\mu$ is the angular momentum about the vertical, and $\nu$ that about the axis OG. If M be the total mass, the potential energy is

$$V = Mgh\cos\theta. \qquad (22)$$

Hence the equations (10) become

$$\left.\begin{aligned} &A\ddot\theta - A\sin\theta\cos\theta\dot\psi^2 + C(\dot\phi + \dot\psi\cos\theta)\dot\psi\sin\theta = Mgh\sin\theta,\\ &\frac{d}{dt}\{A\sin^2\theta\dot\psi + C(\dot\phi + \dot\psi\cos\theta)\cos\theta\} = 0,\\ &\frac{d}{dt}C(\dot\phi + \dot\psi\cos\theta) = 0, \end{aligned}\right\} \qquad (23)$$

of which the last two express the constancy of the momenta $\mu$, $\nu$. Hence

$$\left.\begin{aligned} A\ddot\theta - A\sin\theta\cos\theta\dot\psi^2 + \nu\sin\theta\dot\psi = Mgh\sin\theta,\\ A\sin^2\theta\dot\psi + \nu\cos\theta = \mu, \end{aligned}\right\} \qquad (24)$$

or, eliminating $\dot\psi$,

$$A\ddot\theta - \frac{(\mu - \nu\cos\theta)(\mu\cos\theta - \nu)}{A\sin^3\theta} = Mgh\sin\theta. \qquad (25)$$

An immediate application of (24) is to find the condition for a steady precessional motion, *i.e.*, one in which the axis of the top describes a right circular cone about the vertical. Putting $\ddot\theta = 0$, $\theta = \alpha$, in (24), we obtain

$$A\cos\alpha\dot\psi^2 - \nu\dot\psi + Mgh = 0. \qquad (26)$$

For given values of $\nu$ and $\alpha$ we have two possible values of $\dot\psi$, provided $\nu$ exceed a certain limit. With very rapid rotation, or more precisely, with $\nu$ large in comparison with $\sqrt{(4AMgh\cos\alpha)}$, one value of $\dot\psi$ is small and the other large, viz., the two values are $Mgh/\nu$ and $\nu/A\cos\alpha$, approximately. To find the small oscillation about the steady motion we put $\theta = \alpha + \chi$ in (25), and neglect terms of the second order in $\chi$. The usual method leads to an equation of the type

***Small oscillations.***

$$\ddot\chi + p^2\chi = 0, \qquad (27)$$

where

$$p^2 = \frac{(\mu - \nu\cos\alpha)^2 + 2(\mu - \nu\cos\alpha)(\mu\cos\alpha - \nu)\cos\alpha + (\mu\cos\alpha - \nu)^2}{A^2\sin^4\alpha} \qquad (28)$$

When $\nu$ is large we find that for the slow precession $p = \nu/A$, whilst for the rapid precession $p = \nu/A\cos\alpha = \dot\psi$, approximately. Further, on examining the small variation in $\dot\psi$, it appears that in a slightly disturbed *slow* precession the motion of any point of the axis consists of a rapid circular motion superposed on the slow precession, so that the resultant path has a trochoidal character. This is a type of motion commonly observed in a top spun in the ordinary way, although the successive undulations of the trochoids may be too small to be directly observed. In a slightly disturbed *rapid* precession the added vibration is elliptic-harmonic, with a period equal to that of the precession itself. The ratio of the axes of the ellipse is sec $\alpha$, the major axis being in the plane of $\theta$. The result is that the axis describes a circular cone about a fixed line making a small angle with the vertical. Another view of the matter is appropriate when we study the small oscillations about the vertical position $\alpha = 0$. The motion of any point of the axis may then be described as an elliptic-harmonic motion superposed on a uniform rotation with angular velocity $\nu/2A$ about the vertical OZ. The period of revolution in the ellipse is $2\pi/p$, where

$$p^2 = \frac{\nu^2 - 4AMgh}{4A^2} \qquad (29)$$

This would indicate that the upright position of a top (with the centre of gravity above the pivot) is stable if, and only if, $\nu^2 > 4AMgh$. See, however, § 6.

### *Constrained Systems.*

§ 3. It has so far been assumed that the geometrical relations, if any, which exist between the various parts of the system are of the type § 1 (1), and so do not contain $t$ explicitly. The extension of Lagrange's equations to the case of "varying relations" of the type

***Case of varying relations.***

$$x = f(t, q_1, q_2, \dots q_n),\ y = \&c.,\ z = \&c. \qquad (1)$$

was made by Vieille. We now have

$$\dot x = \frac{\partial x}{\partial t} + \frac{\partial x}{\partial q_1}\dot q_1 + \frac{\partial x}{\partial q_2}\dot q_2 + \dots,\ \&c.,\ \&c., \qquad (2)$$

$$\delta x = \frac{\partial x}{\partial q_1}\delta q_1 + \frac{\partial x}{\partial q_2}\delta q_2 + \dots,\ \&c.,\ \&c., \qquad (3)$$

so that the expression § 1 (8) for the kinetic energy is to be replaced by

$$2T = a_0 + 2a_1\dot q_1 + 2a_2\dot q_2 + \dots + A_{11}\dot q_1^2 + A_{22}\dot q_2^2 + \dots + A_{12}\dot q_1\dot q_2 + \dots, \qquad (4)$$

where

$$\left.\begin{aligned} a_0 = \Sigma m\left\{\left(\frac{\partial x}{\partial t}\right)^2 + \left(\frac{\partial y}{\partial t}\right)^2 + \left(\frac{\partial z}{\partial t}\right)^2\right\},\\ a_r = \Sigma m\left\{\frac{\partial x}{\partial t}\frac{\partial x}{\partial q_r} + \frac{\partial y}{\partial t}\frac{\partial y}{\partial q_r} + \frac{\partial z}{\partial t}\frac{\partial z}{\partial q_r}\right\}, \end{aligned}\right\} \qquad (5)$$

and the forms of $A_{rr}$, $A_{rs}$ are as given by § 1 (7). It is to be remembered that the coefficients $a_0, a_1, a_2, \dots A_{11}, A_{22}, \dots A_{12} \dots$ will in general involve $t$ explicitly as well as implicitly through the co-ordinates $q_1, q_2, \dots$. Again, we find

$$\Sigma m(\dot x\delta x + \dot y\delta y + \dot z\delta z) = (a_1 + A_{11}\dot q_1 + A_{12}\dot q_2 + \dots)\delta q_1$$
$$+ (a_2 + A_{21}\dot q_1 + A_{22}\dot q_2 + \dots)\delta q_2 + \dots$$
$$= \frac{\partial T}{\partial \dot q_1}\delta q_1 + \frac{\partial T}{\partial \dot q_2}\delta q_2 + \dots$$
$$= p_1\delta q_1 + p_2\delta q_2 + \dots, \qquad (6)$$

where $p_r$ is defined as in § 1 (13). The derivation of Lagrange's

equations then follows exactly as before. It is to be noted that the equation § 2 (17) does not as a rule now hold. The proof involved the assumption that T is a homogeneous quadratic function of the velocities $\dot q_1, \dot q_2 \ldots$.

It has been pointed out by Hayward that Vieille's case can be brought under Lagrange's by introducing a new co-ordinate ($\theta$) in place of $t$, so far as it appears explicitly in the relations (1). We have then

$$2T = a_0\dot\theta^2 + 2(a_1\dot q_1 + a_2\dot q_2 + \ldots)\dot\theta + A_{11}\dot q_1^2 + A_{22}\dot q_2^2 + \ldots + 2A_{12}\dot q_1\dot q_2 + \ldots . \quad (7)$$

The equations of motion will be as in § 2 (10), with the additional equation

$$\frac{d}{dt}\frac{\partial T}{\partial \dot\theta} - \frac{\partial T}{\partial \theta} = \Theta, \quad . \quad . \quad . \quad . \quad (8)$$

where $\Theta$ is the force corresponding to the co-ordinate $\theta$. We may suppose $\Theta$ to be adjusted so as to make $\ddot\theta = 0$, and in the remaining equations nothing is altered if we write $t$ for $\theta$ before, instead of after, the differentiations. The reason why the equation § 2 (17) no longer holds is that we should require to add a term $\Theta\dot\theta$ on the right-hand side; this represents the rate at which work is being done by the constraining forces required to keep $\dot\theta$ constant.

As an example, let $x, y, z$ be the co-ordinates of a particle relative to axes fixed in a solid which is free to rotate about the axis of $z$. If $\theta$ be the angular co-ordinate of the solid, we find without difficulty

$$2T = m(\dot x^2 + \dot y^2 + \dot z^2) + 2\dot\theta m(x\dot y - y\dot x) + \{I + m(x^2 + y^2)\}\dot\theta^2, \quad . \quad (9)$$

where I is the moment of inertia of the solid. The equations of motion, viz.,

$$\frac{d}{dt}\frac{\partial T}{\partial \dot x} - \frac{\partial T}{\partial x} = X, \quad \frac{d}{dt}\frac{\partial T}{\partial \dot y} - \frac{\partial T}{\partial y} = Y, \quad \frac{d}{dt}\frac{\partial T}{\partial \dot z} - \frac{\partial T}{\partial z} = Z, \quad (10)$$

and

$$\frac{d}{dt}\frac{\partial T}{\partial \dot\theta} - \frac{\partial T}{\partial \theta} = \Theta, \quad . \quad . \quad . \quad . \quad (11)$$

become

$$m(\ddot x - 2\dot\theta\dot y - x\dot\theta^2 - y\ddot\theta) = X, \quad m(\ddot y + 2\dot\theta\dot x - y\dot\theta^2 + x\ddot\theta) = Y, \quad m\ddot z = Z, \quad (12)$$

and

$$\frac{d}{dt}[\{(I + m(x^2 + y^2)\}\dot\theta + m(x\dot y - y\dot x)] = \Theta. \quad . \quad . \quad (13)$$

If we suppose $\Theta$ adjusted so as to maintain $\ddot\theta = 0$, or (again) if we suppose the moment of inertia I to be infinitely great, we obtain the familiar equations of motion relative to moving axes, viz.,

$$m(\ddot x - 2\omega\dot y - \omega^2 x) = X, \quad m(\ddot y + 2\omega\dot x - \omega^2 y) = Y, \quad m\ddot z = Z, \quad . \quad (14)$$

where $\omega$ has been written for $\dot\theta$. These are the equations which we should have obtained by applying Lagrange's rule at once to the formula

$$2T = m(\dot x^2 + \dot y^2 + \dot z^2) + 2m\omega(x\dot y - y\dot x) + m\omega^2(x^2 + y^2), \quad . \quad (15)$$

which gives the kinetic energy of the particle referred to axes rotating with the constant angular velocity $\omega$.

**Rotating axes.**

More generally, we might apply Lagrange's method to find the equations of motion of a system whose configuration relative to axes rotating with constant angular velocity ($\omega$) is defined by means of generalized co-ordinates $q_1, q_2, \ldots q_n$, writing

$$2T = \Sigma m(\dot x^2 + \dot y^2 + \dot z^2) + 2\omega\Sigma m(x\dot y - y\dot x) + \omega^2\Sigma m(x^2 + y^2)$$
$$= 2\mathfrak{T} + 2\omega\Sigma m(x\dot y - y\dot x) + 2T_0, \quad . \quad . \quad . \quad . \quad (16)$$

say. This problem is interesting on account of its bearing on the kinetic theory of the tides. The details of the work would occupy too much space, but the result may be stated. Assuming that the Cartesian co-ordinates $x, y, z$ of any particle relative to the moving axes are functions of $q_1, q_2, \ldots q_n$, of the form § 1 (1), we find, after cancelling a number of terms, that the typical equation is

$$\frac{d}{dt}\frac{\partial \mathfrak{T}}{\partial \dot q_r} - \frac{\partial \mathfrak{T}}{\partial q_r} + (r,1)\dot q_1 + (r,2)\dot q_2 + \ldots + (r,s)\dot q_s + \ldots - \frac{\partial T_0}{\partial q_r} = Q_r, \quad (17)$$

where

$$(r, s) = 2\omega \,.\, \Sigma m \frac{\partial(x, y)}{\partial(q_s, q_r)}. \quad . \quad . \quad . \quad (18)$$

It is to be noticed that

$$(r, r) = 0, \quad (r, s) = -(s, r). \quad . \quad . \quad (19)$$

The conditions of relative equilibrium are

$$Q_r = -\frac{\partial T_0}{\partial q_r}, \quad . \quad . \quad . \quad . \quad (20)$$

or, in case the forces $Q_r$ depend only on the co-ordinates $q_1, q_2, \ldots$, and are conservative,

$$\frac{\partial}{\partial q_r}(V - T_0) = 0, \quad . \quad . \quad . \quad . \quad (21)$$

*i.e.*, the value of $V - T_0$ must be *stationary*.

If we multiply (17) by $\dot q_r$, and sum the result for $r = 1, 2, 3, \ldots n$, we find, taking account of (19),

$$\frac{d}{dt}(\mathfrak{T} - T_0) = Q_1\dot q_1 + Q_2\dot q_2 + \ldots, \quad . \quad . \quad (22)$$

or, in the case of conservative forces,

$$\mathfrak{T} + V - T_0 = \text{const.} \quad . \quad . \quad . \quad (23)$$

This may be called the equation of relative energy. It may, of course, be easily established from first principles without the use of generalized co-ordinates.

**Constrained systems.**

We have still to notice the modifications which Lagrange's equations undergo when the co-ordinates $q_1, q_2, \ldots q_n$ are not all independently variable. In the first place, we may suppose them connected by a number $m$ ($< n$) of relations of the type

$$A(t, q_1, q_2, \ldots q_n) = 0, \quad B(t, q_1, q_2, \ldots q_n) = 0, \quad \&c., \quad (24)$$

These may be interpreted as introducing partial constraints into a previously free system. The variations $\delta q_1, \delta q_2, \ldots \delta q_n$ in the expressions (6) and (7) of § 2 which are to be equated are no longer independent, but are subject to the relations

$$\frac{\partial A}{\partial q_1}\delta q_1 + \frac{\partial A}{\partial q_2}\delta q_2 + \ldots = 0, \quad \frac{\partial B}{\partial q_1}\delta q_1 + \frac{\partial B}{\partial q_2}\delta q_2 + \ldots = 0, \quad \&c. \quad (25)$$

Introducing indeterminate multipliers $\lambda, \mu, \ldots$, one for each of these equations, we obtain in the usual manner $n$ equations of the type

$$\frac{d}{dt}\frac{\partial T}{\partial \dot q_r} - \frac{\partial T}{\partial q_r} = Q_r + \lambda\frac{\partial A}{\partial q_r} + \mu\frac{\partial B}{\partial q_r} + \ldots, \quad . \quad . \quad (26)$$

in place of § 2 (10). These equations, together with (24), serve to determine the $n$ co-ordinates $q_1, q_2, \ldots q_n$ and the $m$ multipliers $\lambda, \mu, \ldots$.

Again, it may happen that although there are no prescribed relations between the co-ordinates $q_1, q_2, \ldots q_n$, yet from the circumstances of the problem certain geometrical conditions are imposed on their *variations*, thus

$$A_1\delta q_1 + A_2\delta q_2 + \ldots = 0, \quad B_1\delta q_1 + B_2\delta q_2 + \ldots = 0, \quad \&c., \quad (27)$$

where the coefficients are functions of $q_1, q_2, \ldots q_n$ and (possibly) of $t$. It is assumed that these equations are not integrable as regards the variables $q_1, q_2, \ldots q_n$; otherwise, we fall back on the previous conditions. Cases of the present type arise, for instance, in ordinary dynamics when we have a solid rolling on a (fixed or moving) surface. The six co-ordinates which serve to specify the position of the solid at any instant are not subject to any necessary relation, but the conditions to be satisfied at the point of contact impose three conditions of the form (27). The general equations of motion are obtained, as before, by the method of indeterminate multipliers, thus

$$\frac{d}{dt}\frac{\partial T}{\partial \dot q_r} - \frac{\partial T}{\partial q_r} = Q_r + \lambda A_r + \mu B_r + \ldots . \quad . \quad . \quad (28)$$

The co-ordinates $q_1, q_2, \ldots q_n$, and the indeterminate multipliers $\lambda, \mu, \ldots$ are determined by these equations and by the velocity-conditions corresponding to (27). When $t$ does not appear explicitly in the coefficients, these velocity-conditions take the forms

$$A_1\dot q_1 + A_2\dot q_2 + \ldots = 0, \quad B_1\dot q_1 + B_2\dot q_2 + \ldots = 0, \quad \&c. \quad . \quad (29)$$

*Hamiltonian Equations of Motion.*

§ 4. In the Hamiltonian form of the equations of motion of a conservative system with unvarying relations, the kinetic energy is supposed expressed in terms of the *momenta* $p_1, p_2, \ldots$ and the co-ordinates $q_1, q_2, \ldots$, as in § 1 (19). Since the symbol $\delta$ now denotes a variation extending to the co-ordinates as well as to the momenta, we must add to the last member of § 1 (21) terms of the types

$$\frac{\partial T}{\partial q_1}\delta q_1 + \frac{\partial T'}{\partial q_1}\delta q_1 + \ldots . \quad . \quad . \quad . \quad (1)$$

Since the variations $\delta p_1, \delta p_2, \ldots \delta q_1, \delta q_2, \ldots$ may be taken to be independent, we infer the equations § 1 (23) as before, together with

$$\frac{\partial T}{\partial q_1} = -\frac{\partial T'}{\partial q_1}, \quad \frac{\partial T}{\partial q_2} = -\frac{\partial T'}{\partial q_2}, \quad \ldots, \quad . \quad . \quad (2)$$

Hence the Lagrangian equations § 2 (14) transform into

$$\dot p_1 = -\frac{\partial}{\partial q_1}(T' + V), \quad \dot p_2 = -\frac{\partial}{\partial q_2}(T' + V), \quad \ldots . \quad (3)$$

If we write

$$H = T' + V, \quad . \quad . \quad . \quad . \quad (4)$$

so that H denotes the *total energy* of the system, supposed expressed in terms of the new variables, we get

$$\dot p_1 = -\frac{\partial H}{\partial q_1}, \quad \dot p_2 = -\frac{\partial H}{\partial q_2}, \quad \ldots \quad . \quad . \quad (5)$$

If to these we join the equations

$$\dot q_1 = \frac{\partial H}{\partial p_1}, \quad \dot q_2 = \frac{\partial H}{\partial p_2}, \quad \ldots, \quad . \quad . \quad . \quad (6)$$

which follow at once from § 1 (23), since V does not involve $p_1, p_2, \ldots$, we obtain a complete system of differential equations *of the first order* for the determination of the motion.

The equation of energy is verified immediately by (5) and (6), since these make

$$\frac{d\mathrm{H}}{dt}=\frac{\partial \mathrm{H}}{\partial p_1}\dot{p}_1+\frac{\partial \mathrm{H}}{\partial p_2}\dot{p}_2+\ldots+\frac{\partial \mathrm{H}}{\partial q_1}\dot{q}_1+\frac{\partial \mathrm{H}}{\partial q_2}\dot{q}_2+\ldots=0. \quad . \quad (7)$$

The Hamiltonian transformation is extended to the case of varying relations as follows. Instead of (4) we write

$$\mathrm{H}=p_1\dot{q}_1+p_2\dot{q}_2+\ldots-\mathrm{T}+\mathrm{V}, \quad . \quad . \quad . \quad (8)$$

and imagine H to be expressed in terms of the momenta $p_1, p_2, \ldots$, the co-ordinates $q_1, q_2, \ldots$, and the time. The internal forces of the system are assumed to be conservative, with the potential energy V. Performing the variation $\delta$ on both sides, we find

$$\delta \mathrm{H}=\dot{q}_1\delta p_1+\ldots-\frac{\partial \mathrm{T}}{\partial q_1}\delta q_1+\frac{\partial \mathrm{V}}{\partial q_1}\delta q+\ldots, \quad . \quad (9)$$

terms which cancel in virtue of the definition of $p_1, p_2, \ldots$ being omitted. Since $\delta p_1, \delta p_2, \ldots, \delta q_1, \delta q_2 \ldots$ may be taken to be independent, we infer

$$\dot{q}_1=\frac{\partial \mathrm{H}}{\partial p_1}, \quad \dot{q}_2=\frac{\partial \mathrm{H}}{\partial p_2}, \ \ldots, \quad . \quad . \quad . \quad (10)$$

and

$$\frac{\partial}{\partial q_1}(\mathrm{T}-\mathrm{V})=-\frac{\partial \mathrm{H}}{\partial q_1}, \quad \frac{\partial}{\partial q_2}(\mathrm{T}-\mathrm{V})=-\frac{\partial \mathrm{H}}{\partial q_2}, \ \ldots \quad . \quad (11)$$

It follows from (11) that

$$\dot{p}_1=-\frac{\partial \mathrm{H}}{\partial q_1}, \quad \dot{p}_2=-\frac{\partial \mathrm{H}}{\partial q_2}, \ \ldots. \quad . \quad . \quad (12)$$

The equations (10) and (12) have the same form as above, but H is no longer equal to the energy of the system.

### *Cyclic Systems.*

§ 5. A *cyclic* or *gyrostatic* system is characterized by the following properties. In the first place, the kinetic energy is not affected if we alter the absolute values of certain of the co-ordinates, which we will denote by $\chi, \chi', \chi'', \ldots$, provided the remaining co-ordinates $q_1, q_2, \ldots q_m$ and the velocities, including of course the velocities $\dot{\chi}, \dot{\chi}', \dot{\chi}'', \ldots$, are unaltered. Secondly, there are no forces acting on the system of the types $\chi, \chi', \chi'', \ldots$. This case arises, for example, when the system includes gyrostats which are free to rotate about their axes, the co-ordinates $\chi, \chi', \chi'', \ldots$ then being the angular co-ordinates of the gyrostats relatively to their frames. Again, in theoretical hydrodynamics we have the problem of moving solids in a frictionless liquid; the ignored co-ordinates $\chi, \chi', \chi'', \ldots$ then refer to the fluid, and are infinite in number. The same question presents itself in various physical speculations where certain phenomena are ascribed to the existence of *latent motions* in the ultimate constituents of matter. The general theory of such systems has been treated by Routh, Lord Kelvin, and Helmholtz.

***Routh's equations.***

If we suppose the kinetic energy T to be expressed, as in Lagrange's method, in terms of the co-ordinates and the velocities, the equations of motion corresponding to $\chi, \chi', \chi'', \ldots$ reduce, in virtue of the above hypotheses, to the forms

$$\frac{d}{dt}\frac{\partial \mathrm{T}}{\partial \dot{\chi}}=0, \quad \frac{d}{dt}\frac{\partial \mathrm{T}}{\partial \dot{\chi}'}=0, \quad \frac{d}{dt}\frac{\partial \mathrm{T}}{\partial \dot{\chi}''}=0, \ \ldots, \quad . \quad (1)$$

whence

$$\frac{\partial \mathrm{T}}{\partial \dot{\chi}}=\kappa, \quad \frac{\partial \mathrm{T}}{\partial \dot{\chi}'}=\kappa', \quad \frac{\partial \mathrm{T}}{\partial \dot{\chi}''}=\kappa'', \ \ldots, \quad . \quad . \quad (2)$$

where $\kappa, \kappa', \kappa'', \ldots$ are the constant momenta corresponding to the cyclic co-ordinates $\chi, \chi', \chi'', \ldots$. These equations are linear in $\dot{\chi}, \dot{\chi}', \dot{\chi}'', \ldots$; solving them with respect to these quantities and substituting in the remaining Lagrangian equations, we obtain $m$ differential equations to determine the remaining co-ordinates $q_1, q_2, \ldots q_m$. The object of the present investigation is to ascertain the general form of the resulting equations. The retained co-ordinates $q_1, q_2, \ldots q_m$ may be called (for distinction) the *palpable* co-ordinates of the system; in many practical questions they are the only co-ordinates directly in evidence.

If, as in § 1 (25), we write

$$\Theta=\mathrm{T}-\kappa\dot{\chi}-\kappa'\dot{\chi}'-\kappa''\dot{\chi}'-\ldots, \quad . \quad . \quad . \quad (3)$$

and imagine $\Theta$ to be expressed by means of (2) as a quadratic function of $\dot{q}_1, \dot{q}_2, \ldots \dot{q}_m, \kappa, \kappa', \kappa'', \ldots$ with coefficients which are in general functions of the co-ordinates $q_1, q_2, \ldots q_m$, then, performing the operation $\delta$ on both sides, we find

$$\frac{\partial \Theta}{\partial \dot{q}_1}\delta\dot{q}_1+\ldots+\frac{\partial \Theta}{\partial \kappa}\delta\kappa+\ldots+\frac{\partial \Theta}{\partial q_1}\delta q_1+\ldots=\frac{\partial \mathrm{T}}{\partial \dot{q}_1}\delta\dot{q}_1+\ldots+\frac{\partial \mathrm{T}}{\partial q_1}\delta q_1+\ldots$$
$$+\frac{\partial \mathrm{T}}{\partial \dot{\chi}}\delta\dot{\chi}+\ldots+\frac{\partial \mathrm{T}}{\partial \chi_1}\delta q_1+\ldots-\kappa\delta\dot{\chi}-\dot{\chi}\delta\kappa-\ldots. \quad . \quad (4)$$

Omitting the terms which cancel by (2), we find

$$\frac{\partial \mathrm{T}}{\partial q_1}=\frac{\partial \Theta}{\partial \dot{q}_1}, \quad \frac{\partial \mathrm{T}}{\partial \dot{q}_2}=\frac{\partial \Theta}{\partial \dot{q}_2}, \ \ldots, \quad . \quad . \quad . \quad (5)$$

$$\frac{\partial \mathrm{T}}{\partial q_1}=\frac{\partial \Theta}{\partial q_1}, \quad \frac{\partial \mathrm{T}}{\partial q_2}=\frac{\partial \Theta}{\partial q_2}, \ \ldots, \quad . \quad . \quad . \quad (6)$$

$$\dot{\chi}=-\frac{\partial \Theta}{\partial \kappa}, \quad \dot{\chi}'=-\frac{\partial \Theta}{\partial \kappa'}, \quad \dot{\chi}''=-\frac{\partial \Theta}{\partial \kappa''}, \quad . \quad . \quad (7)$$

Substituting in § 2 (10), we have

$$\frac{d}{dt}\frac{\partial \Theta}{\partial \dot{q}_1}-\frac{\partial \Theta}{\partial q_1}=\mathrm{Q}_1, \quad \frac{d}{dt}\frac{\partial \Theta}{\partial \dot{q}_2}-\frac{\partial \Theta}{\partial q_2}=\mathrm{Q}_2, \ \ldots \ldots \quad . \quad (8)$$

These are Routh's forms of the modified Lagrangian equations. Equivalent forms were obtained independently by Helmholtz at a later date.

The function $\Theta$ is made up of three parts, thus

$$\Theta=\Theta_{2,0}+\Theta_{1,1}+\Theta_{0,2}, \quad . \quad . \quad . \quad (9)$$

***Kelvin's equations.***

where $\Theta_{2,0}$ is a homogeneous quadratic function of $\dot{q}_1, \dot{q}_2 \ldots, \dot{q}_m$, $\Theta_{0,2}$ is a homogeneous quadratic function of $\kappa, \kappa', \kappa'', \ldots$, whilst $\Theta_{1,1}$ consists of products of the velocities $\dot{q}_1, \dot{q}_2, \ldots \dot{q}_m$ into the momenta $\kappa, \kappa', \kappa'' \ldots$. Hence from (3) and (7) we have

$$\mathrm{T}=\Theta-\left(\kappa\frac{\partial \Theta}{\partial \kappa}+\kappa'\frac{\partial \Theta}{\partial \kappa'}+\kappa''\frac{\partial \Theta}{\partial \kappa''}+\ldots\right)$$
$$=\Theta_{2,0}-\Theta_{0,2}. \quad . \quad . \quad . \quad . \quad . \quad (10)$$

If, as in § 1 (30), we write this in the form

$$\mathrm{T}=\mathfrak{T}+\mathrm{K}, \quad . \quad . \quad . \quad . \quad . \quad (11)$$

then (3) may be written

$$\Theta=\mathfrak{T}-\mathrm{K}+\beta_1\dot{q}_1+\beta_2\dot{q}_2+\ldots. \quad . \quad . \quad (12)$$

where $\beta_1, \beta_2, \ldots$ are linear functions of $\kappa, \kappa', \kappa'', \ldots$ say

$$\beta_r=\alpha_r\kappa+\alpha'_r\kappa'+\alpha''_r\kappa''+\ldots \quad . \quad . \quad . \quad (13)$$

the coefficients $\alpha_r, \alpha'_r, \alpha''_r, \ldots$ being in general functions of the co-ordinates $q_1, q_2, \ldots q_m$. Evidently $\beta_r$ denotes that part of the momentum-component $\partial\Theta/\partial\dot{q}_r$ which is due to the cyclic motions. Now

$$\frac{d}{dt}\frac{\partial \Theta}{\partial \dot{q}_r}=\frac{d}{dt}\left(\frac{\partial \mathfrak{T}}{\partial \dot{q}_r}+\beta_r\right)=\frac{d}{dt}\frac{\partial \mathfrak{T}}{\partial \dot{q}_r}+\frac{\partial \beta_r}{\partial q_1}\dot{q}_1+\frac{\partial \beta_r}{\partial q_2}\dot{q}_2+\ldots, \quad (14)$$

$$\frac{\partial \Theta}{\partial q_r}=\frac{\partial \mathfrak{T}}{\partial q_r}-\frac{\partial \mathrm{K}}{\partial q_r}+\frac{\partial \beta_1}{\partial q_r}\dot{q}_1+\frac{\partial \beta_2}{\partial q_r}\dot{q}_2+\ldots. \quad . \quad . \quad (15)$$

Hence, substituting in (8), we obtain the typical equation of motion of a gyrostatic system in the form

$$\frac{d}{dt}\frac{\partial \mathfrak{T}}{\partial \dot{q}_r}-\frac{\partial \mathfrak{T}}{\partial q_r}+(r,1)\dot{q}_1+(r,2)\dot{q}_2+\ldots+(r,s)\dot{q}_s+\ldots+\frac{\partial \mathrm{K}}{\partial q_r}=\mathrm{Q}_r, \quad (16)$$

where

$$(r,s)=\frac{\partial \beta_r}{\partial q_s}-\frac{\partial \beta_s}{\partial q_r}. \quad . \quad . \quad . \quad (17)$$

This form is due to Lord Kelvin. When $q_1, q_2, \ldots q_m$ have been determined, as functions of the time, the velocities corresponding to the cyclic co-ordinates can be found, if required, from the relations (7), which may be written

$$\left.\begin{aligned}\dot{\chi}&=\frac{\partial \mathrm{K}}{\partial \kappa}-\alpha_1\dot{q}_1-\alpha_2\dot{q}_2-\ldots,\\ \dot{\chi}'&=\frac{\partial \mathrm{K}}{\partial \kappa'}-\alpha'_1\dot{q}_1-\alpha'_2\dot{q}_2-\ldots,\\ &\&c., \&c.\end{aligned}\right\} \quad . \quad . \quad (18)$$

It is to be particularly noticed that

$$(r,r)=0, \quad (r,s)=-(s,r). \quad . \quad . \quad . \quad (19)$$

Hence, if in (16) we put $r=1, 2, 3, \ldots m$, and multiply by $\dot{q}_1, \dot{q}_2, \ldots \dot{q}_m$ respectively, and add, we find

$$\frac{d}{dt}(\mathfrak{T}+\mathrm{K})=\mathrm{Q}_1\dot{q}_1+\mathrm{Q}_2\dot{q}_2+\ldots \quad . \quad . \quad (20)$$

or, in the case of a conservative system

$$\mathfrak{T}+\mathrm{V}+\mathrm{K}=\text{const.} \quad . \quad . \quad . \quad (21)$$

which is the equation of energy.

The equations (16) include § 3 (17) as a particular case, the eliminated co-ordinate being the angular co-ordinate of a rotating solid having an infinite moment of inertia.

In the particular case where the cyclic momenta $\kappa, \kappa', \kappa'', \ldots$ are all zero, (16) reduces to

$$\frac{d}{dt}\frac{\partial \mathfrak{T}}{\partial \dot{q}_r}-\frac{\partial \mathfrak{T}}{\partial q_r}=\mathrm{Q}_r. \quad . \quad . \quad . \quad (22)$$

The form is the same as in § 2, and the system now behaves, as regards the co-ordinates $q_1, q_2, \ldots q_m$, exactly like the acyclic type there contemplated. These co-ordinates do not, however,

now fix the position of every particle of the system. For example, if by suitable forces the system be brought back to its initial configuration (so far as this is defined by $q_1, q_2, \dots q_m$), after performing any evolutions, the ignored co-ordinates $\chi, \chi', \chi'', \dots$ will not in general return to their original values.

If in Lagrange's equations § 2 (10) we reverse the sign of the time-element $dt$, the equations are unaltered. The motion is therefore reversible; that is to say, if as the system is passing through any configuration its velocities $\dot{q}_1, \dot{q}_2, \dots \dot{q}_n$ be all reversed, it will (if the forces be the same in the same configuration) retrace its former path. But it is important to observe that the statement does not in general hold of a gyrostatic system; the terms of (16), which are linear in $\dot{q}_1, \dot{q}_2, \dots \dot{q}_m$, change sign with $dt$, whilst the others do not. Hence the motion of a gyrostatic system is not reversible, unless indeed we reverse the cyclic motions as well as the velocities $\dot{q}_1, \dot{q}_2, \dots \dot{q}_m$. For instance, the precessional motion of a top cannot be reversed unless we reverse the spin.

***Kineto-statics.***

The *conditions of equilibrium* of a system with latent cyclic motions are obtained by putting $\dot{q}_1 = 0$, $\dot{q}_2 = 0, \dots \dot{q}_m = 0$ in (16); viz., they are

$$Q_1 = \frac{\partial K}{\partial q_1}, \quad Q_2 = \frac{\partial K}{\partial q_2}, \quad \dots \quad . \quad . \quad . \quad (23)$$

These may of course be obtained independently. Thus if the system be guided from (apparent) rest in the configuration $(q_1, q_2, \dots q_m)$ to rest in the configuration $(q_1 + \delta q_1, q_2 + \delta q_2, \dots q_m + \delta q_m)$, the work done by the forces must be equal to the increment of the kinetic energy. Hence

$$Q_1 \delta q_1 + Q_2 \delta q_2 + \dots = \delta K, \quad . \quad . \quad . \quad (24)$$

which is equivalent to (23). The conditions are the same as for the equilibrium of a system without latent motion, but endowed with potential energy K. This is important from a physical point of view, as showing how energy which is apparently potential may in its ultimate essence be kinetic.

By means of the formulæ (18), which now reduce to

$$\dot{\chi} = \frac{\partial K}{\partial \kappa}, \quad \dot{\chi}' = \frac{\partial K}{\partial \kappa'}, \quad \dot{\chi}'' = \frac{\partial K}{\partial \kappa''}, \dots, \quad . \quad . \quad (25)$$

K may also be expressed as a homogeneous quadratic function of the cyclic velocities $\dot{\chi}, \dot{\chi}', \dot{\chi}'', \dots$. Denoting it in this form by $T_0$, we have

$$\delta(T_0 + K) = 2\delta K = \delta(\kappa\dot{\chi} + \kappa'\dot{\chi}' + \kappa''\dot{\chi}'' + \dots) . \quad . \quad (26)$$

Performing the variations, and omitting the terms which cancel by (2) and (25), we find

$$\frac{\partial T_0}{\partial q_1} = -\frac{\partial K}{\partial q_1}, \quad \frac{\partial T_0}{\partial q_2} = -\frac{\partial K}{\partial q_2}, \quad \dots \quad . \quad . \quad (27)$$

so that the formulæ (23) become

$$Q_1 = -\frac{\partial T_0}{\partial q_1}, \quad Q_2 = -\frac{\partial T_0}{\partial q_2}, \quad \dots \quad . \quad . \quad (28)$$

A simple example is furnished by the top (§ 2). The cyclic co-ordinates being $\psi$, $\phi$, we find

$$2\mathfrak{T} = A\dot{\theta}^2, \quad 2K = \frac{(\mu - \nu\cos\theta)^2}{A\sin^2\theta} + \frac{\nu^2}{C},$$

$$2T_0 = A\sin^2\theta\dot{\psi}^2 + C(\dot{\phi} + \dot{\psi}\cos\theta)^2, . \quad . \quad (29)$$

whence we may verify that $\partial T_0/\partial\theta = -\partial K/\partial\theta$ in accordance with (27). And the condition of equilibrium

$$\frac{\partial K}{\partial \theta} = -\frac{\partial V}{\partial \theta} \quad . \quad . \quad . \quad . \quad (30)$$

gives the condition of steady precession, § 2 (26).

*Stability of Equilibrium and of Steady Motion.*

***Statical stability.***

§ 6. The theory of the small oscillations of a conservative system about a configuration of equilibrium, originated by Lagrange, has been greatly developed by Thomson and Tait, Routh, and Lord Rayleigh. The details of the matter belong properly to acoustics, but some reference may be made to the important but rather difficult question of stability. If we neglect small quantities of the second order in the velocities and the displacements, Lagrange's equations assume a linear form, and the deviation of any co-ordinate from its equilibrium value is expressed by a series of terms of the type $Ce^{\pm\lambda t}$, the admissible values of $\lambda^2$ being given by an algebraic equation of degree $n$. In order that the expressions for the deviations may not admit of indefinite increase, the values of $\lambda$ must be purely imaginary (*i.e.*, of the form $i\sigma$), so that the exponentials become replaced by circular functions of $t$. It is found that this will be the case if, and only if, the potential energy V is a minimum in the configuration of equilibrium. Accordingly, it is usual to say that the necessary and sufficient condition for stability is that the equilibrium-value of V should be a minimum.

The validity of this inference has in recent times been contested. It is pointed out that since Lagrange's approximate equations become less and less accurate as the deviation from the equilibrium configuration increases, it is a matter for examination how far rigorous conclusions as to the ultimate extent of the deviation can be based upon them. Some researches in this direction have been instituted by Liapounoff, Poincaré, and others, but the question cannot yet be regarded as completely resolved.

That the occurrence of a minimum value of V is a *sufficient* condition of stability was shown independently by Dirichlet. In the motion consequent on any slight disturbance the total energy $T + V$ is constant, and since T is essentially positive, it follows that V can never exceed its equilibrium value by more than a slight amount depending on the energy of the disturbance. This implies, on the present hypothesis, that there is an upper limit to the deviation of each co-ordinate from its equilibrium value; moreover, this limit diminishes indefinitely with the energy of the original disturbance. No such simple proof is available to show without qualification that the above condition is *necessary*. If, however, we recognize the existence of dissipative forces called into play by any motion of the system, the conclusion can be drawn as follows. However slight these forces may be, the total energy $T + V$ must continually diminish so long as the velocities $\dot{q}_1, \dot{q}_2, \dots \dot{q}_n$ differ from zero. Hence, if the system be started from rest in a configuration for which V is less than in the equilibrium configuration, this expression must still further decrease (since T cannot be negative), and it is evident that either the system will finally come to rest in some new equilibrium configuration, or V will in the long run diminish indefinitely. This argument is due to Thomson and Tait.

***Kinetic stability.***

A little consideration will show that a good deal of the obscurity which attaches to the question arises from the want of a sufficiently precise definition of what is meant by "stability." The same difficulty is encountered, in an aggravated form, when we pass to the question of stability of motion. The various definitions of stability which have been propounded by different writers are examined critically by Klein and Sommerfeld in their book on the theory of the top. Rejecting previous definitions, they base their criterion of stability on the character of the changes produced in the *path* of the system by small arbitrary disturbing impulses. If the undisturbed path be the *limiting form* of the disturbed path when the impulses are indefinitely diminished, it is said to be stable, but not otherwise. For instance, the vertical fall of a particle under gravity is reckoned as stable, although for a *given* impulsive disturbance, however small, the deviation of the particle's position at any time $t$ from the position which it would have occupied in the original motion increases indefinitely with $t$. Even this criterion, as the writers quoted themselves recognize, is not free from ambiguity unless the phrase "limiting form," as applied to a path, be strictly defined. It appears, moreover, that a definition which is analytically precise may not in all cases be easy to reconcile with geometrical prepossessions.

A special form of the problem, of great interest, presents itself in the steady motion of a gyrostatic system, when the non-eliminated co-ordinates $q_1, q_2, \dots q_m$ all vanish (see § 5). This has been discussed by Routh, Thomson and Tait, and Poincaré. These writers treat the question, by an extension of Lagrange's method, as a problem of small oscillations. Whether we adopt the notion of stability which this implies, or take up the position of Klein and Sommerfeld, there is no difficulty in showing that stability is ensured if $V + K$ be a minimum as regards variations of $q_1, q_2, \dots q_m$. The proof is the same as that of Dirichlet for the case of statical stability. It is easily seen that, in the notation of § 5, an equivalent condition is that $V - T_0$ should be a minimum for the same variations.

We can illustrate this condition from the case of the top, where, in our previous notation,

$$V + K = Mgh\cos\theta + \frac{(\mu - \nu\cos\theta)^2}{2A\sin^2\theta} + \frac{\nu^2}{2C} . \quad . \quad . \quad (1)$$

To examine whether the steady motion with the centre of gravity vertically above the pivot is stable, we must put $\mu = \nu$. We then find without difficulty that $V + K$ is a minimum provided $\nu^2 \geqq 4AMgh$. The method of small oscillations gave us the condition $\nu^2 > 4AMgh$, and indicated instability in the cases $\nu^2 \leqq 4AMgh$. The present criterion can also be applied to show that the steady precessional motions in which the axis has a constant inclination to the vertical are stable.

The question remains, as before, whether it is *essential* for stability that $V + K$ should be a minimum. It appears that from the point of view of the theory of small oscillations it is not essential, and that there may even be stability when $V + K$ is a maximum. The precise conditions, which are of a somewhat elaborate character, have been formulated by Routh. An important distinction has, however, been established by Thomson and Tait, and by Poincaré, between what we may call *ordinary* or *accidental* stability (which is stability in the above sense) and *permanent* or *secular* stability, which means stability when regard is had to possible dissipative

forces called into play whenever the co-ordinates $q_1, q_2, \ldots q_m$ vary. Since the total energy of the system at any instant is given (in the notation of § 5) by an expression of the form $\mathfrak{T} + \mathrm{V} + \mathrm{K}$, where $\mathfrak{T}$ cannot be negative, the argument of Thomson and Tait, given above for the statical question, shows that it is a necessary as well as a sufficient condition for secular stability that $\mathrm{V} + \mathrm{K}$ should be a minimum.

*Principle of Least Action.*

§ 7. The preceding theories give us statements applicable to the system at any one instant of its motion. We now come to a series of theorems relating to the whole motion of the system between any two configurations through which it passes, viz., we consider the actual motion and compare it with other imaginable motions, differing infinitely little from it, between the same two configurations. We use the symbol $\delta$ to denote the transition from the actual to any one of the hypothetical motions.

***Stationary action.***

The best-known theorem of this class is that of *Least Action*, originated by Maupertuis, but first put in a definite form by Lagrange. The "action" of a single particle in passing from one position to another is the space-integral of the momentum, or the time-integral of the *vis viva*. The action of a dynamical system is the sum of the actions of its constituent particles, and is accordingly given by the formula

$$\mathrm{A} = \Sigma \int mvds = \Sigma \int mv^2 dt = 2\int \mathrm{T}dt. \quad . \quad . \quad (1)$$

The theorem referred to asserts that the free motion of a conservative system between any two given configurations is characterized by the property

$$\delta \mathrm{A} = 0, \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

provided the total energy have the same constant value in the varied motion as in the actual motion. The proof, from first principles, has been given under MECHANICS (*Ency. Brit.* vol. xv. pp. 723-26), where it is also shown how the equation (2), expressed in terms of generalized co-ordinates, leads to Lagrange's equations.

The equation (2), it is to be noticed, merely expresses that the variation of A vanishes *to the first order;* the phrase *stationary action* has therefore been suggested as indicating more accurately what has been proved. The action in the free path between two given configurations is in fact not invariably a minimum, and even when a minimum it need not be the *least possible* subject to the given conditions. Simple illustrations are furnished by the case of a single particle. A particle moving on a smooth surface, and free from extraneous force, will have its velocity constant; hence the theorem in this case resolves itself into

$$\delta \int ds = 0, \quad . \quad . \quad . \quad . \quad (3)$$

*i.e.*, the path must be a geodesic line. Now a geodesic is not necessarily the *shortest* path between two given points on it; for example, on the sphere a great-circle arc ceases to be the shortest path between its extremities when it exceeds 180°. More generally, taking any surface, let a point P, starting from O, move along a geodesic; this geodesic will be a minimum path from O to P until P passes through a point O′ (if such exist), which is the intersection with a consecutive geodesic through O. After this point the minimum property ceases. On an anticlastic surface two geodesics cannot intersect more than once, and each geodesic is therefore a minimum path between any two of its points. These illustrations are due to Jacobi, who has also formulated the general criterion, applicable to all dynamical systems, as follows:—Let O and P denote any two configurations on a natural path of the system. If this be the sole free path from O to P with the prescribed amount of energy, the action from O to P is a minimum. But if there be several distinct paths, let P vary from coincidence with O along the first-named path; the action will then cease to be a minimum when a configuration O′ is reached such that two of the possible paths from O to O′ coincide. For instance, if O and P be positions on the parabolic path of a projectile under gravity, there will be a second path (with the same energy and therefore the same velocity of projection from O), these two paths coinciding when P is at the other extremity (O′, say) of the focal chord through O. The action from O to P will therefore be a minimum for all positions of P short of O′. Two configurations such as O and O′ in the general statement are called conjugate *kinetic foci.* Cf. VARIATION OF AN INTEGRAL, § 6.

Before leaving this topic the connexion of the principle of stationary action with a well-known theorem of optics may be noticed. For the motion of a particle in a conservative field of force the principle takes the form

$$\delta \int vds = 0. \quad . \quad . \quad . \quad . \quad (4)$$

On the corpuscular theory of light $v$ is proportional to the refractive index $\mu$ of the medium, whence

$$\delta \int \mu ds = 0. \quad . \quad . \quad . \quad . \quad (5)$$

For the further development of this result see OPTICS (*Ency. Brit.* vol. xvii.) and WAVE THEORY (*Ency. Brit.* vol. xxiv.).

In the formula (2) the energy in the hypothetical motion is prescribed, whilst the time of transit from the initial to the final configuration is variable. In another theorem, due to Hamilton, the time of transit is prescribed to be the same as in the actual motion, whilst the energy may be different and need not (indeed) be constant. Under these conditions we have

***Hamiltonian principle.***

$$\delta \int_t^{t'} (\mathrm{T} - \mathrm{V}) dt = 0, \quad . \quad . \quad . \quad (6)$$

where $t, t'$ are the prescribed times of passing through the given initial and final configurations. The proof of (6) is simple; we have

$$\begin{aligned}\delta \int_t^{t'} (\mathrm{T} - \mathrm{V}) dt &= \int_t^{t'} (\delta\mathrm{T} - \delta\mathrm{V}) dt = \int_t^{t'} \{\Sigma m(\dot{x}\delta\dot{x} + \dot{y}\delta\dot{y} + \dot{z}\delta\dot{z}) - \delta\mathrm{V}\} dt \\ &= \Big[\Sigma m(\dot{x}\delta x + \dot{y}\delta y + \dot{z}\delta z)\Big]_t^{t'} \\ &\quad - \int_t^{t'} \{\Sigma m(\ddot{x}\delta x + \ddot{y}\delta y + \ddot{z}\delta z) + \delta\mathrm{V}\} dt. \quad . \quad . \quad (7)\end{aligned}$$

The integrated terms vanish at both limits, since by hypothesis the configurations at these instants are fixed; and the terms under the integral sign vanish by D'Alembert's principle.

The fact that in (6) the variation does not affect the time of transit renders the formula easy of application in any system of co-ordinates. Thus, to deduce Lagrange's equations, we have

$$\begin{aligned}\int_t^{t'} (\delta\mathrm{T} - \delta\mathrm{V}) dt &= \int_t^{t'} \left\{ \frac{\partial\mathrm{T}}{\partial\dot{q}_1}\,\delta\dot{q}_1 + \frac{\partial\mathrm{T}}{\partial q_1}\,\delta q_1 + \ldots - \frac{\partial\mathrm{V}}{\partial q_1}\,\delta q_1 - \ldots \right\} dt \\ &= \Big[p_1\delta q + p_2\delta q_2 + \ldots\Big]_t^{t} \\ &\quad - \int_t^{t'} \left\{ \left(\dot{p}_1 - \frac{\partial\mathrm{T}}{\partial q_1} + \frac{\partial\mathrm{V}}{\partial q_1}\right)\delta q_1 + \left(\dot{p}_2 - \frac{\partial\mathrm{T}}{\partial q_2} + \frac{\partial\mathrm{V}}{\partial q_2}\right)\delta q_2 + \ldots \right\} dt \quad (8)\end{aligned}$$

The integrated terms vanish at both limits; and in order that the remainder of the right-hand member may vanish it is necessary that the coefficients of $\delta q_1\ \delta q_2, \ldots$ under the integral sign should vanish for all values of $t$, since the variations in question are independent, and subject only to the condition of vanishing at the limits of integration. We are thus led to Lagrange's equation of motion for a conservative system. It appears that the formula (6) is a convenient as well as a compact embodiment of the whole of ordinary Dynamics.

The modification of the Hamiltonian principle appropriate to the case of cyclic systems has been given by Larmor. If we write, as in § 1 (25),

***Extension to cyclic systems.***

$$\Theta = \mathrm{T} - \kappa\dot{\chi} - \kappa'\dot{\chi}' - \kappa''\dot{\chi}'' - \ldots, \quad . \quad . \quad (9)$$

we shall have

$$\delta \int_t^{t'} (\Theta - \mathrm{V}) dt = 0, \quad . \quad . \quad . \quad (10)$$

provided that the variation does not affect the cyclic momenta $\kappa, \kappa', \kappa'', \ldots$, and that the configurations at times $t$ and $t'$ are unaltered, so far as they depend on the palpable co-ordinates $q_1, q_2, \ldots q_m$. The initial and final values of the ignored co-ordinates *will* in general be affected.

To prove (10) we have, on the above understandings,

$$\begin{aligned}\delta \int_t^{t'} (\Theta - \mathrm{V}) dt &= \int_t^{t'} (\delta\mathrm{T} - \kappa\delta\dot{\chi} - \ldots - \delta\mathrm{V}) dt \\ &= \int_t^{t'} \left(\frac{\partial\mathrm{T}}{\partial\dot{q}_1}\delta\dot{q}_1 + \ldots + \frac{\partial\mathrm{T}}{\partial q_1}\delta q_1 + \ldots - \delta\mathrm{V}\right) dt, \quad . \quad (11)\end{aligned}$$

where terms have been cancelled in virtue of § 5 (2). The last member of (11) represents a variation of the integral

$$\int_t^{t'} (\mathrm{T} - \mathrm{V}) dt$$

on the supposition that $\delta\chi = 0,\ \delta\chi' = 0,\ \delta\chi'' = 0, \ldots$ throughout, whilst $\delta q_1, \delta q_2, \delta q_m$ vanish at times $t$ and $t'$; *i.e.*, it is a variation in which the initial and final configurations are absolutely unaltered. It therefore vanishes as a consequence of the Hamiltonian principle in its original form.

Larmor has also given the corresponding form of the principle of least action. He shows that if we write

$$\mathrm{A} = \int (2\mathrm{T} - \kappa\dot{\chi} - \kappa'\dot{\chi}' - \kappa''\dot{\chi}'' - \ldots) dt, \quad . \quad . \quad (12)$$

then

$$\delta \mathrm{A} = 0, \quad . \quad . \quad . \quad . \quad (13)$$

provided the varied motion takes place with the same constant value of the energy, and with the same constant cyclic momenta,

between the same two configurations, these being regarded as defined by the palpable co-ordinates alone.

*Hamilton's Principal and Characteristic Functions.*

§ 8. In the investigations next to be described a more extended meaning is given to the symbol $\delta$. We will, in the first instance, denote by it an infinitesimal variation of the most general kind, affecting not merely the values of the co-ordinates at any instant, but also the initial and final configurations and the times of passing through them. If we put

**Principal function.**

$$S=\int_t^{t'}(T-V)dt, \quad . \quad . \quad . \quad . \quad (1)$$

we have, then,

$$\delta S=(T'-V')\delta t'-(T-V)\delta t+\int_t^{t'}(\delta T-\delta V)dt$$

$$=(T'-V')\delta t'-(T-V)\delta t+\Big[\Sigma m(\dot{x}\delta x+\dot{y}\delta y+\dot{z}\delta z)\Big]_t^{t'}. \quad . \quad (2)$$

Let us now denote by $x'+\delta x'$, $y'+\delta y'$, $z'+\delta z'$, the final co-ordinates (*i.e.*, at time $t'+\delta t'$) of a particle $m$. In the terms in (2) which relate to the upper limit we must therefore write $\delta x'-\dot{x}'\delta t'$, $\delta y'-\dot{y}'\delta t'$, $\delta z'-\dot{z}'\delta t'$ for $\delta x$, $\delta y$, $\delta z$. With a similar modification at the lower limit, we obtain

$$\delta S=-H\delta\tau+\Sigma m(\dot{x}'\delta x'+\dot{y}'\delta y'+\dot{z}'\delta z')$$
$$-\Sigma m(\dot{x}\delta x+\dot{y}\delta y+\dot{z}\delta z), \quad . \quad . \quad (3)$$

where $H(=T+V)$ is the constant value of the energy in the free motion of the system, and $\tau\ (=t'-t)$ is the time of transit. In generalized co-ordinates this takes the form

$$\delta S=-H\delta\tau+p'_1\delta q'_1+p'_2\delta q'_2+\ldots$$
$$-p_1\delta q_1-p_2\delta q_2-\ldots \quad . \quad . \quad . \quad (4)$$

Now if we select any two arbitrary configurations as initial and final, it is evident that we can in general (by suitable initial velocities or impulses) start the system so that it will of itself pass from the first to the second in any prescribed time $\tau$. On this view of the matter, S will be a function of the initial and final co-ordinates ($q_1, q_2, \ldots$ and $q'_1, q'_2, \ldots$) and the time $\tau$, as independent variables. And we obtain at once from (4)

$$\left.\begin{aligned} p'_1&=\frac{\partial S}{\partial q'_1},\quad p'_2=\frac{\partial S}{\partial q'_2},\ \ldots,\\ p_1&=-\frac{\partial S}{\partial q_1},\quad p_2=-\frac{\partial S}{\partial q_2},\ \ldots,\end{aligned}\right\} \quad . \quad . \quad . \quad (5)$$

and
$$H=-\frac{\partial S}{\partial\tau}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

S is called by Hamilton the *principal function;* if its general form for any system can be found, the preceding equations suffice to determine the motion resulting from any given conditions. If we substitute the values of $p_1$, $p_2$, ... and H from (5) and (6) in the expression for the kinetic energy in the form T' (see § 1), the equation

$$T'+V=H \quad . \quad . \quad . \quad . \quad . \quad (7)$$

becomes a partial differential equation to be satisfied by S. It has been shown by Jacobi that the dynamical problem resolves itself into obtaining a "complete" solution of this equation, involving $n+1$ arbitrary constants. This aspect of the subject, as a problem in partial differential equations, has received great attention at the hands of mathematicians, but must be passed over here.

There is a similar theory for the function

**Characteristic function.**

$$A=2\int Tdt=S+H\tau \quad . \quad . \quad . \quad . \quad (8)$$

It follows from (4) that

$$\delta A=\tau\delta H+p'_1\delta q'_1+p'_2\delta q'_2+\ldots$$
$$-p_1\delta q_1-p_2\delta q_2-\ldots \quad . \quad . \quad . \quad (9)$$

Selecting, as before, any two arbitrary configurations, it is in general possible to start the system from one of these, with a prescribed value of the total energy H, so that it shall pass through the other. Hence, regarding A as a function of the initial and final co-ordinates and the energy, we find

$$\left.\begin{aligned} p'_1&=\frac{\partial A}{\partial q'_1},\quad p'_2=\frac{\partial A}{\partial q'_2},\ \ldots,\\ p_1&=-\frac{\partial A}{\partial q_1},\quad p_2=-\frac{\partial A}{\partial q_2},\ \ldots,\end{aligned}\right\} \quad . \quad . \quad (10)$$

and
$$\tau=\frac{\partial A}{\partial H}. \quad . \quad . \quad . \quad . \quad . \quad (11)$$

A is called by Hamilton the *characteristic function;* it represents, of course, the "action" of the system in the free motion (with prescribed energy) between the two configurations. Like S, it satisfies a partial differential equation, obtained by substitution from (10) in (7). Some illustrations of the theory, for the case of a single particle, are given under MECHANICS (*Ency. Brit.* vol. xv. pp. 724–25).

The preceding theorems are easily adapted to the case of cyclic systems. We have only to write

$$S=\int_t^{t'}(\Theta-V)dt=\int_t^{t'}(T-\kappa\dot{\chi}-\kappa'\dot{\chi}'-\ldots-V)dt \quad . \quad (12)$$

in place of (1), and

$$A=\int(2T-\kappa\dot{\chi}-\kappa'\dot{\chi}-\ldots)dt, \quad . \quad . \quad . \quad (13)$$

in place of (8); cf. § 7 *ad fin.* It is understood, of course, that in (12) S is regarded as a function of the initial and final values of the palpable co-ordinates $q_1, q_2, \ldots q_m$, and of the time of transit $\tau$, the cyclic momenta being invariable. Similarly in (13), A is regarded as a function of the initial and final values of $q_1, q_2, \ldots q_m$, and of the total energy H, with the cyclic momenta invariable. It will be found that the forms of (4) and (9) will be conserved, provided the variations $\delta q_1$, $\delta q_2$, ... be understood to refer to the palpable co-ordinates alone. It follows that the equations (5), (6), and (10), (11) will still hold under the new meanings of the symbols.

*Reciprocal Properties of Direct and Reversed Motions.*

§ 9. We may employ Hamilton's principal function to prove a very remarkable formula connecting any *two* slightly disturbed natural motions of the system. If we use the symbols $\delta$ and $\Delta$ to denote the corresponding variations, the theorem is

**Lagrange's formula.**

$$\frac{d}{dt}\Sigma(\delta p_r.\Delta q_r-\Delta p_r.\delta q_r)=0\,; \quad . \quad . \quad . \quad (1)$$

or, integrating from $t$ to $t'$,

$$\Sigma(\delta p'_r.\Delta q'_r-\Delta p'_r.\delta q'_r)=\Sigma(\delta p_r.\Delta q_r-\Delta p_r.\delta q_r). \quad . \quad (2)$$

If for shortness we write

$$(r,\ s)=\frac{\partial^2 S}{\partial q_r\partial q_s},\quad (r,\ s')=\frac{\partial^2 S}{\partial q_r\partial q'_s}, \quad . \quad . \quad (3)$$

we have

$$\delta p_r=-\Sigma_s(r,\ s)\delta q_s-\Sigma_s(r,\ s')\delta q'_s \quad . \quad . \quad (4),$$

with a similar expression for $\Delta p_r$. Hence the right-hand side of (2) becomes

$$-\Sigma_r\{\Sigma_s(r,\ s)\delta q_s+\Sigma_s(r,\ s')\delta q'_s\}\Delta q_r+\Sigma_r\{\Sigma_s(r,\ s)\Delta q_s+\Sigma_s(r,\ s')\Delta q'_s\}\delta q_r$$
$$=\Sigma_r\Sigma_s(r,\ s')\{\delta q_r.\Delta q'_s-\Delta q_r.\delta q'_s\} \quad . \quad (5)$$

The same value is obtained in like manner for the expression on the left hand of (2); hence the theorem, which, in the form (1), is due to Lagrange, and was employed by him as the basis of his method of treating the dynamical theory of *Variation of Arbitrary Constants.*

The formula (2) leads at once to some remarkable reciprocal relations which were first expressed, in their complete form, by Helmholtz. Consider any natural motion of a conservative system between two configurations O and O′ through which it passes at times $t$ and $t'$ respectively, and let $t'-t=\tau$. As the system is passing through O let a small impulse $\delta p_r$ be given to it, and let the consequent alteration in the co-ordinate $q_s$ after the time $\tau$ be $\delta q'_s$. Next consider the *reversed* motion of the system, in which it would, if undisturbed, pass from O′ to O in the same time $\tau$. Let a small impulse $\delta p'_s$ be applied as the system is passing through O′, and let the consequent change in the co-ordinate $q_r$ after a time $\tau$ be $\delta q_r$. Helmholtz's first theorem is to the effect that

**Helmholtz's reciprocal theorems.**

$$\delta q_r : \delta p'_s=\delta q'_s : \delta p_r. \quad . \quad . \quad . \quad . \quad (6)$$

To prove this, suppose, in (2), that all the $\delta q$ vanish, and likewise all the $\delta p$ with the exception of $\delta p_r$. Further, suppose all the $\Delta q'$ to vanish, and likewise all the $\Delta p'$ except $\Delta p'_s$, the formula then gives

$$\delta p_r.\Delta q_r=-\Delta p'_s.\delta q'_s, \quad . \quad . \quad . \quad (7)$$

which is equivalent to Helmholtz's result, since we may suppose the symbol $\Delta$ to refer to the reversed motion, provided we change the signs of the $\Delta p$. For example, in the most general motion of a top (§ 2), suppose that a small impulsive couple about the vertical produces after a time $\tau$ a change $\delta\theta$ in the inclination of the axis, the theorem asserts that in the reversed motion an equal impulsive couple in the plane of $\theta$ will produce after a time $\tau$ a change $\delta\psi$, in the azimuth of the axis, which is equal to $\delta\theta$. It is understood, of course, that the couples have no components (in the generalized sense) except of the types indicated; for instance, they may consist in each case of a force applied to the top at a point of the axis, and of the accompanying reaction at the pivot. Again, in the corpuscular theory of light let O, O′ be any two points on the axis of a symmetrical optical combination, and let V, V′ be the corresponding velocities of light. At O let a small impulse be applied perpen-

dicular to the axis so as to produce an angular deflection $\delta\theta$, and let $\beta'$ be the corresponding lateral deviation at O′. In like manner, in the reversed motion, let a small deflection $\delta\theta'$ at O′ produce a lateral deviation $\beta$ at O. The theorem (6) asserts that

$$\frac{\beta}{V'\delta\theta'}=\frac{\beta'}{V\delta\theta}, \quad . \quad . \quad . \quad . \quad . \quad (8)$$

or, in optical language, the "apparent distance" of O from O′ is to that of O′ from O in the ratio of the refractive indices at O′ and O respectively.

**Helmholtz's second reciprocal theorem.**

In the second reciprocal theorem of Helmholtz the configuration O is slightly varied by a change $\delta q_r$ in one of the co-ordinates, the momenta being all unaltered, and $\delta p'_s$ is the consequent variation in one of the momenta after time $\tau$. Similarly in the reversed motion a change $\delta q'_s$ produces after time $\tau$ a change of momentum $\delta p_r$. The theorem asserts that

$$\delta p'_s : \delta q_r = \delta p_r : \delta q'_s \quad . \quad . \quad . \quad . \quad . \quad (9)$$

This follows at once from (2) if we imagine all the $\delta p$ to vanish, and likewise all the $\delta q$ save $\delta q_r$, and if (further) we imagine all the $\Delta p'$ to vanish, and all the $\Delta q'$ save $\Delta q'_s$. Reverting to the optical illustration, if F, F′, be principal foci, we can infer that the convergence at F′ of a parallel beam from F is to the convergence at F of a parallel beam from F′ in the inverse ratio of the refractive indices at F′ and F. This is equivalent to Gauss's relation between the two principal focal lengths of an optical instrument. It may be obtained otherwise as a particular case of (8).

We have by no means exhausted the inferences to be drawn from Lagrange's formula. It may be noted that (6) includes as particular cases various important reciprocal relations in Optics and Acoustics formulated by Clausius, Helmholtz, Thomson and Tait, and Lord Rayleigh. In applying the theorem care must be taken that in the reversed motion the reversal is complete, and extends to every velocity in the system; in particular, in a cyclic system the cyclic motions must be imagined to be reversed with the rest. Conspicuous instances of the failure of the theorem through incomplete reversal are afforded by the propagation of sound in a wind and the propagation of light in a magnetic medium.

It may be worth while to point out, however, that there is no such limitation to the use of Lagrange's formula (1). In applying it to cyclic systems, it is convenient to introduce conditions already laid down, viz., that the co-ordinates $q_r$ are the palpable co-ordinates, and that the cyclic momenta are invariable. Special inferences can then be drawn as before, but the interpretation cannot be expressed so neatly owing to the non-reversibility of the motion.

Authorities.—The most important and most accessible early authorities are Lagrange, *Mécanique Analytique*, 1st ed., Paris, 1788, 2nd ed., Paris, 1811; Hamilton, "On a General Method in Dynamics," *Phil. Trans.*, 1834 and 1835; Jacobi, *Vorlesungen über Dynamik*, Berlin, 1866, reprinted in *Werke*, *Supp.-Bd.*, Berlin, 1884. An account of the extensive literature on the differential equations of dynamics and on the theory of variation of parameters is given by Cayley, "Report on Theoretical Dynamics," *Brit. Assn. Rep.*, 1857, *Mathematical Papers*, vol. iii., Cambridge, 1890. For the modern developments reference may be made to Thomson and Tait, *Natural Philosophy*, 1st ed., Oxford, 1867, 2nd ed., Cambridge, 1879; Lord Rayleigh, *Theory of Sound*, vol. i., 1st ed., London, 1877, 2nd ed., London, 1894; Routh, *Stability of Motion*, London, 1877, and *Rigid Dynamics*, 4th ed., London, 1884; Helmholtz, "Ueber die physikalische Bedeutung des Princips der kleinsten Action," *Crelle*, vol. c. 1886, reprinted (with other cognate papers) in *Wiss. Abh.* vol. iii., Leipzig, 1895; Larmor, "On Least Action," *Proc. Lond. Math. Soc.* vol. xv. 1884. As to the question of stability, reference may be made to Poincaré, "Sur l'équilibre d'une masse fluide animée d'un mouvement de rotation," *Acta Math.* vol. vii., 1885; Klein and Sommerfeld, *Theorie des Kreisels*, pts. 1, 2, Leipzig, 1897–98; Lioupanoff and Hadamard, *Liouville*, 5me série, vol. iii., 1897. A remarkable interpretation of various dynamical principles is given by Hertz in his posthumous work *Die Prinzipien der Mechanik*, Leipzig, 1894, of which an English translation appeared in 1900. (H. Lb.)

**Dynamo.**—Invented by Faraday in 1831, the dynamo ranks with the telegraph and telephone among the most striking achievements of science, and the material progress that marked the later years of the 19th century was in no small measure due to the practical application of these three electrical inventions. Since 1830 the simple model constructed by Faraday has been gradually developed into the dynamos of 5000 horse-power or more, which are constructed to meet the needs of large cities for electric lighting and power, and the machines in use are to be numbered, not by hundreds or thousands, but by hundreds of thousands. Yet the fundamental theory of the dynamo, as a machine for generating electromotive force, remains but little changed, and the advance since Faraday's time may, by comparison with his results, be regarded as a progressive improvement of the mechanical and electrical design leading to a fuller realization of the idea which was already present in his mind. His experiments on the induction of currents in a coil of wire during the approach or recession of a magnet led naturally to the explanation of induced electromotive force as caused by the linking or unlinking of magnetic lines of flux with an electric circuit. For the more definite case of the dynamo, however, we may, with Faraday, make the transition from line-linkage to the precisely equivalent conception of "*line-cutting*" as the source of E.M.F.—in other words, to the idea of electric conductors "cutting" or intersecting[1] the lines of flux in virtue of relative motion of the magnetic field and electric circuit. On 28th October 1831 Faraday mounted a copper disc so that it could be rotated edgewise between the poles of a permanent horse-shoe magnet. When so rotated, it cut the lines of flux which passed transversely through its upper half, and by means of two rubbing contacts, one on its periphery and the other on its spindle or axis, the circuit was closed through a galvanometer, which indicated the passage of a continuous current so long as the disc was rotated (Fig. 1). Thus by the invention of the first dynamo Faraday proved his idea that the E.M.F. induced through the interaction of a magnetic field and an electric circuit was due to the passage of a portion of the electric circuit *across* the lines of flux, or *vice versâ*, and so could be maintained if the cutting of the lines were made continuous.[2]

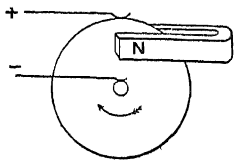

Fig. 1.

A dynamo, then, is a machine in which, by means of continuous relative motion, an electrical conductor or system of conductors forming part of a circuit is caused to cut the lines of a magnetic field or fields; the cutting of the magnetic flux induces an electromotive force in the conductors, and when the circuit is closed a current flows, whereby mechanical energy is converted into electrical energy.

Little practical use could be made of electrical energy so long as its only known sources were frictional machines and voltaic batteries. The cost of the materials for producing electrical currents on a large scale by chemical action was prohibitive, while the frictional machine only yielded very small currents at extremely high potentials. In the dynamo, on the other hand, electrical energy in a convenient form could be cheaply and easily obtained by mechanical means, and with its invention the application of electricity to a wide range of commercial purposes became economically possible. As a converter of energy from one form to another it is only surpassed in efficiency by another electrical appliance, namely, the transformer (see Transformers). In this there is merely conversion of electrical energy at a high potential into electrical energy at a low potential, or *vice versâ*, but in the dynamo the mechanical energy which must be applied to maintain the relative movement of magnetic field and conductor is absorbed, and reappears in an electrical form. A true transformation takes place, and the proportion which the rate of delivery of electrical energy bears to the power absorbed, or in other words the *efficiency*, is the more remarkable. The useful return or "output" at the terminals of a large machine may amount to as much as 95 per cent. of the mechanical energy which forms the "input." Since it needs some prime mover to drive it, the dynamo has not made any direct addition to our sources of energy, and does not therefore rank with the primary battery or oil engine, or even the steam engine, all of which draw their energy more immediately from

[1] *Experimental Researches in Electricity*, series ii. § 6, pars. 256, 259–60, and series xxviii. § 34.

[2] *Ibid.*, series i. § 4, pars. 84–90.

nature. Yet by the aid of the dynamo the power to be derived from waterfalls can be economically and conveniently converted into an electrical form and brought to the neighbouring factory or distant town, to be there reconverted by motors into mechanical power. Over any but very short distances energy is most easily transmitted when it is in an electrical form, and turbine-driven dynamos are very largely and successfully employed for such transmission. Thus by conducing to the utilization of water-power which may previously have had but little value owing to its disadvantageous situation, the dynamo may almost be said to have added another to our available natural resources.

The two essential parts of the dynamo, as required by its definition, may be illustrated by the original disc machine of Faraday. They are (1) the *iron magnet*, between the poles of which a magnetic field exists, and (2) the *electrical conductors*, represented by the rotating copper disc. The sector of the disc [1] cutting the lines of the field forms part of a closed electric circuit, and has an E.M.F. induced in it, by reason of which it is no longer simply a conductor, but may be called an "*inductor*." In its more highly developed form the simple copper disc becomes a system of many inductors so inter-connected as to add up their several E.M.F.'s. Since these inductors are very commonly mounted on an iron structure, which may be likened to the keeper or "armature" of a magnet rotating between its poles, the term "*armature*" has been extended to cover not only the iron core, but also the wires on it, and is often applied to the copper conductors themselves even when there is no iron core. In the dynamo of Faraday it is the "armature" which is rotated, and such is usually the case; sometimes, however, the magnet, or a portion of it, is rotated. It is in fact immaterial to the action whether the one or the other is moved, or both, so long as their relative motion causes the armature inductors to cut the magnetic flux. As to the ultimate reason why an E.M.F. should be thereby induced, physical science cannot as yet yield any surer knowledge than in the days of Faraday.[2] For the engineer, the simple fact is sufficient that the E.M.F. of the dynamo is due to the cutting of the magnetic flux by the inductors, and, further, is proportional to the rate at which the lines are cut.[3]

The equation of the *electromotive force* which is required in order to render this statement quantitative must contain three factors, namely, the density of the flux in the air-gap through which the inductors move, the length of the inductors, and the speed of their movement. For given values of the first and third factors and a single straight inductor moved parallel to itself through a uniform field, the maximum rate of cutting is evidently obtained when the three directions of the lines, the armature inductor, and the relative motion are respectively at right angles to each other, as shown by the three co-ordinate axes of Fig. 2. Under these circumstances the E.M.F. of the inductor is

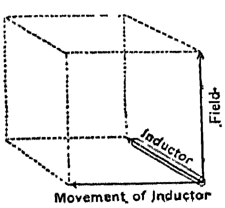

Fig. 2.

$$E = B_g LV \times 10^{-8} \text{ volts}, \quad . \quad . \quad . \quad . \quad \text{(I.)}$$

where $B_g$ is the density [4] of the lines of flux per square centimetre in the air-gap, L is the active length of the inductor within the field in centimetres, and V is the velocity of movement in centimetres per second. Further, the direction in which the E.M.F. has the above maximum value is along the length of the inductor, its "sense" being determined by the relative directions of the field and movement.[5]

The second fundamental equation of the dynamo brings to light its mechanical side, and rests on Oerstedt's discovery of the interaction of a magnetic field and an electric current. If a straight electric conductor carrying a current be so placed in a magnetic field that its length is not parallel to the direction of the lines of flux, it is acted on by a force which, if not balanced by an equal and opposite force, will cause the conductor to move in a definite direction; or if the conductor is fixed and the magnet be unconstrained, the latter will itself move in the opposite direction. Now in the dynamo the inductors are placed so that their length may be as nearly as possible at right angles to the field; hence when they are rotated and an electric current begins to flow under the E.M.F. which they induce, a mutual force at once arises between the copper conductors and the magnet, and the direction of this force must by Lenz's law [6] be opposed to the direction of the movement. Thus as soon as the disc of Fig. 1 is rotated and its circuit is closed, it experiences a mechanical pull or drag, which must be overcome by the force applied to rotate it. While the magnet must be firmly held so as to remain stationary, the mechanical construction of the armature must be such that its inductors can be forcibly driven through the magnetic field against the mutual pull. The law of electrodynamic action requires its *equation of mechanical force*, just as the law of electromagnetic induction requires the equation of electromotive force, and it may be expressed in analogous terms. If a conductor of length L cm., carrying a current C amperes, is immersed in a field of uniform density $B_g$, and the length of the conductor is at right angles to the direction of the lines, it is acted on by a force

$$F = B_g LC \times 10^{-1} \text{ dynes}, \quad . \quad . \quad . \quad . \quad \text{(II.)}$$

and the direction of this force is at right angles to the conductor and to the field. The rate at which electrical energy is developed, when this force is overcome by moving the inductor as a dynamo through the field, is $EC = B_g LVC \times 10^{-8}$ watts, whence the equality of the mechanical power absorbed and the electrical power developed (as required by the law of the conservation of energy) is easily established. The whole of this power is not, however, available at the terminals of the machine; if $R_a$ be the resistance of the armature in ohms, the passage of the current $C_a$ through the armature inductors causes a loss of pressure of $C_a R_a$ volts, and a corresponding loss of energy in the armature at the rate of $C_a^2 R_a$ watts. As the resistance of the external circuit $R_e$ is lowered, the current $C = \dfrac{E_a}{R_e + R_a}$ is increased, but at the same time the external voltage at the terminals of the machine is decreased, until a maximum output is reached, when the loss of volts over the internal resistance is equal to the loss of volts over the external resistance. The increase of the current is, however, accompanied by a progressive increase in the loss of energy over the armature, and as this is expended in heating the armature conductors, their temperature may rise so much as to destroy the insulating materials with which they are covered. Hence the temperature which the machine may be permitted to attain in its working is of great importance in determining its output, the current which forms one factor therein being primarily limited by the heating of the armature wires. The lower the resistance of the armature, the less the rise of its temperature for a given current flowing through it; and the reason for

[1] See ELECTRICITY, *Ency. Brit.* vol. viii. p. 78.
[2] "On the Physical Lines of Magnetic Force," *Phil. Mag.*, June 1852.
[3] Faraday, *Exp. Res.*, series xxviii. § 34, pars. 3104, 3114–15.
[4] See ELECTROMAGNET, New Volumes, *Ency. Brit.*
[5] Faraday, *Exp. Res.*, series i. § 4, pars. 114–119.
[6] ELECTRICITY, *Ency. Brit.* vol. viii. pp. 11 and 76.

the almost universal adoption of copper as the material for the armature inductors is now seen to lie in its high conductivity.[1]

Since the voltage of the dynamo is the second factor to which its output is proportional, the conditions which render the induced E.M.F. a maximum must evidently be reproduced as far as possible in practice, if the best use is to be made of a given mass of iron and copper. The first problem, therefore, in the construction of the dynamo is the disposition of the inductors and field in such a manner that the three directions of field, inductors, and movement are at right angles to one another, and so that the relative motion is continuous. Reciprocating motion, such as would be obtained by direct attachment of the inductors to the piston of a steam-engine, has been successfully employed only in the special case of an "oscillator"[2] producing a small current very rapidly changing in direction. *Rotary motion* is therefore universally adopted, and with this two distinct cases arise. Either (A) the length of the inductor is parallel to the axis of rotation, or (B) it is at right angles to it. A single inductor cannot, however, be made to give more than a few volts, and hence it is necessary to use several inductors, and to add up their E.M.F.'s by connecting them in series. Two methods of effecting this may be distinguished, and as each may be applied both to case (A) and to case (B), four types of armatures result therefrom.

(A). If an inductor is rotated in a rectangular gap formed in a horse-shoe magnet by two pole-pieces having plane faces opposed to each other, as in Fig. 3, not only is the density of the flux in the gap between the poles small, but the direction of movement is not always at right angles to the direction of the lines. Starting from the position of the inductor when it is mid-way between the pole-tips, its rate of line-cutting will increase to a maximum as it passes under the centre of a pole-face, and will then decrease to zero. As it crosses a line drawn symmetrically through the gaps between the poles, the direction of the E.M.F. along its length is reversed, since its motion relatively to the direction of the field is reversed. If the ends of the inductor are electrically connected to two collecting rings fixed on, but insulated from, the shaft, two stationary brushes *b b* can be pressed so as to make rubbing contact with the rings, and an external circuit may be connected to the brushes, which then form the "terminals" of the machine; the alternating E.M.F. set up in the inductor will cause an alternating current to flow through the external circuit, and the simplest form of *alternator* is obtained. If the field cut by the inductor is of uniform density, and all the lines pass straight across from one pole to the other (both of which assumptions are approximately correct), a curve connecting the instantaneous values of the E.M.F., as ordinates, with time or degrees of revolution, as abscissæ (as shown at the foot of Fig. 3), will be sinusoidal when the speed of rotation is uniform.

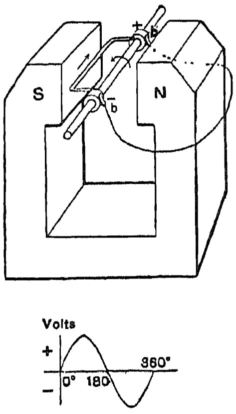


Fig. 3.

If, however, the inductor is mounted on an iron cylinder (Fig. 4),[3] a sufficient margin being allowed for mechanical clearance between the inductor and the poles, not only will the reluctance of the magnetic circuit be reduced, and the total flux and its density in the air-gap $B_g$ be thereby increased, but the path of the lines will become nearly radial, except at the "fringe" near the edges of the pole-tips, and hence the relative directions of the movement and lines will be continuously at right angles. The shape of the E.M.F. curve will then be as shown in Fig. 4—flat-topped, with rounded corners rapidly sloping down to the zero line.

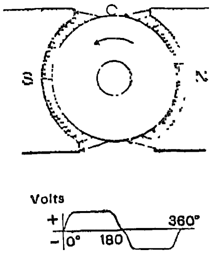


Fig. 4.

With the addition of a number of similar inductors arranged along the length of the armature core parallel to the first, the question arises of their connexion, in order to add their E.M.F.'s. Since the E.M.F.'s generated by the inductors under the one pole-piece are opposite in direction to those induced under the other pole-piece as viewed from one end of the armature (Fig. 5, where the dotted and crossed wires indicate E.M.F.'s directed towards and away from the observer), two distinct methods are possible by which two or more inductors can be joined in series.

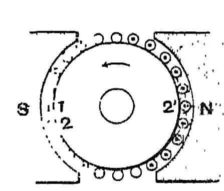


Fig. 5.

(1) The first, or *ring*-winding, was invented by Dr Antonio Pacinotti of Florence[4] in 1860, and was subsequently and independently reintroduced in 1870[5] by the Belgian electrician, Zénobe Théophile Gramme, whence it is also frequently called the "Gramme" winding. By this method the farther end of inductor 1 (Fig. 5) is joined to the near end of inductor 2; this latter lies next to it on the surface of the core or immediately above it, so that both are simultaneously under the same pole-piece. For this connexion to be possible, the armature core must be a hollow cylinder, supported from the shaft on an open non-magnetic spider or hub, between the arms of which there is room for the internal wire completing the loop (Fig. 6). The end of one complete loop or turn embracing one side of the armature core thus forms the starting-point for another loop, and the process can be continued if required to form a coil of two or more turns. In the ring armature the iron core serves the double purpose of conducting the lines across from one pole to the other, and also of shielding from the magnetic flux the hollow interior through which the connecting wires pass. Any lines which leak across the central space are cut by the internal wires, and the direction of cutting is such that the E.M.F. caused thereby opposes the E.M.F. due to the inductors proper on the external surface. If, however, the section of iron in the core

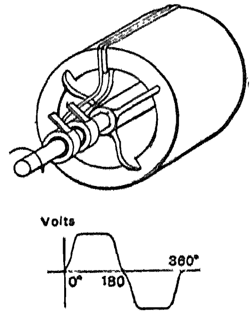


Fig. 6.

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[1] Faraday, *Exp. Res.*, series ii. § 6, pars. 211, 213; series xxviii. § 34, par. 3152.

[2] Invented by Nikola Tesla (*Elec. Eng.* vol. xiii. p. 83. Cp. Brit. Pat., Spec. Nos. 2801 and 2812, 1894). Several early inventors, *e.g.*, Dal Negro in 1832 (*Phil. Mag.*, third series, vol. i. p. 45), adopted reciprocating or oscillatory motion, and this was again tried by Edison in 1878.

[3] The advantage to be obtained by making the poles closely embrace the armature core was first realized by Dr Werner von Siemens of Berlin in his "shuttle-wound" armature (Brit. Pat., No. 2107, 1856).

[4] *Nuovo Cimento*, 19, p. 378, 1865. Elias of Amsterdam is by some credited with having used ring winding on a motor even earlier than 1860.

[5] Brit. Pat., No. 1668, 1870. *Comptes Rendus*, 73, p. 175, 1871.

be correctly proportioned, the number of lines which cross the interior will bear but a small ratio to those which pass entirely through the iron, and the counter E.M.F. of the internal wires will become very small; they may then be regarded simply as connectors for joining the external inductors in series.

(2) The second or *drum* method was used in the original "shuttle-wound" armatures invented by Dr Werner von Siemens in 1856, and is still known as the "Siemens" winding. The farther end of inductor 1 (Fig. 5) is joined by a connecting wire to the farther end of another inductor 2′ situated nearly diametrically opposite on the other side of the core and under the opposite pole-piece. The near end of the complete loop or turn is then brought across the end of the core, and can be used as the starting-point for another loop beginning with inductor 2, which is situated by the side of the first inductor. The iron core may now be solid from the surface to the shaft, since no connecting wires are brought through the centre, and each loop embraces the entire armature core (Fig. 7). By the formation of two loops in the ring armature and of the single loop in the drum armature, two inductors are placed in series; the curve of instantaneous E.M.F. is therefore similar in shape to that of the single inductor (Fig. 4), but with its ordinates raised throughout to double their former height, as shown at the foot of Fig. 6.

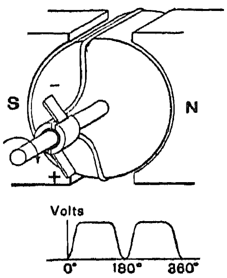

Fig 7

Next, if the free ends of either the ring or drum loops, instead of being connected to two collecting rings, are attached to the two halves of a split-ring insulated from the shaft (as shown in Fig. 7 in connexion with a drum armature), and the stationary brushes are so set relatively to the loops that they pass over from the one half of the split-ring to the other half at the moment when the loops are passing the centre of the interpolar gap, and so are giving little or no E.M.F., each brush will always remain either positive or negative. The current in the external circuit attached to the brushes will then have a constant direction, although the E.M.F. in the inductors still remains alternating; the curve of E.M.F. obtained at the brushes is thus (as in Fig. 7) entirely above the zero line. The first dynamo of Pixii,[1] which immediately followed Faraday's discovery, gave an alternating current, but in 1832[2] the alternator was converted into a machine giving a *unidirected current* by the substitution of a rudimentary "commutator" in place of mercury collecting cups.

On passing to case (B) we are at once reminded of the original dynamo of Faraday, yet though the disc of Fig. 1 is in reality a single inductor whose plane of movement is at right angles to its axis of rotation, it has the peculiarity that the E.M.F. generated is always in the same direction along the inductor's length; it thus represents a class of machines which are distinguished by the somewhat misleading name of "unipolar" dynamos. In this special form the (B) principle of arrangement is seldom employed, since it is difficult to add other inductors in order to increase the E.M.F. If, however, the magnetic circuit be interrupted by another air-gap (Fig. 8), a single inductor can be arranged to cut the flux twice in each revolution in different directions as it passes through the two air-gaps. The E.M.F. which is now produced in the inductor will be first radially outwards, and then inwards towards the centre, *i.e.*, it alternates in direction just as in case (A). It then becomes possible to employ a number of inductors (Fig. 9), and to add together their E.M.F.'s in series by methods which are analogous to the ring and drum winding already discussed under case (A), and which yield the third and fourth types of armature.

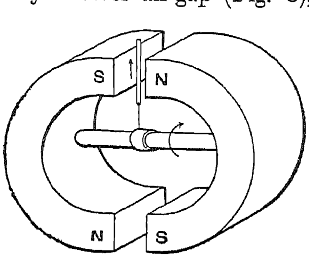

Fig. 8

(3) By the *discoidal* or flat-ring method (Fig. 10) an inductor 1 is joined to its next neighbour 2, and for this to be possible it is again necessary that there should be an iron core (as A in Fig. 9) to convey the lines from one pole to the other, and at the same time to shield the connecting wires, so that they may not themselves cut the field. A second magnet M′ (shown dotted in Fig. 10) can now be arranged on the opposite side of the armature core to the first magnet M, with poles of the same sign facing each other. The greater portion of the length of the wires which previously served merely as conductors can then also be rendered usefully inductive, the inactive connectors being simply the wires joining the two sides of each loop.[3] The armature thus takes the form of a flat ring (Fig. 10), and is analogous to a ring armature in which a second pair of poles is introduced into the centre of the core, each of the same sign as the external pole which it faces.

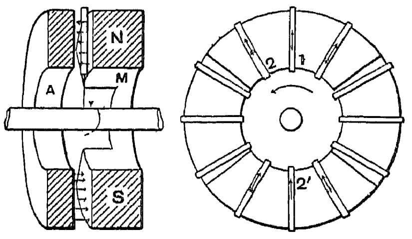

Fig. 9.

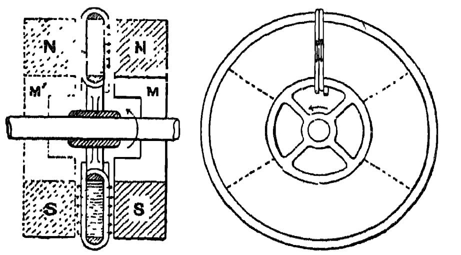

Fig. 10.

(4) The fourth or *disc* winding was in principle em-

[1] *Ann. Chim. Phys.* vol. l. p. 322.

[2] *Ann. Chim. Phys.* vol. li. p. 76. Since in Pixii's machine the armature was stationary, while both magnet and commutator rotated, four brushes were used, and the arrangement was not so simple as the split-ring described above, although the result was the same. Saxton's machine (1833) and Clarke's machine (1835, see Sturgeon's *Annals of Electricity*, vol. i. p. 145) were similar to one another in that a unidirected current was obtained by utilizing every alternate half-wave of E.M.F., but the former still employed mercury collecting cups, while the latter employed metal brushes. Sturgeon in 1835 followed Pixii in utilizing the entire wave of E.M.F., and abandoned the mercury cups in favour of metal brushes pressing on four semi-circular discs (*Scientific Researches*, p. 252). The simple split-ring is described by Wheatstone and Cooke in their Patent No. 8345, 1840.

[3] The advantage originally claimed for the discoidal-ring machine, namely, that the rim of the armature could also be utilized by joining the opposite poles, and that so the inactive length of the wire was considerably reduced as compared with the longitudinally-wound ring (Schuckert, Brit. Pat., No. 4464, 1877), has proved somewhat illusory, owing to the difficulty of avoiding eddy-currents in the core when the flux enters it in two directions at right angles to each other, from the sides and from the overarching pole-piece respectively.

ployed in many of the earliest machines, and especially in alternators, but has not met with much favour for continuous-current dynamos. In this method the outer end of inductor 1 is joined, by a connecting wire passing round the periphery, to the outer end of another inductor 2′ situated nearly diametrically opposite under the other pole (Fig. 9). No iron core is now required; the two opposite poles can be brought close together, leaving but a short path for the lines in the air-gap, and any mechanical support on which the wires are wound may be non-magnetic. By bringing the inner end of inductor 2′ along the inside periphery (Fig. 11), a loop is formed, which may be again repeated. If the ends of the loops

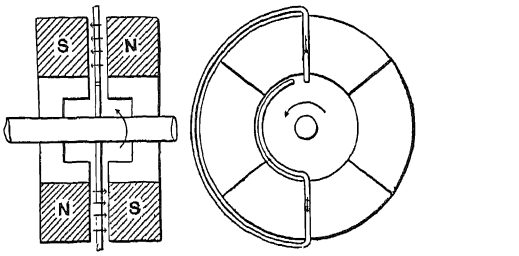


Fig 11

thus formed by either method (3) or (4) are connected to a pair of collecting rings, a simple discoidal-ring or disc alternator is obtained, while if they are connected to a split-ring the current may be commuted, and the dynamo gives a unidirected E.M.F. and current in the external circuit. It is therefore true to say that in almost all dynamos which are used in practice, whether they supply an alternating or a continuous current to the external circuit, the E.M.F. and current in the inductors themselves are alternating.

The addition of new loops leads to a coil of many turns, and thence to a number of coils. If the several new loops are wound over each other in the ring, drum, and discoidal-ring armatures, or by the side of each other in the disc, the depth of the wires in the air-gap would necessitate such a long distance between the pole-piece and the armature core, or between the opposing poles of the disc, that it would be difficult to obtain a sufficiently strong magnetic field. The additional loops must be wound side by side in the first three cases, or on the top of each other in the disc armature. The coil thus has a certain width along the face of the poles, and the effect of such width must be considered in its relation to the width of the poles. The *pitch-line* being defined as a circle drawn through the middle of the length of the inductors, or, in other words, as the mean path traversed by them in their rotation, it is convenient to refer the widths of pole, interpolar gap, and coil to the *pitch*, or the distance measured along the pitch-line from the centre of one pole to the centre of a neighbouring pole of opposite sign. In the ring armature, if the E.M.F.'s induced by the turns in any one coil are to be added in series, they must be in the same direction along the inductors. A ring core entirely overwound with one coil in a continuous helix would give no E.M.F. at the ends; but when the coil is divided into two halves, these may, by means of appropriate connexions, be placed either in series or in parallel, and each half will at any instant give the same E.M.F. The ring armature must therefore be divided into at least two coils, and it is then evident that if the width of each coil exceeds the width of the interpolar gap, the loops will for some portion of one revolution be moving at the same time under two poles of opposite sign, and consequently *differential action* will be set up, by which one part of the coil will be inducing an E.M.F. opposed in direction to that of the rest. If this disadvantageous action is to be avoided, either the width of the coil or the width of the pole, or both, must be reduced until the coil is no wider than the interpolar gap. If the coil be wide, the poles must be narrow, so that with a given density the number of lines in a field will be very small; while, on the other hand, if the coil be narrow and the pole wide, the flux of one field may be large, but the number of inductors in the coil must be small.

If the poles of the alternator are arranged in two separate circles (as in Fig. 43), all the N poles forming one crown and all the S poles another crown, the width of the poles may be equal to the pitch; but if they occur alternately, first a N pole and then a S pole round the same circle, their width must be less than equal to the pitch in order to avoid an excessive amount of magnetic leakage between the adjacent pole-edges. Considerations of the inductance of the armature and of its heating in turn limit the feasible width of winding in the armature coils. A compromise has therefore to be made, and experience shows that in practice the best combined use of an armature core and field-magnet of given size is made if the width of the poles of alternate sign is approximately half the pitch, and the width of the ring coil is equal to the width of a pole. The two-pole machine will then have two coils,

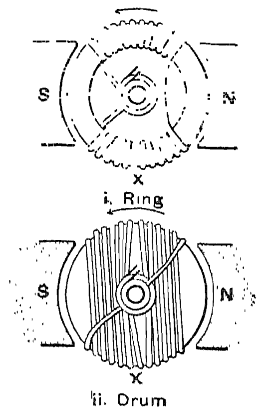


Fig. 12.

and the armature core will be only half covered with winding (Fig. 12 i.). The same considerations govern the best width of a drum coil. If the core be entirely overwound (as in Fig. 12 ii., if the blank portions of the core were covered with loops of continually diminishing size), the arrangement is the equivalent of the ring armature with two coils in series, each of width equal to the pitch. The single coil of the bipolar drum may equally well be divided into two coils, the largest loop of each half having a width equal to the pitch; and the two coils so formed may be connected either in series or in parallel. Again, however, if there is to be no differential action, opposite sides of one coil must never be moving under the same pole, and the innermost or smallest loop must not be less in width than the pole-face. The best proportions are obtained if the width of the inner loop and the width of the field are each approximately equal to half the pitch (Fig. 12 ii.). The same reasoning can easily be applied to the discoidal ring and disc machines, and will lead to like results.

If the bipolar armatures of Fig. 12 are imagined to be cut through to the centre from any point X and opened out, it is evident that any number of pairs of coils similarly spaced to the original pair may be inserted without in any way affecting the action, save to increase the periodicity of the alternating E.M.F.; an equal number of pairs of poles may then also be added, with a corresponding increase in the total E.M.F., and the *multipolar alternators*[1] of Fig. 13 are obtained. As the wires of a coil pass gradually into or out of action, the total E.M.F. of the coil, being the sum of the E.M.F.'s in the separate inductors, rises or falls gradually, the maximum value being reached when the coil is immediately under a pole in the ring armature, or when the side of a coil is under a pole in the drum and disc machines. When the coil enters under the next pole of opposite sign, the gradual rise and fall are again repeated, but the E.M.F. is in the opposite direction. Thus the passage of a coil through two magnetic fields of opposite direction yields a complete wave of E.M.F. such as is shown in Fig. 6, and the time in seconds taken by the E.M.F. or current to pass through such a complete cycle is the "period" of the alternator. The number of complete periods through which the E.M.F. or current passes per second is called the *periodicity* or *frequency*, and in the bipolar alternator is equal to the number of revolutions per second. In the multipolar alternators of Fig. 13 the coils may be arranged either in series or in parallel, since their phases are all alike; the periodicity of the multipolar alternator is with either arrangement equal to the number of pairs of fields through which a coil passes in one second, so that in general the periodicity$=\frac{N}{60}\times p$, where N = the number of revolutions per

[1] The first use of a number of pairs of coils and an equal number of pairs of poles was due to Stöhrer of Leipzig, *Pogg. Ann.* lxi. 417, 1844.

minute, and $p$ = the number of pairs of fields. In the ring and drum alternators, $p$ is also the number of pairs of poles, but in the discoidal ring and the disc types the pairs of poles must be reckoned on one side only, since each pair of poles facing each other on opposite sides of the armature only corresponds to a single field.

The above reasoning has, so far, led us in all cases to as many coils as there are fields and an armature core only half covered with winding, and such is the form taken by the *single-phase alternator*. But since only one-half of the armature core is utilized, an entirely distinct but similar set of coils may be wound to form a second armature circuit between the coils of the first circuit. The phase of this second circuit will differ by a quarter of a period from that of the first, and it may either be used to feed an entirely separate external circuit, possibly at a different pressure, or, if it be composed of the same number of inductors and therefore gives the same pressure, it may be inter-connected with the first circuit to form a *quarter-phase alternator*. By an extension of the same process, if the width of winding in each ring coil be reduced to

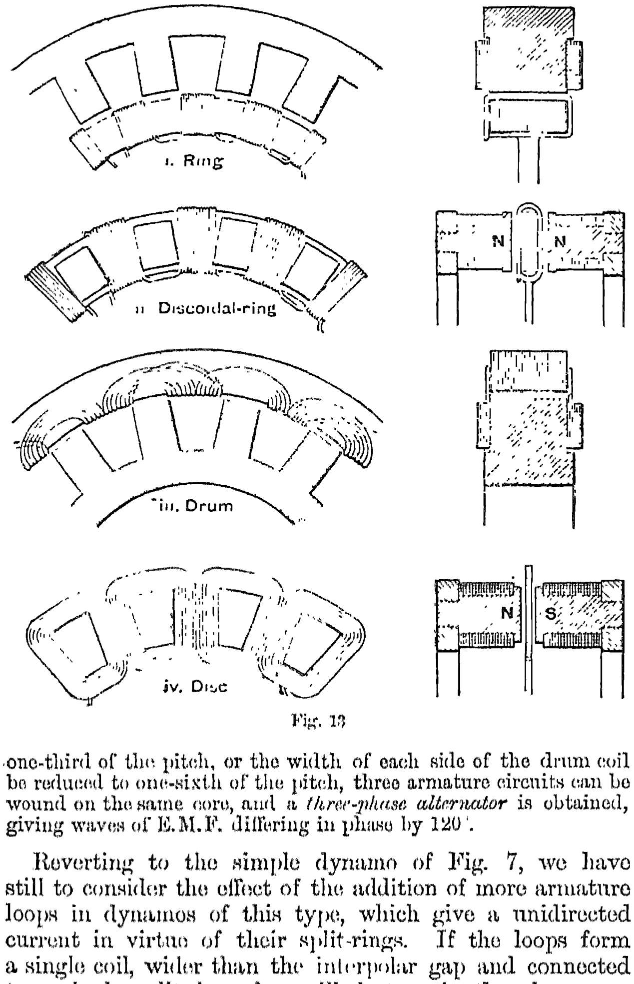


Fig. 13

one-third of the pitch, or the width of each side of the drum coil be reduced to one-sixth of the pitch, three armature circuits can be wound on the same core, and a *three-phase alternator* is obtained, giving waves of E.M.F. differing in phase by 120°.

Reverting to the simple dynamo of Fig. 7, we have still to consider the effect of the addition of more armature loops in dynamos of this type, which give a unidirected current in virtue of their split-rings. If the loops form a single coil, wider than the interpolar gap and connected to a single split-ring, they will, just as in the alternator, act differentially against one another during part of a revolution. Hence the coil must be more or less concentrated into a narrow band. Such an arrangement in the case of drum winding gives the H-form "shuttle" armature invented by Dr Werner von Siemens. Although its E.M.F. has a much higher maximum value than that of the curve of Fig. 7, it still periodically varies during each revolution, and so gives a pulsating current. To avoid the pulsation, recourse must be had to a new principle peculiar to the *closed-coil continuous-current machine*, which is by far the most largely used of all dynamos. Since a second coil placed at right angles to the original coil will yield a wave of E.M.F. of which the crests will coincide with the hollows of the first wave, the E.M.F.'s of the two coils when in series will supplement each other, and the fluctuations of the resultant curve will be greatly reduced, although its maximum may be no higher. Instead, therefore, of concentrating the new loops into a narrow coil, as in the case of the alternator, the opposite course must be pursued, and the loops be divided between several coils equally spaced round the armature. Given two coils at right angles and with their split-rings displaced through a corresponding angle of 90°, they may be connected in series by joining one brush to the opposite brush of the second coil, the external circuit being applied to the two remaining brushes.[1] The same arrangement may again be repeated with another pair of coils in parallel with the first, and we thus obtain Fig. 14 with four split-rings,

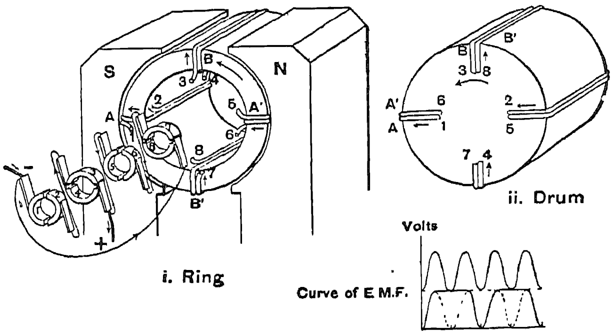


Fig. 14.

their connexions to the loops being marked by corresponding numerals; the four coils will give the same E.M.F. as the two, but they will be jointly capable of carrying twice the current, owing to their division into two parallel circuits. Now, since the effect of joining brush 2 across to brush 3 is virtually to connect the end of coil A with the beginning of coil B, and so on until they are closed upon themselves in a continuous helix, the four split-rings may be replaced by the simpler arrangement of Fig. 15, consisting of four segmental portions of a cylinder, insulated from one another and from the shaft, and requiring only two brushes, which form the terminals of the external circuit. Each sector replaces a pair of halves of adjacent split-rings, in the order of sequence, 2 and 3, 4 and 5, 6 and 7, 8 and 1. The function of this structure[2] being not merely to collect the current, but to commute its direction in any coil as it passes through the interpolar gap, it is known as the *commutator*. Each coil is successively short-circuited, as a brush bridges over the insulation between the two sectors which terminate it; and the brushes must be so set that the period of short-circuit takes place when the coil is generating little or no E.M.F., *i.e.*, when it is moving through the zone between the pole-tips. The effect of the four coils in reducing the percentage fluctuation of the E.M.F. is very marked, as shown at the foot of Fig. 14 (where the upper curve is the resultant obtained by adding together the separate curves of coils A and B), and the levelling process may evidently be carried still further by the insertion of more coils and more corresponding sectors in the commutator, until the whole armature is covered with winding. For example, Fig. 16 shows a ring and a drum armature, each with eight coils and eight commutator sectors; their resultant curve, on the assumption that a single inductor

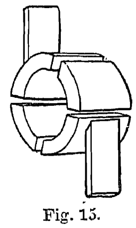

Fig. 15.

[1] Such was the arrangement of Wheatstone's machine (Brit. Pat., No. 9022) of 1841, which was the first to give a more nearly *continuous* current, the number of sections and split-rings being five.

[2] Its development from the split-ring was due to Pacinotti and Gramme (Brit. Pat., No. 1668, 1870) in connexion with their ring armatures.

gives the flat-topped curve of Fig. 4, will be the upper wavy line of E.M.F. obtained by adding together two of the resultant curves of Fig. 14, with a relative displacement of 45°. The amount of fluctuation for a given number of commutator sectors depends upon the shape of the curve of E.M.F. yielded by the separate small sections of the armature winding; the greater the polar arc, the less the fluctuation. In practice, with a polar arc equal to about 0·75 of the pitch, any number of sectors over 32 yields an E.M.F. which is sensibly constant throughout one or any number of revolutions. If the armatures of Fig. 16 be imagined to be cut across to the centre from any point such as X and opened out, as was also done in the case of alternators, any number of pairs of poles, with a corresponding increase in the number of inductors, may be added, and multipolar continuous-current dynamos are obtained. But whereas in the alternator there may in each phase be only one circuit through the armature, in the continuous-current closed-coil armature there can never be less than two parallel circuits, while if there are more than two, there must be as many as there are poles.[1] The two conditions coincide in the simple bipolar armature, since it has two parallel paths through the armature, or as many as there are poles.

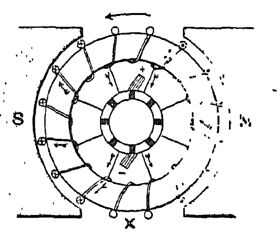

Fig. 16A

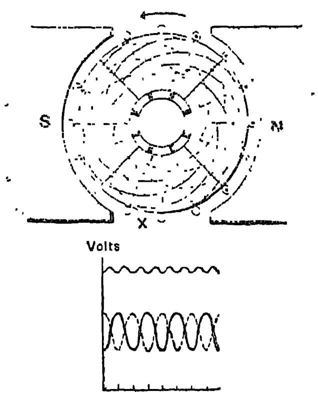

Fig. 16B.

The fundamental *electromotive force equation* can now be given a more definite form, suitable for both the continuous-current dynamo and the alternator. Let $Z_a$ = the number of C.G.S. lines or the total flux, which issuing from any one pole flows through the armature core, to leave it by another pole of opposite sign. Since each inductor cuts these lines, first, as they enter into the armature core from one pole, and then as they emerge from it to enter another pole, the total number of lines cut in one revolution by any one inductor is $2pZ_a$. The time in seconds taken to perform one complete revolution is $\frac{60}{N}$, where N is the number of revolutions per minute. The average E.M.F. induced in each inductor in one revolution, being proportional to the total number of lines which it cuts, divided by the time taken to cut them, is therefore $2p \cdot \frac{N}{60} \cdot Z_a \times 10^{-8}$ volts. Let $\tau$ be the total number of inductors on the surface of the armature, whether ring- or drum-wound, and let $q$ be the number of parallel circuits into which the armature winding of a continuous-current dynamo is divided, whence the number of inductors in series is $\frac{\tau}{q}$. The average E.M.F. induced in the armature is then $E_a = 2 \cdot \frac{pN}{60} \cdot \frac{\tau}{q} \cdot Z_a \times 10^{-8}$ volts, and in the continuous-current machine, with a sufficient number of inductors and commutator sectors, this is the same as the instantaneous E.M.F.; for the sum total of the several E.M.F.'s set up in the different inductors of one circuit, spread uniformly over the armature core, will at any moment be equal to the average E.M.F. set up in one inductor multiplied by the number of inductors in series, *i.e.*, it is independent of the distribution of the flux in the air-gap. It should be observed that $Z_a$, or the number of lines flowing *through* the armature, is taken, since in the ring machine this will differ from the number that cross the air-gap or $Z_g$ by the small percentage which leak across the interior of the ring, and so are cut in the opposite sense by the internal connecting wires.

[1] Except in the special case of multiple-circuit windings, which will be referred to later.

The case of the discoidal armature may best be treated by reducing it to the analogous simple ring; each pair of opposing poles, since they are of the same sign, forms in effect a single divided pole, whence a total number of lines $Z_a$ pass into the armature core; $\tau$ must then be reckoned as equal to the number of loops in the ring, or the number of inductors on one only of its two faces. The equation of E.M.F. thus becomes exactly the same as that of the simple ring machine. The disc winding is analogous to the drum, so that in all cases *the E.M.F. of the continuous-current closed-coil armature* is

$$E_a = \frac{2}{q} \cdot \frac{pN}{60} \cdot \tau \cdot Z_a \times 10^{-8} \text{ volts}, \qquad \text{(I.}a\text{)}$$

where $q$ must be an even number, and can never be less than 2.

In the continuous-current dynamo the instantaneous and average values of the E.M.F. from the armature as a whole are the same; but when we pass to the alternator, its "effective" E.M.F. is equal to the square root of the mean square of the instantaneous values of the E.M.F., since this is the value of the equivalent unidirected and unvarying E.M.F., which, when applied to a given resistance or to a glow lamp, would give the same amount of heat or of light as the alternating E.M.F. produces (see ELECTRICITY, iii. *Electric Current*). The shape of the curve of instantaneous E.M.F. therefore becomes a matter of the greatest importance, for upon it will depend the effective voltage of the alternator, even though its average E.M.F. may be the same with some different shape of E.M.F. curve. Assuming, as we may, that the density of the lines is the same along the length of an inductor for any given position of it during rotation, its instantaneous E.M.F., $= B_g L V \times 10^{-8}$ volts, will vary as $B_g$ varies, according to the position of the inductor under or between the poles. Hence the addition of more inductors in series may not give a proportionate addition of E.M.F., and in fact will not do so, unless they are so close beside each other that their difference of spacial position or of phase can be neglected; the nearest practical approach to this will be in the case of a toothed or tunnel armature, when the inductors of a coil are wound in the same slot or hole. Differential action, which has been already discussed, is indeed only an aggravated case of the same effect as must take place when a coil is gradually coming into or out of action, and is not entirely under a pole. Further, it is evident that the curve of E.M.F. of the coil may be given any shape that we please, by so shaping the pole-piece as to give the required variation in density of the lines in the air-gap. Thus the length of gap between pole-face and armature core might be so varied as to give a curve of E.M.F. varying after a sine law (cp. Fig. 3—for the case of a single inductor), and the ratio of the effective E.M.F. to the average E.M.F. would then have the particular value of $\frac{\pi}{2\sqrt{2}} = 1 \cdot 11$. Two points have, then, to be considered in an alternator, namely, what is the ratio of the square root of the mean square to the average value of its E.M.F., and what is the ratio which either the instantaneous or the average E.M.F. of a coil bears to the instantaneous or average E.M.F. of a single inductor. Both depend on the ratio of the width of coil and pole, and on the law which governs the variation in density of the field. If $e_c$ = the effective E.M.F. of one coil, and the total number of coils in one phase, *i.e.*, $2p$, be divided into $q$ parallels, the effective E.M.F. of the phase is $E_{ae} = \frac{2p}{q} \cdot e_c$. Let $k'$ = the ratio of the square root of the mean square to the average value of the E.M.F. of the coil, or $= \dfrac{\sqrt{\dfrac{\int_0^T e^2 dt}{T}}}{\dfrac{\int_0^T e\,dt}{T}}$, then the effective value of the E.M.F. of the phase is $\frac{2p}{q} \cdot k' \cdot e_{av}$, where T is the time of a period and $e_{av}$ = the net average value of the E.M.F. of a coil. Let $k''$ = the ratio which the net average E.M.F. of the coil bears to the gross average E.M.F. on the supposition that there is no differential action, and let $e$ = the average E.M.F. of a single inductor; then if $t$ be the number of inductors in a coil, the reduction of the E.M.F. of a coil as a whole may be taken into account by multiplying the product $te$ by a breadth coefficient $k''$, which must be less than unity if the coil have any width. The effective E.M.F. per phase is therefore $\frac{2p}{q} \cdot k' \cdot k'' \cdot te$. If $m$ = the number of separate phases into which the armature winding is divided, $t = \frac{\tau}{m \cdot 2p}$; further, the average E.M.F. of the single inductor $e$ is $2 \cdot \frac{pN}{60} \cdot Z_a \times 10^{-8}$ volts; whence the *effective E.M.F. of one phase of the alternator* is
$E_{ae} = \frac{2p}{q} \cdot k' \cdot k'' \cdot \frac{\tau}{m \cdot 2p} \cdot \frac{2p \cdot N}{60} \cdot Z_a \times 10^{-8} = \frac{2 \cdot k' \cdot k''}{m \cdot q} \cdot \frac{pN}{60} \cdot \tau Z_a \times 10^{-8}$ volts. The two factors $k'$ and $k''$ may be united into one constant

K, and the equation then takes its final form of

$$E_{ae} = \frac{2 \cdot K}{mq} \cdot \frac{pN}{60} \cdot \tau \cdot Z_a \times 10^{-8} \text{ volts} \quad . \quad . \quad . \quad . \quad (\text{I}.b)$$

In contrast to the continuous-current dynamo, $q$ may be unity. The analogy of this equation to that of the continuous-current machine is at once apparent; the process by which it is arrived at really consists in stating the E.M.F. of the alternator as that of a similarly wound continuous-current dynamo multiplied by a certain constant, and only because this is the most convenient method of expressing it are we interested in its average E.M.F. The second term $\frac{p \cdot N}{60}$ in both equations gives the periodicity of the alternating E.M.F. in the inductors; and even though the current be commuted, as in the continuous-current machine, it is of importance as determining the loss by hysteresis in the core, and by eddy currents in the armature as a whole.

The fundamental equation of the electromotive force of the dynamo in its fully developed forms (I.$a$) and (I.$b$) may be compared with its previous simple statement (I.). The three variable terms still find their equivalents, but are differently expressed, the density $B_g$ being replaced by the total flux of one field $Z_a$, the length L of the single inductor by the total number of inductors $\tau$, and the velocity of movement V by the number of revolutions per second. Even when the speed is fixed, an endless number of changes may be rung by altering the relative values of the remaining two factors; and in successful practice these may be varied between fairly wide limits without detriment to the working or economy of the machine. While it may be said that the equation of the E.M.F. was implicitly known from Faraday's time onwards, the difficulty under which designers laboured in early days was the problem of choosing the correct relation of $Z_a$ and $\tau$ for the required output; this, again, was due chiefly to the difficulty of predetermining the total flux before the machine was constructed.[1] The general error lay in employing too weak a field and too many inductors, and credit must here be given to the American inventors, Weston and Edison, for their early appreciation of the superiority in practical working of the drum armature, with comparatively few inductors rotating in a strong field.

The *equation of mechanical force* now requires to be given, in its turn, a more fully developed form correlative to that of the electromotive force. Let the inductors of a continuous-current dynamo be carrying a current of $c$ amperes; then each, so long as it is moving under a pole-face, is subjected to a mechanical drag of $B_g L c \times 10^{-1}$ dynes, or if the length and force be expressed in English units of inches and pounds, of 57 $B_g L'' c \times 10^{-8}$ pounds. This force is gradually removed and re-established $2p$ times in each revolution as the inductor passes the interpolar gaps, but its direction is always tangential to the path of rotation, and opposed to it, so that the torque resisting the movement of a single inductor is $B_g L c \cdot r \times 10^{-1}$ dyne-centimetres, where $r$ is the radius in cm. of the mean path of the inductor. The total torque acting on the armature is due to the combined effect of the several inductors with which it is wound; and since the number of inductors within one polar face is $\tau \cdot \frac{\phi}{2\pi}$, where $\phi$ is the angle subtended by the polar arc in radians, the total torque of the armature due to the $2p$ fields is $T = p \cdot \tau \cdot \frac{\phi}{\pi} \cdot B_g \cdot L \cdot c \cdot r \times 10^{-1}$ dyne-centimetres.

Since $B_g = \frac{Z_a}{Lr\phi}$,

$$T = \frac{p \cdot \tau \cdot c \cdot Z_a}{\pi} \times 10^{-1} \text{ dyne-centimetres, or}$$

$$= \frac{p \cdot \tau \cdot c \cdot Z_a}{4.26} \times 10^{-8} \text{ pound-feet} \quad . \quad . \quad . \quad . \quad (\text{II}.a).$$

In the above statement the lines are treated as if confined strictly to the area of the pole-face—an assumption which is not strictly true, since the fringe surrounding the pole-edges has been neglected. The correction for this slightly decreases the value of $B_g$ for a given value of $Z_a$, but correspondingly increases the number of inductors which are subjected to the torque, so that the final form of the equation is strictly true for the continuous-current armature as a whole. This may be proved if the torque be multiplied by the angular velocity in radians per sec., and the rate of absorption of mechanical energy as thus obtained in ergs per sec. or foot-pounds per sec. be equated to the rate of development of electrical energy. The latter is equal to E C watts, or since $C = qc$, the electrical horse-power is

$$\frac{2}{q} \cdot \frac{pN}{60} \cdot \frac{\tau \cdot Z_a \cdot 10^{-8}}{746} \cdot qc = \frac{2pN}{60} \cdot c \cdot \tau \cdot Z_a \times 1.33 \times 10^{-11}.$$

On the other hand, the angular velocity in radians per sec. is equal to the number of revolutions per sec. multiplied by $2\pi$, so that the mechanical horse-power absorbed is equal to

$$\frac{p \cdot \tau \cdot c \cdot Z_a}{4.26} \times 10^{-8} \times \frac{2\pi N}{60} \times \frac{1}{550} = \frac{2pN}{60} \cdot c \cdot \tau \cdot Z_a \times 1.33 \times 10^{-11}.$$

Since the expression for the drag on any single inductor involves the term $B_g$, it is evident that it is dependent on the distribution of the flux in the air-gap, *i.e.*, on the shape of the curve of $B_g$, and if the average value of $B_g$ is alone considered, the equation (II.$a$), although giving the average pull on the inductor, does not express its instantaneous values. As will be explained subsequently, the value of the actual $B_g$ in the continuous-current dynamo when at work is not uniform even under the pole-face. Hence the instantaneous pull on any inductor varies on either side of the average value, and in practice its maximum value at full load may be as much as 20 per cent. greater than the average value.

Lastly, in the alternator the current $c$ varies as well as the density $B_g$, so that the problem becomes much more complicated and no simple equation can express it. If the current in the armature were in phase with the induced E.M.F., and so with the flux-density which causes it, the maxima values of $B_g$ and $c$ would occur simultaneously. The maximum drag thereby produced will be far greater than the average value, and may considerably exceed the force acting on the equivalent continuous-current dynamo. But, more than this, if there be inductance in the circuit, the current in the armature will lag in phase behind the induced E.M.F. and behind the $B_g$ curve. The pull on the inductors now becomes zero not only when $B_g$ is zero, but also when $c$ is zero, and, further, its direction relatively to the rotation changes each time that either the one or the other passes through zero. Thus the alternator is subjected to a racking action which is much more trying than the simple torque of the continuous-current machine. The armature is alternately dragged back when the directions of field and current coincide, and driven forward as a motor when they are opposed, the backward drags being more powerful and lasting longer than the forward pushes, so that on the whole the machine absorbs mechanical energy and acts as a generator.

If the inductors, instead of being wound on the surface of a smooth armature core, are sunk into slots or passed through holes close to the edges of the core-discs, the force which would otherwise be expended on them is largely transferred to the iron teeth which project between the slots or tunnels. The lines of the field, after passing through the air-gap proper, divide between the teeth and the slots in proportion to their relative permeances. Hence at any moment the inductors are situated in a weak field, and for a given armature current the force on them is only proportional to this weak field.[2] This surprising result is connected with the fact that when the armature is giving current the distribution of the lines over the face of each tooth is distorted, so that they become denser on the "trailing" side than on the "leading"[3] side (Fig. 17); the lines tend to straighten and shorten themselves, and the result of the unsymmetrical distribution acting on all the teeth is to produce a magnetic drag on the armature core proportional to the current taken out of the inductors, so that the total resisting force remains the same as if the armature had a smooth core. The amount by which the stress on the inductors is reduced entirely depends upon the degree to which the teeth are saturated, but since the relative permeabilities of iron even at a flux density of 20,000 lines per square centimetre is to that of air as 33 : 1, the embedded inductors are very largely relieved of the driving stress.

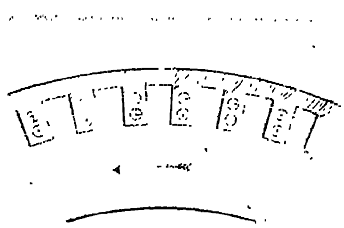

Fig. 17.

### Continuous-Current Dynamos.

On passing to the separate consideration of continuous-current dynamos, the winding of the armature may first be taken in greater detail, and certain results drawn from

[1] Cp. Kapp, *Journ. Soc. Tel. Eng.* vol. xv. p. 5901, 886.

[2] *Electrician*, vol. xxxiv. p. 757 (Sayers), and vol. xli. p. 108 (Du Bois); Swinburne, *Industries and Iron*, February 2, 1894; Mordey, *Journ. Inst. Elec. Eng.* vol. xxvi. p. 564; Houston and Kennelly, *Elec. Eng.* vol. xviii. p. 208.

[3] By the "leading" side is to be understood that side which first enters under a pole after passing through the gap between the poles, and the edge of the pole under which it enters is here termed the "leading" edge, as opposed to the "trailing" edge or corner from under which a tooth or coil emerges into the interpolar gap; cp. Fig. 30, where the leading and trailing edges are marked $ll$ and $tt$.

the ring and drum armatures of Fig. 16, which are equally true for the discoidal and disc forms.

**Ring winding.** The simple ring winding consisting of a continuous helix is in itself unaffected by the number of poles; by the mere placing of $2p_{\prime}$ sets of brushes on the surface of the commutator at equal distances apart, the winding is at once divided into as many equal and symmetrical paths through the armature, or $q=2p_{\prime}$. Hence if $2p_{\prime}$ is made equal to $2p$ or the number of poles, a *multipolar parallel-wound ring* is obtained, having as many parallel circuits and as many points of collection of the current as there are poles. The E.M.F. of the armature is then $\frac{2p}{2p_{\prime}} \cdot \frac{N}{60} \cdot \tau \cdot Z_a \times 10^{-8} = \frac{N}{60} \cdot \tau \cdot Z_a \times 10^{-8}$ volts, whether it be bipolar or multipolar, and the current in any one inductor is $\frac{C}{2p}$. All the sets of brushes which are of the same sign must be connected together in order to collect the total current C. The potential rises gradually in the armature wires as we pass from a negative to a positive brush, or falls as we proceed onwards from a positive to a negative brush. The difference of potential between adjacent wires is only that due to the added voltage of one inductor if the winding be in one layer, or to one section if there be several layers; and as this is but a few volts even in machines giving as much as 3000 volts at the terminals, the insulation of the wires from one another presents no difficulty. On this score the ring winding contrasts favourably with the drum, and it is therefore more especially suited to very high potential machines. If the increased number of brush-sets in the multipolar parallel-wound armature is regarded as a disadvantage, they may again be reduced to two by cross-connexion of sectors situated $\frac{360°}{p}$ apart; but the commutator must then be lengthened $p$ times in order to provide sufficient brush-contact surface to collect the total current C, and, further, the number of sections must be an even number.

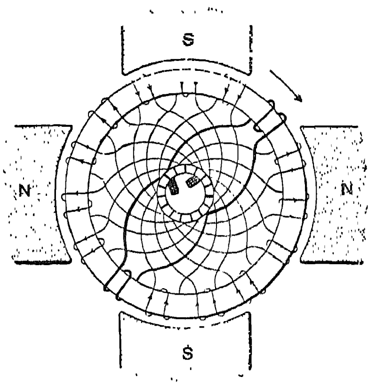

Fig 18.

It is, however, often required to add together the inductive effect of sections of the winding situated under two or more poles, especially in high voltage machines. This may be done by connecting together in series a set of coils symmetrically situated in fields of like polarity, as diagrammatically shown in Fig. 18; the current in the armature is then only divided between two parallel paths, and there are only two sets of brushes, or $p_{\prime}=1$ and $q=2p_{\prime}=2$. Hence the E.M.F. of the *series-wound multipolar armature* is $E_a = p \cdot \frac{N}{60} \cdot \tau \cdot Z_a \times 10^{-8}$ volts.

**Drum winding.** The development of the modern *drum winding* from the shuttle-wound Siemens armature is chiefly due to von Hefner Alteneck of Berlin (1871). From Fig. 16B it will be seen that, in order to avoid differential action, the width of each loop must exceed the width of a pole-face and may be equal to the pitch of the poles, *i.e.*, the loop may be wound diametrically across the bipolar armature core. If, however, the number of commutator sectors be even and the winding be disposed in one layer, a symmetrical winding cannot be obtained unless the width of the loop falls short of the above maximum width by at least the width of one inductor, *i.e.*, the "pitch" of the loop at the "back" end of the armature farthest from the commutator, or the number of inductors passed through in joining one inductor to another, must not exceed $\frac{\tau}{2}-1$. Since $\frac{\tau}{2}$ is with an even number of sectors itself also an even number, the pitch at the back end of the armature must then be an uneven number. Even if the armature winding be disposed in two layers, or the commutator sectors be an uneven number, it is not advisable for the loops to be wound diametrically across the armature core; hence it may be said in general that the pitch of the winding at the back end of the armature must be an uneven number less than $\tau/2$, so that the loop spans a chord less than the diameter, and is in effect wound on one side of the core (cp. Fig. 16B). In completing the loop and joining it to the next loop, two possible cases present themselves. By the first, or *lap winding* (Fig. 16), the end of the loop is taken to a commutator sector, and thence starts off again to a third inductor on the same side of the core as the first loop, and lying within its two sides, *i.e.*, the next loop starts with the inductor next but one to the first inductor. The pitch of the front end is therefore less than the pitch of the back end, and differs from it by two. Thus the winding works continually forwards and backwards, until it passes right round the armature and finally closes on itself. The development on a flat surface shows that the completed winding takes the form of a number of partially overlapping loops, whence its name originates. One of these loops is marked in heavy lines in Fig. 19 i., where the firm-line portion gives the development of Fig. 16B, if cut through at the point marked X. The multipolar parallel-wound drum is precisely similar, as shown by the dotted additions in Fig. 19 i., which convert it from a two-pole to a four-pole armature; the only difference is that the pitch at the back end must in all cases be an odd number less than, but not far different from, $\tau/2p$. The maximum difference of potential in the drum armature exists between neighbouring wires as they successively pass the neutral points corresponding to the position of the brushes, and is here equal to the full E.M.F. of the machine. These wires lie side by side in the smooth-core armature with one layer, or one on the top of the other if there are two layers, as is usually the case in slotted

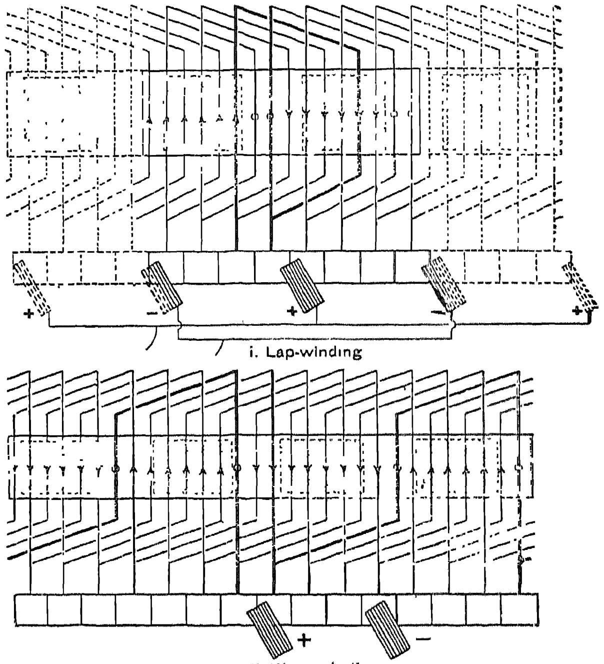

Fig. 19.

armatures; so that good insulation must be provided between the adjacent sides of the wires in the former case, and between the two layers in the latter case.

**Wave winding.** By the second, or *wave*, method of drum winding, the end of the first loop in the bipolar armature is taken to a commutator sector on the opposite side of the diametric line to the first loop, and thence the second loop starts with an inductor lying *outside* the first loop and next but one to the original inductor. The method may be extended to multipolar machines, and then gives the series-wound multipolar armature; when the completed winding is developed on a flat surface (Fig. 19 ii.), it is seen to work continuously forwards in a zigzag wave round the armature, one inductor under each pole being successively joined up until the winding closes on itself. The average of the front and back pitches must be $\frac{\tau \pm 2}{2p}$, so that, *e.g.*, in a four-pole machine, the possible number of inductors goes up by steps of four.

The equations of the E.M.F. of parallel-wound and series-wound drum armatures are the same as those for the parallel-wound and series-wound rings, the latter in each case being $p$ times the former. Thus the chief advantage of the series-wound armature, whether ring or drum, is that for a given voltage the number of inductors and the space lost in insulation of the wires is only $1/p$ of the number of inductors and the space lost in the parallel-wound armature. A further advantage is that the two circuits from brush to brush consist of inductors influenced by all the poles in the drum, or by all the poles of like sign in the ring; hence

if for any reason, such as eccentricity of the armature in the bore of the pole-pieces, the inductive effect of one field is not equal to that of any other, the equality of voltage produced by the two halves of the winding is not affected thereby. In the parallel-wound armature inequality of the voltage of the various parallels may be avoided by a combination of the series and parallel methods. For large currents, multiple circuits are possible both with series and parallel winding, and $q=2p, \times x$, where $x=$ the number of separate armatures which are virtually wound on the same core.

***Armature core.*** When the core of the armature is constructed of iron or other metal, the passage of it through the lines of the field sets up in its mass E.M.F.'s which are in opposite directions under poles of opposite sign, and are greatest at the surface where the rate of line-cutting is greatest. Hence if the core were a solid mass, a current-sheet would flow along its surface under each pole, and complete its circuit by passing through the inner parts of the core or by returning in a sheet under a pole of opposite sign. The result would be a considerable reduction in the efficiency of the machine, since the power absorbed by these so-called *eddy-currents* would be entirely dissipated in heating the core. The production of the E.M.F. cannot be prevented, but the paths of the eddy-currents can be broken up, so that they meet with a comparatively high resistance and are reduced in amount. In the first place, the metal core must be divided into laminations whose planes are at right angles to the length of the inductors proper, since these are arranged to secure the maximum E.M.F. The laminae must be slightly insulated from one another; and if the insulation be maintained right up to their edges, the E.M.F.'s which still act across their thickness will not be added up along the length of the core, but will only produce very small currents, which circulate through the interior of the separate laminations. This remedy is practically realized in ring and drum armatures by building up their cores of thin iron plates or discs, strung on the shaft or on a supporting hub, so that their edges are presented to the lines of the field. Each disc is either coated with an insulating varnish or has one of its sides covered with a sheet of very thin paper; or in some cases no special insulating material is employed, and reliance is placed on the thin film of oxide which forms on the disc in the process of manufacture, and which is a poor electrical conductor. The thickness of the discs is usually about one-fortieth of an inch, and if this be not exceeded, the eddy-currents set up in the mass of the core are reduced to an almost negligible amount. The discs are in the ring machine notched with three or more key-ways, and are then passed over a gun-metal hub with three or more arms running parallel to the shaft, which fit into the corresponding slots on the inner periphery of the discs (cp. Fig. 6 and the sections of Fig. 13). In the case of small bipolar drums the discs are often keyed directly to the shaft, but in larger multipolar machines the required radial depth of iron is small, and the discs are then mounted on a hub similar to that of the ring armature, save that it may now be made of cast-iron. If the armature is more than 4 feet in diameter, the discs become too large to be conveniently made in one piece, and are therefore divided into segments, which are built up so that they alternately break joint. In all cases the stout end-plates between which the discs are clamped together must be kept well out of the influence of the field, since otherwise the lines which curve round into the ends of the core from the edges of the poles may cause eddy-currents in their mass. Hence the axial length of the core is often made slightly greater than the corresponding dimension of the poles. In discoidal-ring armatures the laminations must be concentric with the axis of rotation, and a thin ribbon of iron is wound on the supporting wheel, which may be of cast-iron (cp. Figs. 10 and 13 ii.).

***Armature winding.*** When the armature core has been built up and all rough edges smoothed off, it is covered with some material of good insulation, resistance, and durability, such as oiled linen, varnished paper, or micanite sheeting, so that all edges and surfaces on which the winding rests are thoroughly protected. In the ring wire-wound armature a length of wire sufficient for one section of the armature is cut off, treated with shellac, and dried; one end is passed through the interior of the ring, and the required number of loops are wound tightly round the core. The next section is then similarly wound, until finally the whole core is covered, and the beginnings and ends of contiguous sections are united at the commutator to form a continuous helix. If the size of the solid wire becomes too large to be conveniently bent, two or more wires may be wound in parallel, with, however, some necessary loss of space owing to the subdivision. The small drum armature may be similarly *hand-wound*, the loops of wire overlapping at the ends of the armature core; but the method is accompanied by the disadvantage that if one section has to be repaired, the whole armature may have to be taken to pieces and rewound. Hence various methods have been devised for winding drums with coils formed on shapers previously to fixing them in place. The *former-wound* coils have the advantage that they are perfectly symmetrical and interchangeable, can be thoroughly insulated before they are placed on the core, and, further, are economical in cost of labour. If, however, the current in each inductor is large, the drum armature must be *bar-wound*. The inductors are then large and heavy bars of rectangular section, which are laid on the core and joined up in regular sequence by soldering to the end-connectors. These latter are strips of copper from one to two inches wide, which are bent in a double evolute curve so that they span the correct pitch and unite the short end of one bar to the long end of another bar situated at the proper distance apart round the circumference of the core. For multipolar armatures with two or more layers of inductors, "surface" or "*barrel*" winding is now extensively used, in which no separate end-connectors are employed; at each end the inductors project beyond the core and are bent through an angle corresponding nearly to half the pitch of the poles, the upper layer being bent in the opposite direction to the lower; the ends of the two layers are then soldered together to form loops lying entirely on the surface of the cylindrical armature.

Since any inductor must have a certain width in the direction of rotation, one edge enters or leaves the field sooner than the other edge. Hence when a solid bar is moving through the fringe of lines between the pole-tips, where the density varies considerably, the E.M.F. set up along the one edge is different from that set up along the other, and an eddy-current will flow round the bar, passing down one side and up the other, due to the difference between the E.M.F.'s of the two edges. Thus in a rotating armature an eddy-current will be set up in each and every solid bar as it passes between the pole-tips. To prevent the reduction in efficiency that results therefrom, and the consequent heating of the bar, it is necessary to make use of a stranded bar in which the separate strands, lightly insulated from each other, are twisted so that they pass from one side to the other, at least once midway along the length of the bar. The E.M.F. induced in each strand is then practically the same, since it is the average of the E.M.F.'s of the two sides, and the eddy-current loss is very largely avoided.

***Driving the inductors.*** In every dynamo with rotating armature the driving force has to be transmitted from the shaft or coupling to the hub, thence to the discs, and finally to the inductors. The discs must therefore be securely keyed to the hub, and in the smooth-surface armature any slip between the core and the inductors is opposed by the friction between the two. The bands of binding wire, which are placed at intervals along the length of the armature in order to resist the stress of centrifugal force, further increase the friction. In the wire-wound ring the loops themselves grip the core tightly, and are also held in place by passing through the interior of the ring between the arms of the hub. But in the smooth-core drum the firm attachment of the inductors to the core presents greater difficulties, and in order to ensure the positive driving of the bars through the magnetic field against the mechanical drag, it is usual to groove a number of longitudinal slots in the periphery of the core at equal distances apart of some four inches, and to drive tightly into these hard-wood driving strips, which project from the core to a height equal to that of the inductors. Thus the inductors are split up into groups, and the combined drag due to a group is taken up by a corresponding strip. A still more perfect method of driving is found in the toothed or slotted core. This was the original type of armature invented by Pacinotti, but after some considerable use it was largely discarded in favour of the smooth core; of recent years, however, it has again been reintroduced, with a fuller understanding of the special precautions

required in its design, and it has met with great success in the construction of traction dynamos, in which the stresses set up by the varying load are very great. Not only are the bars securely driven by the teeth, but, as previously mentioned, they are largely relieved of the driving stress. A further advantage is due to the fact that the lines snap across the inductors from tooth to tooth with a velocity far in excess of the speed of rotation. The product of the weaker density in the slots and the increased velocity of the relative movement gives the same E.M.F. as in the equivalent smooth-core armature, but owing to the comparatively uniform density of the lines within any one slot, and the extremely rapid rate at which they cut the inductors, solid bars of much greater width may be used in the toothed armature than on a smooth core without trouble from eddy-currents.[1] One disadvantage of the slotted core remains to be mentioned. If the top of the slot be open, and its width of opening be considerably greater than the length of the single air-gap from the iron of the pole-piece to the surface of the core, the lines become unequally distributed not only at the surface of the teeth, but also at the bored face of the pole-pieces; and this massing of the lines into bands causes the density at the pole-face to be rhythmically varied as the teeth pass under it. No such variation can take place in a solid mass of metal without the production of eddy-currents within it; hence if the proportion[2] of the width of slot-opening to the length of air-gap is equal to or exceeds 2 : 1, it becomes advisable to laminate the pole-pieces to avoid eddy-currents in them. This precaution is less necessary with half-closed slots, and is entirely unnecessary with tunnel armatures, in which the inductors are threaded through holes pierced close to the surface of the core; but we are then met with the difficulty that such closed, or nearly closed, slots greatly increase the inductance of the loops, and are therefore disadvantageous to the commutation and sparkless collection of the current.

On passing to the second fundamental part of the dynamo, namely, the field-magnet, its functions may be briefly recalled as follows:—It has to supply the magnetic flux; to provide for it an iron path as nearly closed as possible upon the armature, save for the air-gaps which must exist between the pole-system and the armature core, the one stationary and the other rotating; and, lastly, it has to give the lines such direction and intensity within the air-gaps that they may be cut by the armature inductors to the best advantage. Roughly corresponding to the three functions above summarized are the three portions which are more or less differentiated in the complete structure. These are: (1) the magnet "cores" or "*limbs*," carrying the exciting coils whereby the inert iron is converted into an electro-magnet; (2) the *yoke*, which joins the limbs together and conducts the flux between them; and (3) the *pole-pieces*, which face the armature and transmit the lines from the limbs through the air-gap to the armature core, or *vice versâ*.

***Forms of field-magnet.***

Of the countless shapes which the field-magnet may take, it may be said, without much exaggeration, that almost all have been tried; yet those which have proved economical and successful, and hence have met with general adoption, may be classed under a comparatively small number of types. For bipolar machines the *single horse-shoe* (Fig. 20), which is the lineal successor of the permanent magnet employed in the first magneto-electric machines, has been very largely used, and for all outputs up to 150 kilowatts remains one of the simplest, most economical, and most compact types. It takes two principal forms, according as the pole-pieces and armature are above or beneath the magnet limbs and yoke. The "over-type" form is best suited to small belt-driven dynamos, while the "under-type" is admirably adapted to be directly driven by the steam-engine, the armature shaft being immediately coupled to the crank-shaft of the engine, and the axis of rotation being thus kept low. In the latter case the magnet must be mounted on non-magnetic supports of gun-metal or zinc, so as to hold it at some distance away from the iron bed-plate which carries both engine and dynamo; otherwise a large proportion of the flux which passes through the magnet limbs would leak through the bed-plate across from pole to pole without passing through the armature core, and so would not be cut by the armature inductors. The field-system is thus—to use a somewhat inaccurate expression—"magnetically insulated" from the bed-plate, the intervening distance being some eight to ten times the length of the single air-gap.

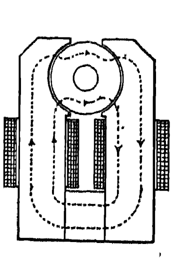

Fig. 20.

Next may be placed the "*Manchester*" field (Fig. 21)—the type of a divided magnetic circuit in which the flux forming one field or pole is divided between two magnets. An exciting coil is placed on each half of the double horse-shoe magnet, the pair being so wound that consequent poles are formed above and below the armature. Each magnet thus carries one-half of the total flux, the lines of the two halves uniting to form a common field where they issue forth into or leave the air-gaps. Or the coils may be divided and placed on the limbs of each horse-shoe, as in Fig. 22, instead of on the yoke, as in Fig. 21. The pole-pieces in both cases may be lighter than in the single horse-shoe type, and the field is much more symmetrical, whence it is well suited to ring armatures of large diameter. Yet these advantages are greatly discounted by the excessive magnetic leakage, and by the increased weight of copper in the exciting coils. Even if the greater percentage which the leakage lines bear to the useful flux is neglected, and the cross sectional area of each magnet core is but half that of the equivalent single horse-shoe, the weight of wire in the double magnet for the same rise of temperature in the coils must be some 40 per cent. more than in the single horse-shoe, and the rate at which energy is expended in heating the coils will exceed that of the single horse-shoe in the same proportion.

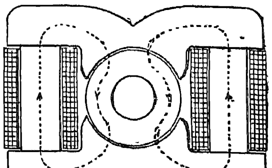

Fig. 21.

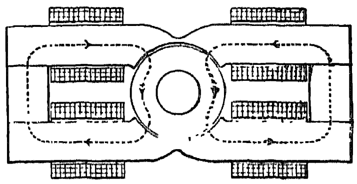

Fig. 22.

A somewhat similar form of two-pole field is required by the discoidal machine, but the poles now face the sides of the flat-ring armature (cp. Fig. 13 ii.); opposite poles of similar sign may be joined together by an overarching pole-piece, but owing to the difficulty of avoiding eddy-currents in the core it is more usual for the magnetic circuits to be entirely divided.

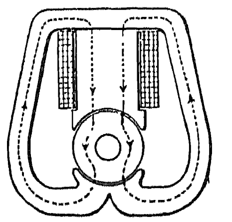

Fig. 23A.

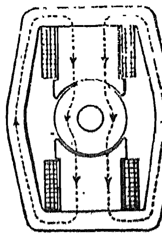

Fig. 23B.

Fourthly comes the two-pole *ironclad* type, so called from the exciting coil being more or less encased by the iron yoke; this latter is divided into two halves, which pass on either side of the armature. Unless the yoke be kept well away from the polar edges and armature, the leakage across the air into the yoke becomes considerable, especially if only one exciting coil is used, as in Fig. 23A; it is better, therefore, to divide the excitation between two coils, as in Fig. 23B, when the field also becomes symmetrical.

From this form is easily derived the *multipolar* type[3] of Fig. 24, which is by far the most usual for any number of poles from four upwards; its leakage coefficient is but small, and it is economical in weight both of iron and copper. The multipolar discoidal magnet takes the shape shown in the four-pole machine of Fig. 25, with which may be compared Fig. 13 ii. Another four-pole type (Fig. 26) may also be derived from Fig. 23B, if we suppose the

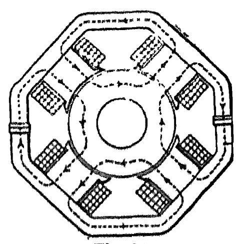

Fig. 24.

[1] Elihu Thomson, *Elec. Eng.* vol. iii. p. 499.

[2] Cp. Esson, *Elec. Review*, vol. xvii., 1885, and *Journ. Inst. Elec. Eng.* vol. xxvi. p. 596; Sayers, *Journ. Inst. Elec. Eng.* vol. xxii. p. 393.

[3] For the advantages of multipolar machines, *vide* Esson, "Notes on the Design of Multipolar Dynamos," *Journ. Inst. Elec. Eng.* vol. xx. p. 265.

yoke on either side of the armature to be pushed inwards until it nearly meets the armature on a horizontal diameter, and the direction of winding of one coil to be changed. Two salient poles and two consequent poles are thus obtained, and the machine is like that of Fig. 24, but with only two poles wound. The leakage across from pole to pole is great in a four-pole magnet of this type,

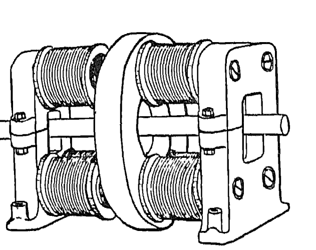

Fig. 25.

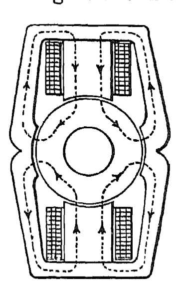

Fig. 26.

but in alternators where a large number of poles are required it may be convenient to wind only half their number, owing to their close proximity to one another. The multipolar equivalent of Fig. 21 is shown in Fig. 27, and again the weight of copper on the divided magnetic circuits must be greater than in the preceding multipolar magnets. Fig. 28, which is best suited to four

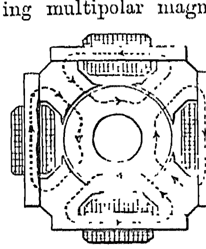

Fig. 27.

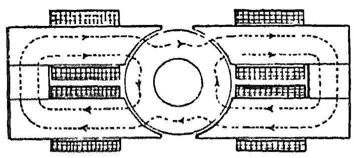

Fig. 28.

poles, may be obtained from Fig. 22 by dividing the pole-pieces and reversing the direction of winding on one side. The two single horse-shoe magnets thus formed have the peculiarity that half of the flux passing from one pole returns at once through the armature core to the opposite pole of the same magnet, while half passes onwards to a pole of the second magnet. Lastly, the multipolar magnet of Fig. 29, in which there is only one magnetizing coil enclosed between overarching claws forming the poles, those of one sign projecting into the gaps between the others of opposite sign, is economical in the weight of copper in its single coil, but the leakage between the sides of adjacent poles is considerable.

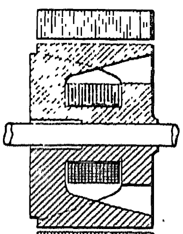

Fig. 29.

**Materials of magnets.**

As regards the materials of which magnets are made, generally speaking there is little difference in the permeability of *wrought-iron* or *mild-steel forgings* and good *cast-steel*; typical (B,H) curves connecting the magnetizing force required with different flux-densities for these materials are given under ELECTROMAGNET. On the other hand, there is a marked inferiority in the case of *cast-iron*, which for a flux-density of B = 8000 requires practically the same number of ampere-turns per centimetre length as steel requires for B = 16,000. Whatever the material, if the flux-density be pressed to a high value the ampere-turns are very largely increased owing to its approaching saturation, and this implies either a large amount of copper in the field coils or an undue expenditure of electrical energy in their excitation. Hence there is a limit imposed by practical considerations to the density at which the magnet should be worked, and this limit may be placed at about B = 16,000 for wrought-iron or steel, and at half this value for cast-iron. For a given flux, therefore, the cast-iron magnet must have twice the sectional area and be twice as heavy, although this disadvantage is partly compensated by its greater cheapness. If, however, cast-iron be used for the portion of the magnetic circuit which is covered with the exciting coils, the further disadvantage must be added that the weight of copper on the field-magnet is much increased, so that it is usual to employ forgings or cast-steel for the magnet cores on which the coils are wound. If weight is not a disadvantage, a cast-iron yoke may be combined with the wrought-iron or cast-steel magnet cores. An absence of joints in the magnetic circuit is only desirable from the point of view of economy of expense in machining the component parts during manufacture; when the surfaces which abut against each other are drawn firmly together by screws, the want of homogeneity at the joint, which virtually amounts to the presence of a very thin film of air, produces little or no effect on the total reluctance by comparison with the very much longer air-gaps surrounding the armature. In order to reduce the eddy-currents in the pole-pieces, due to the use of toothed armatures with relatively wide slots, the pole-pieces must be laminated in the same direction as the armature core is laminated; the poles are then built up of thin sheets of charcoal iron or mild steel, and these are sometimes fixed by casting them into the outer yoke-ring.

However it be built up, the mechanical strength of the magnet system must be carefully considered. Any two surfaces between which there exists a field of density $B_g$ experience a force tending to draw them together proportional to the square of the density, and having a value of $\frac{B_g^2}{1{\cdot}735 \times 10^6}$ lb per square inch of surface, over which the density may be regarded as having the uniform value $B_g$. Hence, quite apart from the torque with which the stationary part of the dynamo tends to turn with the rotating part as soon as current is taken out of the armature, there exists a force tending to make the pole-pieces close on the armature as soon as the field is excited. Since both armature and magnet must be capable of resisting this force, they require to be rigidly held; although the one or the other must be capable of rotation, there should otherwise be no possibility of one part of the magnetic circuit shifting relatively to any other part. An important conclusion may be drawn from this circumstance. If the armature be placed exactly concentric within the bore of the poles, and the two or more magnetic fields be symmetrical about a line joining their centres, there is no tendency for the armature core to be drawn in one direction more than in another; but if there is any difference between the densities of the several fields, it will cause an unbalanced stress on the armature and its shaft, under which it will bend, and as this bending is continually reversed relatively to the fibres of the shaft, they will eventually become weakened and give way. Especially is this likely to take place in dynamos with short air-gaps, wherein any difference in the lengths of the air-gaps produces a much greater percentage difference in the flux-density than in dynamos with long air-gaps. In toothed armatures with short air-gaps the shaft must on this account be of great stiffness; even when the shaft is sufficiently strong to withstand the stress without appreciable bending, any unbalanced pull on the armature as a whole should be avoided, since it may produce greater friction in the bearings, and cause them to develop an undue amount of heat.

**The magnetic circuit.**

Reference has already been made to the importance in dynamo design of the *predetermination of the flux* due to a given number of ampere-turns wound on the field-magnet, or, conversely, of the number of ampere-turns which must be furnished by the exciting coils in order that a certain flux corresponding to one field may flow through the armature core from each pole. An equally important problem is the correct proportioning of the field-magnet, so that the useful flux $Z_a$ may be obtained with the greatest economy in materials and exciting energy. The key to the two problems is to be found in the concept of a magnetic circuit as originated by Rowland and Bosanquet;[1] and the full solution of both may be especially connected with the name of the late Dr J. Hopkinson, from his practical application of the concept in his design of the Edison-Hopkinson machine, and in his paper on "Dynamo-Electric Machinery."[2] The publication of this paper in 1886 begins the second era in the history of the dynamo; it at once raised its design from the level of empirical rules-of-thumb to a science, and is thus worthy to be ranked as the necessary supplement of the original discoveries of Faraday. The process of predetermining the necessary ampere-turns is described in a simple case under ELECTROMAGNET. In its extension to the complete dynamo, it consists merely in the division of the magnetic

[1] And extended by Kapp, "On Modern Continuous-Current Dynamo-Electric Machines," *Proc. Inst. C.E.* vol. lxxxiii. p. 136.

[2] Drs J. and E. Hopkinson, "Dynamo-Electric Machinery," *Phil. Trans.*, May 6, 1886; this was further expanded in a second paper on "Dynamo-Electric Machinery," *Proc. Roy. Soc.*, Feb. 15, 1892, and both are reprinted in *Original Papers on Dynamo-Machinery and Allied Subjects.*

circuit into such portions as have the same sectional area and permeability and carry approximately the same total flux; the difference of magnetic potential that must exist between the ends of each section of the magnet in order that the flux may pass through it, is then calculated *seriatim* for the several portions into which the magnetic circuit is divided, and the separate items are summed up into one magnetomotive force that must be furnished by the exciting coils.

The chief sections of the magnetic circuit are (1) the air-gaps, (2) the armature core, and (3) the iron magnet.

*The air-gap* of a dynamo is partly filled with copper and partly with the cotton, mica, or other materials used to insulate the core and inductors; all these substances are, however, sensibly non-magnetic, so that the whole interferric gap between the iron of the pole-pieces and the iron of the armature may be treated as an air-space, of which the permeability is constant for all values of the flux-density, and in the C.G.S. system is unity. Hence in the simple bipolar machine with single horse-shoe magnet, if $l_g$ and $A_g$ be the length and area of the single air-gap in cm. and sq.cm., the reluctance of the double air-gap is $\frac{2l_g}{A_g}$, and the difference of magnetic potential required to pass $Z_g$ lines over this reluctance is $Z_g \cdot \frac{2l_g}{A_g} = B_g \cdot 2l_g$; or, since one ampere-turn gives 1·257 C.G.S. units of magnetomotive force, the exciting power in ampere-turns required over the two air-gaps is $X_g = \frac{B_g \cdot 2l_g}{1{\cdot}257} = 0{\cdot}8\ B_g \cdot 2l_g$. In the determination of the area $A_g$ a small allowance must be made for the fringe of lines which extend beyond the actual polar face; and in the ring machine, as already mentioned, $Z_g$ is a few per cent. more than $Z_a$, owing to the leakage across the interior of the core.

In *the armature core* the length of path continually shortens as we pass from the middle of the pole towards the centre line of symmetry. On the other hand, as the lines gradually accumulate in the core, their density increases from zero midway under the poles until it reaches a maximum on the line of symmetry. The two effects partially counteract one another, and tend to equalize the difference of magnetic potential required over the paths of varying lengths; but since the reluctivity of the iron increases more rapidly than the density of the lines, we may approximately take for the length of path ($l_a$) the minimum peripheral distance between the edges of adjacent pole-faces, and then assume the maximum value of the density of the lines as holding throughout this entire path. In ring and drum machines the flux issuing from one pole divides into two halves in the armature core, so that the maximum density of lines in the armature is $B_a = \frac{Z_a}{2ab}$, where $a$ = the radial depth of the discs in centimetres and $b$ = the net length of iron core parallel to the axis of rotation. A distinction must be made between the gross length of the core and the net length of iron, owing to the waste of space through the insulating varnish or paper between the discs, and the presence of ventilating air-ducts, which are sometimes introduced at intervals along the length of the core, especially in multipolar armatures of large diameter. The former deduction may be said to average about 7 to 10 per cent. of the gross length. Reference has now to be made to a (B H) or flux-density curve, from which may be found the number of ampere-turns required per centimetre length of path. This may be expressed as a function of the assumed density $B_a$, and the total exciting power required between the pole-pieces is therefore, at no load, $X_p = X_g + X_a$, where $X_a = f(B_a) \cdot l_a$; in order, however, to allow for the effect of the armature current, which increases with the load, a further term $X_b$ must be added.

In the continuous-current dynamo it may be, and usually is, necessary to move the brushes forward from the interpolar line of symmetry through a small angle in the direction of rotation, in order to avoid sparking between the brushes and the commutator (*vide infra*). When the dynamo is giving current, the inductors on either side of the diameter of commutation form a current-sheet flowing along the surface of the armature from end to end, and whatever the actual end-connexions of the wires, the inductors may be imagined to be joined together into a system such that the two sides of each loop are carrying current in opposite directions. Thus a number of armature ampere-turns are formed, and their effect on the entire system of magnet and armature must be taken into account. So long as the diameter of commutation coincides with the line of symmetry, the armature may be regarded as a cylindrical electromagnet producing a flux of lines, as shown in Fig. 30. The direction of the self-induced flux in the air-gaps is the same as that of the lines of the external field in one quadrant on one side of DC, but opposed to it in the other quadrant on the same side of DC; hence in the resultant field due to the combined action of the field-magnet and armature ampere-turns, the flux is as much strengthened over the one half of each polar face as it is weakened over the other, and the total number of lines is unaffected, although their distribution is altered. The armature ampere-turns are then called *cross-turns*, since they produce a cross-field, which, when combined with the symmetrical field, causes the leading pole-corners $ll$ to be weakened and the trailing pole-corners $tt$ to be strengthened, the neutral line of zero field being thus twisted forwards in the direction of rotation.

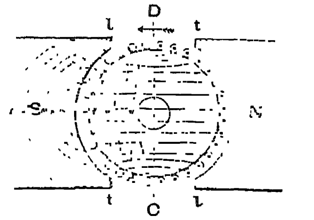

Fig. 30.

But when the brushes and diameter of commutation are shifted forward, as shown in Fig. 31, it will be seen that a number of ampere-turns, forming a zone between the lines D$n$ and $m$C, are in effect wound immediately on the magnetic circuit proper, and this belt of ampere-turns is in direct opposition to the ampere-turns of the field, as shown by the dotted and crossed wires on the pole-pieces.

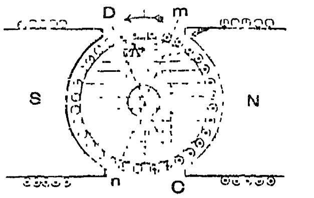

Fig. 31.

The armature ampere-turns are then divisible into the two bands, the *back-turns*, included within twice the angle of lead λ, weakening the field, and the cross-turns, bounded by the lines D$m$, $n$C, again producing distortion of the weakened symmetrical field. If, therefore, a certain flux is to be passed through the armature core in opposition to the demagnetizing turns, the difference of magnetic potential between the pole-faces must include not only $X_a$ and $X_g$, but also an item $X_b$, in order to balance the "back" ampere-turns of the armature. The amount by which the brushes must be shifted forward increases with the armature current, and in corresponding proportion the back ampere-turns are also increased, their value being $c \cdot \tau \cdot \frac{2\lambda}{360}$, where $c$ = the current carried by each of the $\tau$ inductors. Thus the term $X_b$ takes into account the effect of the armature reaction on the total flux; it varies as the armature current and angle of lead required to avoid sparking are increased; and the reason for its introduction in the third place ($X_p = X_g + X_a + X_b$), is that it increases the magnetic difference of potential which must exist between the poles of the dynamo, and to which the greater part of the leakage is due. The leakage paths which are in parallel with the armature across the poles must now be estimated, and so a new value be derived for the flux at the commencement of the *iron-magnet* path. If P = their joint permeance, the leakage flux due to the difference of potential at the poles is $z_{,} = 1{\cdot}257\ X_p \times P$, and this must be added to the useful flux $Z_g$, or $Z_p = Z_g + z_{,}$. There are also certain leakage paths in parallel with the magnet cores, and upon the permeance of these a varying number of ampere-turns is acting as we proceed along the magnet coils; the magnet flux therefore increases by the addition of leakage along the length of the limbs, and finally reaches a maximum near the yoke. Either, then, the density in the magnet $B_m = \frac{Z_m}{A_m}$ will vary if the same sectional area be retained throughout, or the sectional area of the magnet must itself be progressively increased. In general, sufficient accuracy will be obtained by assuming a certain number of additional leakage lines $z_{,,}$ as traversing the entire length of magnet limbs and yoke ($=l_m$), so that the density in the magnet has the uniform value $B_m = \frac{Z_p + z_{,,}}{A_m}$. The leakage flux added on actually within the length of the magnet core or $z_{,,}$ will be approximately equal to half the total M.M.F. of the coils multiplied by the permeance of the leakage paths around one coil. The corresponding value of H can then be obtained from the (B H) curve of the material of which the magnet is composed, and the ampere-turns thus determined must be added to $X_p$, or $X = X_p + X_m$, where $X_m = f(B_m) \cdot l_m$. The final equation for the exciting power required on the magnetic circuit as a whole will therefore take the form

$$X = AT = 0{\cdot}8B_g \cdot 2l_g + f(B_a) \cdot l_a + X_b + f(B_m) \cdot l_m \quad . \; . \; . \quad \text{(III.)}$$

Since no substance is impermeable to the passage of magnetic flux, the only form of magnetic circuit free from leakage is one uniformly wound with ampere-turns over its whole length. The reduction of the *magnetic leakage* to a minimum in any given type is therefore primarily a question of distributing the winding as far as

possible uniformly upon the circuit, and as the winding must be more or less concentrated into coils, it resolves itself into the necessity of introducing as long air-paths as possible between any surfaces which are at different magnetic potentials. No iron should be brought near the machine which does not form part of the magnetic circuit proper, and especially no iron should be brought near the poles, between which the difference of magnetic potential practically reaches its maximum value. In default of a machine of the same size or similar type on which to experiment, the probable direction of the leakage flux must be assumed from the drawing, and the air surrounding the machine must be mapped out into areas, between which the permeances are calculated as closely as possible by means of such approximate formulæ as those devised by Professor Forbes.[1]

***Magnetic leakage.***

***Excitation of field-magnet.***

In the earliest "magneto-electric" machines permanent steel magnets, either simple or compound, were employed, and for many years these were retained in certain alternators, some of which are still in use for arc lighting in lighthouses. But since the field they furnish is very weak, a great advance was made when they were replaced by soft-iron electromagnets, which could be made to yield a much more intense flux. As early as 1831 Faraday[2] experimented with electromagnets, and after 1850 they gradually superseded the permanent magnet. When the total ampere-turns required to excite the electromagnet have been determined, it remains to decide how the excitation shall be obtained; and, according to the method adopted, continuous-current machines may be divided into four well-defined classes.

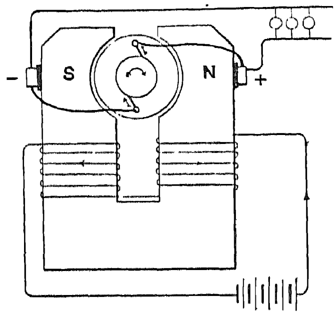


Fig. 32.

The simplest method, and that which was first used, is *separate excitation* from some other source of direct current, which may be either a primary or a secondary battery or another dynamo (Fig. 32). But since the armature yields a continuous current, it was early suggested (by Brett in 1848 and Sinsteden in 1851) that this current might be utilized to increase the flux; combinations of permanent and electromagnets were therefore next employed, acting either on the main armature or on separate armatures, until in 1867 Dr Werner von Siemens and Sir C. Wheatstone almost simultaneously discovered that the dynamo could be made *self-exciting* through the residual magnetism retained in the soft-iron cores of the electromagnet.[3] The former proposed to take the whole of the current round the magnet coils which were in series with the armature and external circuit, while the latter proposed to utilize only a portion derived by a shunt from the main circuit; we thus arrive at the second and third classes, namely, *series* and *shunt* machines. The starting of the process of excitation in either case is the same; when the brushes are touching the commutator and the armature is rotated, the small amount of flux left in the magnet is cut by the inductors, and a very small current begins to flow round the closed circuit; this increases the flux, which in turn further increases the E.M.F. and current, until, finally, the cumulative effect stops through the increasing saturation of the iron cores. Fig. 33, illustrating the *series* machine, shows the winding of the exciting coils to be composed of a few turns of thick wire. Since the current is undivided throughout the whole circuit, the resistance of both the armature and field-magnet winding must be low as compared with that of the external circuit, if the useful power available at the terminals of the machine is to form a large percentage of the total electrical power—in other words, if the efficiency is to be high. Fig. 34 shows the third

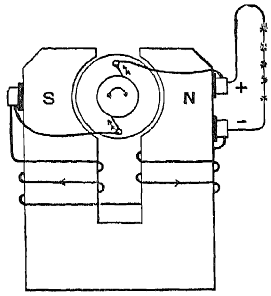


Fig. 33.

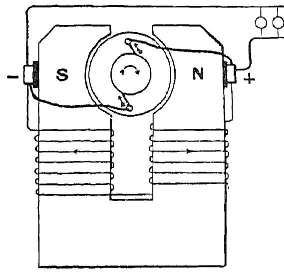


Fig. 34.

method, in which the winding of the field-magnets is a *shunt* or fine-wire circuit of many turns applied to the terminals of the machine; in this case the resistance of the shunt must be high[4] as compared with that of the external circuit, in order that only a small proportion of the total energy may be absorbed in the field.

Since the whole of the armature current passes round the field-magnet of the series machine, any alteration in the resistance of the external circuit will affect the excitation and also the voltage. A curve connecting together corresponding values of external current and terminal voltage for a given speed of rotation is known as the *external-characteristic* of the machine; in its main features it has the same appearance as a curve of magnetic flux, but when the current exceeds a certain amount, it begins to bend downwards and the voltage decreases. The reason for this will be found in the armature reaction at large loads, which gradually produces a more and more powerful demagnetizing effect, as the brushes are shifted forwards to avoid sparking; eventually the back ampere-turns overpower any addition to the field that would otherwise be due to the increased current flowing round the magnet. The "external characteristic" for a shunt machine has an entirely different shape. The field-magnet circuit being connected in parallel with the external circuit, the exciting current, if the applied voltage remains the same, is in no way affected by alterations in the resistance of the latter. As, however, an increase in the external current causes a greater loss of volts in the armature and a greater armature reaction, the terminal voltage, which is also the exciting voltage, is highest at no load and then diminishes. The fall is at first gradual, but after a certain critical value of the armature current is reached, the machine is rapidly demagnetized and loses its voltage entirely.

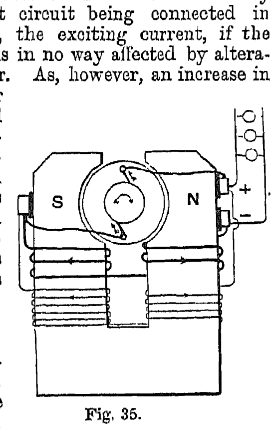


Fig. 35.

The last method of excitation, namely, *compound-winding* (Fig. 35), is a combination of the two preceding, and was first used by S. A. Varley[5] and by Brush. If a machine is in the first instance shunt-wound, and a certain number of series-turns are added, the latter, since they carry the external current, can be made to counteract the effect which the increased external current would have in lowering the voltage of the simple shunt machine. The ampere-turns of the series winding must be such that they not only balance the increase of the demagnetizing back ampere-turns on

[1] *Soc. Tel. Eng.* vol. xv. p. 555, 1886. Cp. also Ives, "Magnetic Leakage in Dynamos and Motors," *Elec. Rev.*, Jan. 22 and 29, 1892, and Puffer, *Elec. Rev.*, April 15, 1892.

[2] *Exp. Res.*, series i. § 4, par. 111. In 1845 Wheatstone and Cooke patented the use of "voltaic" magnets in place of permanent magnets (No. 10,655).

[3] In Pat. No. 3006, 1863, Wilde described the use of a small magneto-machine as exciter of a larger dynamo with electromagnets; cp. also his paper read before the Royal Society, April 1866. In 1866 C. and S. A. Varley provisionally protected a machine having electromagnets only, excited initially by the application of a direct current for a short time (No. 3394, 1866); this appeared again in the complete Patent No. 1755, 1867; but meantime the same device had been patented by Sir C. W. Siemens, Jan. 31, 1867, No. 261. Dr Werner von Siemens's paper was submitted to the Berlin Academy of Sciences, Jan. 1867 (*Pogg. Ann.*, Feb. 1867), and his results were communicated to the Royal Society in London by Sir William Siemens in a paper "On the Conversion of Dynamical into Electrical Force without the Aid of Permanent Magnetism," which was read on Feb. 14, 1867. On the same day Sir C. Wheatstone's paper "On the Augmentation of the Power of a Magnet by the Reaction thereon of Currents induced by the Magnet itself" was read before the Royal Society.

[4] Sir William Siemens, *Phil. Trans.*, part iii., 1880, "On the Dynamo-Electric Current, and on Certain Means to Improve its Steadiness," and Brit. Pat., No. 4534, 1879.

[5] In Brit. Pat., No. 4905, 1876, he describes a machine with its field-magnet wound with two coils of different resistance; and Brush (Brit. Pat., No. 2003, 1878) employed a shunt circuit to maintain the magnetism of a series-wound machine. But the full advantages of compound-winding were not realized until the patent of Crompton and Kapp (No. 4810, 1882).

the armature, but further increase the useful flux, and compensate for the loss of volts over their own resistance and that of the armature. The machine will then give for a constant speed a nearly constant voltage at its terminals, and the curve of the external characteristic becomes a straight line for all loads within its capacity. Since with most prime movers an increase of the load is accompanied by a drop in speed, this effect may also be counteracted; while, lastly, if the series-turns are still further increased, the voltage may be made to rise with an increasing load, and the machine is "over-compounded."

***Commutation and sparking.***

The question of the commutation [1] of the current in a section of the armature winding during the time when it is short-circuited by the brush resting simultaneously on both the trailing and leading sectors, turns primarily on the varying contact-resistance between the brush tip and the commutator sectors.[2] If the brushes are of the same width as the sectors, and T = the total time of the short-circuit depending on the speed of rotation, the area of contact between the brush and the leading sector at any time $t$ (reckoned from the commencement of short-circuit) is $\propto \frac{T-t}{T}$, while that between the brush and the trailing sector is $\propto \frac{t}{T}$; hence as the brush slides over from the leading to the trailing sector (Fig. 36), the contact-resistance of the leading sector gradually increases from $R_{\prime}$ to $\infty$, and at any time $t$ within the period of short-circuit is $R_{\prime} \cdot \frac{T}{T-t}$, while the contact-resistance of the trailing sector gradually diminishes from $\infty$ to $R_{\prime}$, and at any time is $R_{\prime}\frac{T}{t}$. If $c_1$ and $c_2$ be the instantaneous values of the current in the leading and trailing sectors respectively, the current densities $s_1$ and $s_2$ are $\propto \frac{c_1 T}{T-t}$ and $\frac{c_2 \cdot T}{t}$. If R = the resistance of the coil and its commutator connexions, and $f(t)$ be the E.M.F. induced in the coil by its rotation through the external field, either positive or negative according as it is moving on the trailing or leading side of the neutral line of zero field, the direction of the old current in the coil being reckoned as positive, the complete equation to the short circuit is by Kirchhoff's laws—

$$-L\frac{dc}{dt} + f(t) - Rc - \left(\frac{c_1}{T-t} + \frac{c_2}{t}\right) R\,T = 0.$$

Now when there is no induced E.M.F., or $f(t) = 0$—in other words, if the short-circuited section is moving in zero field—the current persists in the section by reason of its inductance, and does not fall in proportion to the amount by which the brush passes over on to the trailing sector; hence the current density of $c_1$ in the leading sector is greater than the density of $c_2$ in the trailing sector. There is thus a difference in the two values in the bracket, and $s_1$ being greater than $s_2$, there is a greater fall of potential between sector 1 and the brush than between sector 2 and the rest of the brush. Further, $c_2$ is negative, and the brush tip being necessarily throughout at the same potential, there results a potential difference acting round the circuit in the direction 1 – coil – 2, *i.e.*, against the positive decaying current of the coil, and assisting the current which is growing up in the trailing sector. Some part, therefore, of the self-induced E.M.F. is spent in overcoming this negative E.M.F. until equality is reached, and then the current becomes negative simply in virtue of the E.M.F. set up by the unequal current densities. If the equation as above expressed holds good unconditionally, and no secondary effects come into play, it will be found that the current in the short-circuited coil will be reversed to the exact value that is required in the new direction, or be automatically commuted at the end of the period of short-circuit by the mere action of the brush-contact resistance; and further, that this will be the case wherever the brush be placed, and whatever the direction

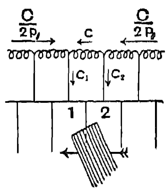


Fig. 36.

of the field in which the short-circuited coil is moving. If, however, it be moving in the old field, or $f(t)$ is positive, the current-density under the leading brush edge will be enormously great, in order to counterbalance both the E.M.F. of self-induction and that impressed by the field. There is, however, an important secondary effect, which comes into play when the current-density becomes very high, and which causes sparking at the brushes when the position of the brushes is not correctly adjusted. When a circuit is broken by an ordinary switch, the area of contact is diminished more or less rapidly, and when the current-density over the decreasing contact-surface rises beyond a certain limit, the local development of heat is so great that some portion of the metal forming the contact becomes incandescent and eventually is volatilized, and an arc results. In exactly the same way, under a very high current-density, the trailing edge of the leading sector or the leading edge of the brush becomes fused so that as the brush tip leaves the leading sector the current still finds an outlet for a short time through the heated vapour, and a series of small arcs are started every time that a sector passes from under the brush.

***Brushes.***

Now, in the dynamo, if the brushes are kept fixed on the line of symmetry, and current be taken out of the armature, the distribution of the field is so distorted by the action of the cross ampere-turns of the armature that the neutral line of zero field, where the lines just dip into the armature core and immediately leave it again, is displaced ahead of the line of symmetry. As the coil is now moving in the trailing field, the E.M.F. set up by it is in the old direction and tends to keep up the old current, hence the excessive current-density is magnified, and the more so as the current is increased. The higher the brush contact-resistance, however, the less the abnormal density, and the less the difficulty of commutation. One remedy, then, is to employ a brush of high contact-resistance, and for this purpose the only suitable material that has been discovered is carbon moulded into hard blocks. Even if some little sparking does take place with carbon brushes, the damage done thereby to the commutator surface is very much less than would be the case with metal brushes. The only objection to their use is that in virtue of their high resistance they necessarily increase the normal loss of volts between the armature winding and the external terminals. If brushes of copper wire or gauze are used, it is not possible to maintain them on the line of symmetry, when the current reaches any great amount, without excessive sparking, and the only remedy is to shift the brushes forward in the direction of rotation through an angle of lead, which increases roughly as the armature current is increased. By the shifting of the brushes the armature ampere-turns become divisible into the two groups of back- and cross-turns, as shown in Fig. 31. The latter are progressively reduced, so that though the total flux may not be so large as at no load, the distortion becomes less; and if the shifting is carried far enough, the diameter of commutation eventually overtakes the neutral line, and finally the short-circuited coil is moving in a reversing field, or $f(t)$ is negative. The reversing E.M.F. then rapidly causes the old current to decay, starts a reversed current, and if the adjustment is correct, the strength to which the new current is raised at the end of short-circuit is precisely that of the armature current in the portion of the winding which it is to join, so that on opening the short-circuit there is no sparking.

***Heating effects.***

From the moment that a dynamo begins to run with excited field, heat is continuously generated by the passage of the current through the windings of the field-magnet coils and the armature, as well as by the action of hysteresis and eddy-currents in the armature and pole-pieces. Whether the source of the heat be in the field-magnet or in the armature, the mass in which it originates will continue to rise in temperature until such a difference of temperature is established between itself and the surrounding air that the rate at which the heat is carried off by radiation, convection, and conduction is equal to the rate at which it is being generated. Evidently, then, the temperature which any part of the machine attains after a prolonged run must depend on the extent and effectiveness of the cooling surface from which radiation takes place, upon the presence or absence of any currents of air set up by the rotation of itself or surrounding parts, and upon the presence of neighbouring masses of metal to carry away the heat by conduction. In the field-magnet coils the rate at which heat is being generated is easily determined, since it is equal to the square of the current passing through them multiplied by their resistance. Further, the magnet is usually stationary, and only indirectly affected by draughts of air due to the rotating armature. Hence for machines of a given type and of similar proportions, it is not difficult to decide upon some method of reckoning the cooling surface of the magnet coils $S_c$, such that the rise of temperature above that of the surrounding air may be predicted from an equation of the form $t^{\circ} = \frac{k \cdot W}{S_c}$, where W = the rate in watts at

[1] Cp. Swinburne, "The Theory of Armature Reactions in Dynamos and Motors," and Esson, "Some Points in Dynamo and Motor Design," *Journ. Inst. Elec. Eng.* vol. xix., Feb. 13, 1890; Esson, "Notes on the Design of Multipolar Dynamos," *Journ. Inst. Elec. Eng.* vol. xx. p. 265; J. Fischer-Hinnen, *E.T.Z.*, No. 5, 1893, p. 53; Sayers, *Journ. Inst. Elec. Eng.* vol. xxiv. p. 122 ff.; Mordey, *Journ. Inst. Elec. Eng.* vol. xxvi. p. 532 ff.; Allen, "Sparkless Reversal in Dynamos," *Journ. Inst. Elec. Eng.* vol. xxvii. p. 209; J. Fischer-Hinnen, *E.T.Z.*, 1898, Nos. 51, 52; Prof. Arnold and Dr Mie, *E.T.Z.*, 1899, Nos. 5, 7, 8; Everett and Peake, *Electrician*, vol. xl. p. 861, and vol. xlii. p. 328.

[2] Housman, *Journ. Inst. Elec. Eng.* vol. xxii. p. 399 · Thorburn Reid, *American Inst. E.E.*, Dec. 15, 1897, vol. xv. p. 33.

which heat is generated in the coils, and $k$ is some constant depending upon the exact method of reckoning their cooling surface. As a general rule the cooling surface of a field-coil is reckoned as equal to the exposed outer surface of its wire, the influence of the end flanges being neglected, or only taken into account in the case of very short bobbins wound with a considerable depth of wire. In the case of the rotating armature a similar formula must be constructed, but with the addition of a factor to allow for the increase in the effectiveness of any given cooling surface due to the rotation causing convection currents in the surrounding air. Only experiment can determine the exact effect of this, and even with a given type of armature it is dependent on the number of poles, each of which helps to break up the air-currents, and so to dissipate the heat. For example, in two-pole machines with drum bar-armatures, if the cooling surface be reckoned as equal to the cylindrical exterior plus the area of the two ends, the heating coefficient for a peripheral speed of 1500 feet per minute is less than half of that for the same armature when at rest. A further difficulty still meets the designer in the correct predetermination of the total loss of watts in an armature before the machine has been tested. It is made up of three separate items, namely, the copper loss in the armature winding, the loss by hysteresis in the iron, and the loss by eddy-currents, which again may be divided into those in the armature bars and end-connexions, and those in the core and its end-plates. The two latter items are both dependent upon the speed of the machine; but whereas the hysteresis loss is proportional to the speed for a given density of flux in the armature, the eddy-current loss is proportional to the square of the speed, and owing to this difference, the one loss can be separated from the other by testing an armature at varying speeds. Thus for a given rise of temperature, the question of the amount of current which can be taken out of an armature at different speeds depends upon the proportion which the hysteresis and eddy watts bear to the copper loss, and the ratio in which the effectiveness of the cooling surface is altered by the alteration in speed. Experimental data, again, can alone decide upon the amount of eddy-currents that may be expected in given armatures, and caution is required in applying the results of one machine to another in which any of the conditions, such as the width of the inductors, the number of poles, or the extent of lamination of the core, are altered.

It remains to add, that the rise of temperature which may be permitted in any part of a dynamo after a prolonged run is very generally placed at about 70° Fahr. above the surrounding air. Such a limit in ordinary conditions of working leads to a final temperature of about 170° Fahr., beyond which the durability of the insulation of the wires is liable to be injuriously affected. Upon some such basis the output of a dynamo in continuous working is rated, although for short periods of, say, two hours the normal full-load current of a large machine may be exceeded by some 25 per cent. without unduly heating the armature.

***Uses of continuous-current dynamos.***

For the electro-deposition of metals or the electrolytic treatment of ores a continuous current is a necessity; but, apart from such use, the purposes for which the continuous-current dynamo is well adapted are so numerous that they cover nearly the whole field of electrical engineering, with one important exception. To meet these various uses, the pressures for which the machine is designed are of equally wide range; for the transmission of power over long distances they may be as high as 3000 volts, and for electrolytic work as low as five. Each electrolytic bath, with its leads, requires on an average only some four or five volts, so that even when several are worked in series the voltage of the dynamo seldom exceeds 60. On the other hand, the current is large and may amount to as much as from 1000 to 14,000 amperes, necessitating the use of two commutators, one at either end of the armature, in order to collect the enormous current without excessive heating of the sectors and brushes. The field-magnets are invariably shunt-wound, in order to avoid reversal of the current through polarization at the electrodes of the bath. For incandescent lighting by glow lamps, the requirements of small isolated installations and of central stations for the distribution of electrical energy over large areas must be distinguished. For the lighting of a private house or large factory, the dynamo giving from 5 to 100 kilowatts of output is commonly wound for a voltage of 100, and is driven by pulley and belt from a gas, oil, or steam engine; or, if approaching the higher limit above mentioned, it is often directly coupled to the crank-shaft of the steam engine. If used in conjunction with an accumulator of secondary cells, it is shunt-wound, and must give the higher voltage necessary to charge the battery; otherwise it is compound-wound, in order to maintain the pressure on the lamps constant under all loads within its capacity. The compound-wound dynamo is likewise the most usual for the lighting of steamships, and is then directly coupled to its steam-engine; its output seldom exceeds 60 kilowatts, at a voltage ranging from 60 to 100. For central-station work, economy in the distributing mains dictates a higher voltage, especially in connexion with a three-wire system; the larger dynamos may then give 500 volts, and be connected directly across the two outer wires. A pair of smaller machines coupled together, and each capable of giving 250 volts, are often placed in series across the system, with their common junction connected to the middle wire; the one which at any time is on the side carrying the smaller current will act as a motor and drive the other as a dynamo, so as to balance the system. The directly-coupled steam dynamo may be said to have practically displaced the belt- or rope-driven sets which were formerly common in central stations. Though in Great Britain the bipolar machine has been generally retained for outputs up to 150 kilowatts, or even more, the tendency is towards the multipolar machine, which is largely used on the Continent and in the United States, even for comparatively small outputs. The generating units of the central station are arranged in progressive sizes, rising from, it may be, 250 or 500 horse-power up to 750 or 1000, or in large towns to as much as 5000 horse-power. They are usually shunt-wound, the regulation of the voltage, to keep the pressure constant on the distributing system under the gradual changes of load, being effected by variable resistances in the shunt circuit of the field-magnets.

Generators used for supplying current to electric tramways are commonly wound for 500 volts at no load and are over-compounded, so that the voltage rises to 550 volts at the maximum load, and thus compensates for the loss of volts over the transmitting lines. Since the changes of load are very rapid, it would not be possible to shift copper gauze brushes so that they should always be at the exact position to avoid sparking; hence carbon brushes are employed. For arc lighting it was formerly usual to employ a class of dynamo which, from the nature of its construction, was called an "open-coil" machine, and which gave a unidirected but pulsating current. Of such machines the Brush and Thomson-Houston types were very widely used; their E.M.F. ranged from 2000 to 3000 volts for working a large number of arcs in series, and by means of special regulators their current was maintained constant over a wide range of voltage. But as their efficiency was low and they could not be applied to any other purpose, they have been largely superseded in central stations by closed-coil dynamos or alternators, which can also be used for incandescent lighting. In cases where the central station is situated at some distance from the district to which the electric energy is to be supplied, voltages from 1000 to 2000 are employed, and these are transformed down at certain distributing centres by continuous-current transformers (see TRANSFORMERS and ELECTRICITY SUPPLY). These latter machines are in reality motor-driven dynamos, and hence are also called "*motor-generators*"; the armatures of the motor and dynamo are often wound on the same core, with a commutator at either end, the one to receive the high-pressure motor current, and the other to collect the low-pressure current furnished by the dynamo.

In all large central stations it is necessary that the dynamos should be capable of being run *in parallel*, so that their outputs may be combined on the same "omnibus bars," and thence distributed to the network or feeders. With simple shunt-wound machines this is easily effected by coupling together terminals of like sign when the voltage of the two or more machines are closely equal. With compound-wound dynamos not only must the external terminals of like sign be coupled together, but the junctions of the brush leads with the series winding must be connected by an "equalizing" lead of low resistance; otherwise, should the E.M.F. of one machine for any reason fall below the voltage of the omnibus bars, there is a danger of its polarity being reversed by a back current from the others with which it is in parallel.

Owing to the necessary presence in the continuous-current dynamo of the commutator, with its attendant liability to sparking at the brushes, and further, owing to the difficulty of insulating the rotating armature wires, a pressure of 3000 volts has seldom been exceeded in any one continuous-current machine, and has been given above as the limiting voltage of the class. If, therefore, it is required to work with higher pressures in order to secure economy in the transmitting lines, two machines must be coupled *in series* by connecting together two terminals which are of unlike sign. The stress of the total voltage may still fall on the insulation of the winding from the body of the machine; hence for high-voltage transmission of power over very long distances, the continuous-current dynamo must yield in convenience to the alternator. In this there is no commutator, the armature coils may be stationary and can be more thoroughly insulated, while further, if it be thought undesirable to design the machine for the full transmitting voltage, it is easy to wind the armature for a low pressure; this can be subsequently transformed up to a high pressure by means of the alternating-current transformer, which has stationary windings and so high an efficiency that but little loss arises from its use. With these remarks, the transition may be made to the fuller discussion of the alternator.

## ALTERNATORS.

**Value of K in E.M.F. equation.** The value of the factor K in the electromotive-force equation of the alternator (I. *b*) depends on the ratio of the pole-width to the pitch, and upon the distribution of the inductors of the coil; in the latter, two cases may be distinguished as "*grouped*" and "*uniform*" distribution. By the first, the coil is split up into two or more groups, each of these groups being itself so closely wound that its inductors may be regarded as in phase, although the several groups which are in series differ in phase.[1] By the second, the coil is uniformly wound over a certain portion of the periphery of the armature, as in Fig. 13. Thus the distinction of the two cases lies in the fact that with grouped distribution a small number of widely distinct phases are compounded together, while with uniform distribution a large number of phases differing very little from each other are united. In either case the result must be the same, namely, a reduction in the effective E.M.F. as compared with the same winding concentrated in a single line, since the several components are more or less out of phase. Yet the advantages are gained of a smaller inductance and a better ventilation of the armature conductors on the surface, and still more at the ends of the core. Further, the reduction in the E.M.F. only takes place in its full force at no load; when the armature is giving current its reaction on the field tends to crowd the lines towards one or other edge of each pole, and so to narrow the effective width of the pole-face. In actual machines the value of K usually falls between the limits of 1 and 1·25.[2]

**Shape of E.M.F. curve.** The first experimental determination of the shape of the E.M.F. curve of an alternator was made by Joubert in 1880. A revolving contact-maker charged a condenser with the E.M.F. produced by the armature at a particular instant during each period. The condenser was discharged through a ballistic galvanometer, and from the measured throw the instantaneous E.M.F. could be deduced. The contact-maker was then shifted through a small angle, and the instantaneous E.M.F. at the new position corresponding to a different moment in the period was measured; this process was repeated until the E.M.F. curve for a complete period could be traced. Various modifications of the same principle have since been used, and recently a form of "oscillograph" has been perfected which is well adapted for the purpose of tracing the curves both of E.M.F. and of current (see MEASURING INSTRUMENTS, ELECTRIC). The machine on which Joubert carried out his experiments was a Siemens disc alternator having no iron in its armature, and it was found that the curve of E.M.F. was practically identical with a sine curve. The same law has also been found to hold true for a smooth-core ring or drum armature, but the presence of the iron core enables the armature current to produce greater distorting effect, so that the curves under load may vary considerably from their shape at no load. In toothed armatures, the broken surface of the core, and the still greater reaction from the armature current, may produce wide variations from the sine law, the general tendency being to give the E.M.F. curve a more peaked form. The great convenience of the assumption that the E.M.F. obeys the sine law has led to its being very commonly used as the basis for the mathematical analysis of alternator problems; but any deductions made from this premiss require to be applied with caution if they are likely to be modified by a different shape of the curve. Further, the same alternator will give widely different curves even of E.M.F., and still more so of current, according to the nature of the external circuit to which it is connected. As will be explained later, the phase of the current relatively to the E.M.F. depends not only on the inductance of the alternator itself, but also upon the inductance and capacity of the external circuit, so that the same current will produce different effects according to the amount by which it lags or leads. The question as to the relative advantages of differently shaped E.M.F. curves has led to much discussion, but can only be answered by reference to the nature of the work that the alternator has to do—*i.e.*, whether it be arc lighting, motor driving, or incandescent lighting through transformers. The shape of the E.M.F. curve is, however, of great importance in one respect, since upon it depends the ratio of the maximum instantaneous E.M.F. to the effective value, and the insulation of the entire circuit, both external and internal, must be capable of withstanding the maximum E.M.F. While the maximum value of the sine curve is $\sqrt{2}$ or 1·414 times the effective value, the maximum value of a $\wedge$ curve is 1·732 times the effective value, so that for the same effective E.M.F. the armature wires must not only be more heavily insulated than in the continuous-current dynamo, but also the more peaked the curve, the better must be the insulation.

**Frequency.** The frequency employed in alternating-current systems for distributing power and light varies between such wide limits as 40 and 135; yet in recent times the tendency has been towards common standards of 50 and 60 or 100 as a maximum. High frequencies involve more copper in the magnet coils, owing to the greater number of poles, and a greater loss of power in their excitation, but the alternator as a whole is somewhat lighter, and the transformers are cheaper. On the other hand, high frequency may cause prejudicial effects, due to the inductance and capacity of the distributing lines; and in asynchronous motors used on polyphase systems the increased number of poles necessary to obtain reasonable speeds reduces their efficiency, and is otherwise disadvantageous, especially for small horse-powers. A frequency lower than 40 is, however, not permissible where arc lighting is to form any considerable portion of the work and is to be effected by the alternating current without rectification, since below this value the eye can detect the periodic alteration in the light as the carbons alternately cool and become heated. Thus for combined lighting and power 50 or 60 are the most usual frequencies; but if the system is designed solely or chiefly for the distribution of power, a still lower frequency is preferable, and on this account 25 was selected by the engineers for the Niagara Falls power transmission,[3] after careful consideration of the problem.

Each of the four methods of forming coils of many turns, namely, the ring, drum, discoidal ring, and disc, have already been shown to be applicable to alternators. *Ring*

[1] Such is the case of an armature having slots or holes evenly distributed round its periphery, each side of a drum coil or each complete ring coil being divided between two or more slots.

[2] Kapp, "Alternate-Current Machinery," *Proc. Inst. C.E.* vol. xcvii. part iii., 1888–89, and Elihu Thomson's remarks, p. 101; Parshall, *Engineering*, vol. lxv. p. 388; Fischer-Hinnen, *Elec. Eng.* vol. xx. p. 597; Brousson, *Electrical World*, 1895, vol. xxvi. p. 236.

[3] See Forbes, *Journ. Inst. Elec. Eng.* vol. xxii. p. 493.

*winding* (Fig. 13 i.) was early employed in the machines of Gramme and Wilde, and later of De Meritens. Owing to the excellent grip of the wires on the core, the ring coils are well adapted to withstand centrifugal force, and high peripheral speeds become permissible. The discoidal form of ring winding, with its appropriate form of field-magnet, may be easily derived from Figs. 13 ii. and 25. *Drum winding* in some of its numerous varieties is, however, more usual at the present time in alternators, as in continuous-current machines, and for the same reasons, namely, that it requires less wire and has less inductance. As in the continuous-current dynamo, the coils may be hand-wound, former-wound, or composed of bars united by end-connectors. If the armature core is smooth and the section of wire is small, the drum coil may be former-wound, and with a large number of poles the curvature required to fit it to the circumference of the armature core is so slight that it becomes almost flat; the open space within the inside turn is usually filled with a wood centre, flush with the sides. The complete coils may be placed either on the outside or inside of the armature core (Fig. 13 iii.), according as the poles are external or internal. A single coil per pair of poles may be used, as shown in Fig. 37, but the advantages of its division into two halves, as in Fig. 13 iii., namely, the better utilization of the space at the ends of the core and the gain in effective cooling surface, have already been mentioned. A pair of outside ends of adjacent coils and a pair of inside ends are then alternately connected together, and the maximum difference of potential between any two adjacent wires is equal to twice the voltage of one coil. But if the coils are all connected in series right round the armature, one of the groups, consisting of the adjacent halves of the first and last coils, is subjected to the strain of the total voltage; hence for high pressures it may be advantageous to insert one dummy coil to separate the first and last coils. Another plan is to divide the armature winding into two halves and to connect these in parallel, as in Fig. 38. Either circuit then carries half the current, but must give the total voltage of the machine, so that twice the number of inductors of half the section are required; there is thus a greater amount of space lost in insulation, and, as with all cases of parallel circuits, it is very necessary to secure close equality of the E.M.F.'s of the two branches at every instant, since otherwise the load will not divide equally between them, and a loss of efficiency, with greater heating, will result. As compared with ring winding, the drum coils on a rotating smooth core are not so easily held in place against centrifugal force and the alternating stresses due to the magnetic pull on them; the wood filling-pieces, being screwed to the core, serve as drivers, but with high peripheral speeds the surface must be covered at frequent intervals by bands of binding wire. It is therefore even more common to employ a toothed armature core, although the embedded wires have more inductance and more reaction on the field; the alternator then requires more alteration of its excitation if the voltage is to be kept constant under varying loads. When the slots of the armature have parallel sides, or the teeth do not close entirely over the opening at the top, the coils may still be wound on a former in the lathe, and afterwards pressed into the slot, which is well lined with micanite, press-spahn, or other highly-insulating material. But if the armature has holes pierced close to the periphery of the discs, hand-winding must be resorted to, and the wires are threaded through the holes in tubes of micanite or paper. The wires themselves must be well insulated, but do not need to be very tight in the holes, as by far the largest part of the mechanical pull is transferred to the iron core.

***Winding.***

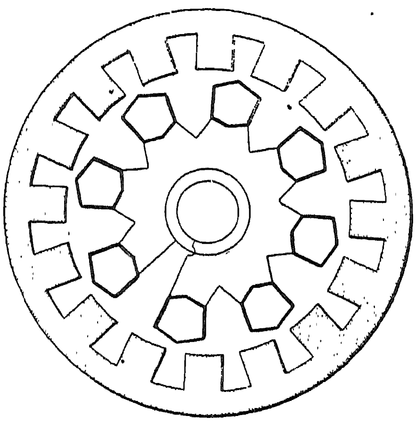

Fig. 37.

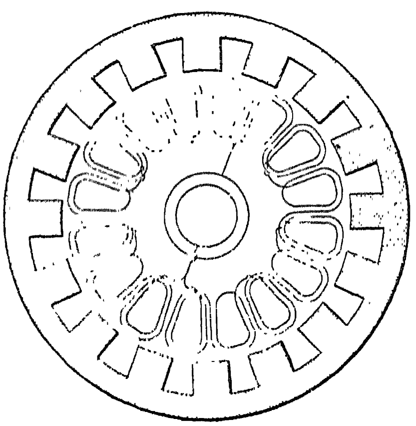

Fig 38.

*Disc winding* (Fig. 13 iv.) has been very successfully used for alternators, as in the large magneto-machines invented by Nollet, and afterwards constructed and improved by the Alliance Co. (1860), and also in the alternators of Wilde (1866) and Siemens (1878). The connexions of the coils can be followed from Figs. 37 and 38, which are as applicable to disc as to drum winding. It is usual for the armature to revolve, and no iron is employed in the core; there is therefore no loss from hysteresis, but a somewhat large exciting-current loss is involved by the length of the air-gap between the opposing poles of opposite sign. An undulatory winding which was adopted in some early alternators has since been discarded in favour of coils, as in Fig. 38. In the modern Ferranti alternator, the centres on which the coils are wound are made up of strips of brass soldered together at their inner ends and lightly insulated, to separate the teeth of the comb; eddy-currents in the core are thus largely prevented, and the advantage of a metal centre is retained. The thin copper strip employed in winding the coils is corrugated along its centre line, to retain it in its place and to prevent it shifting sideways. The very high peripheral speed which is used in this type of machine tends to keep the composite structure of the armature rigid in the plane of rotation.

***Quarter-phase alternators.***

The general idea of the polyphase alternator giving two or more E.M.F.'s of the same frequency, but displaced in phase, has been already described. The several phases may be entirely independent, and such was the case with the early polyphase machines of Gramme, who used four independent circuits, and also in the large two-phase alternators designed by Gordon in 1883. If the phases are thus entirely separate, each requires two collector rings and two wires to its external circuit, *i.e.*, four in all for two-phase, and six for three-phase, machines. The only advantage of the polyphase machine as thus used is that the whole of the surface of the armature core may be efficiently covered with winding, and the output of the alternator for a given size be thereby increased. It is, however, also possible so to interlink the several circuits of the armature that the necessary number of transmitting lines to the external circuits may be reduced, and also the weight of copper in them for a given loss in the transmission.[1] The condition which obviously must be fulfilled, for such interlinking of the phases to be possible, is that in the lines meeting at any common junction the algebraic sum of the instantaneous currents, reckoned as positive if away from such junction and as negative if towards it, must be zero. Thus if the phases be diagrammatically represented by the relative angular position of the coils in Fig. 39, the current in the coils

[1] As in the historical transmission of energy from Lauffen to Frankfort (1891).

A and B differs in phase from the current in the coils C and D by a quarter of a period, or 90°; hence if the two wires $b$ and $d$ be replaced by the single wire $bd$, this third wire will serve as a common path for the currents of the two phases either outwards or on their return. At any instant the value of the current in the third wire must be the vector sum of the two currents in the other wires, and if the shape of the curves of instantaneous E.M.F. and current are identical, and are assumed to be sinusoidal, the effective value of the current in the third wire will be the vector sum of the effective values of the currents in the other wires; in other words,

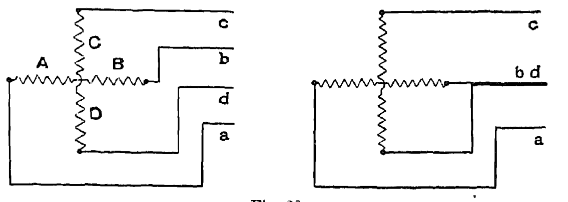

Fig. 39.

if the system is balanced, the effective current in the third wire is $\sqrt{2}$, or 1·414 times the current in either of the two outer wires. Since the currents of the two phases do not reach their maximum values at the same time, the sectional area of the third wire need not be twice that of the others; in order to secure maximum efficiency by employing the same current density in all three wires, it need only be 40 per cent. greater than that of either of the outer wires. The effective voltage between the external leads may in the same way be calculated by a vector diagram, and with the above *star connexion* the voltage between the outer pair of wires $a$ and $c$ is $\sqrt{2}$, or 1·414 times the voltage between either of the outer wires and the common wire $bd$. Next, if the four coils are joined up into a continuous helix, just as in the winding of a continuous-current machine, four wires may be attached to equidistant points at the opposite ends of two diameters at right angles to each other (Fig. 40). Such a method is known as the *mesh connexion*, and gives a perfectly symmetrical four-phase system of distribution. Four collecting rings are necessary if the armature rotates, and there is no saving in copper in the transmitting lines; but the importance of the arrangement lies in its use in connexion with rotary converters, in which it is necessary that the winding of the armature should form a closed circuit. If $e$ = the effective voltage of one

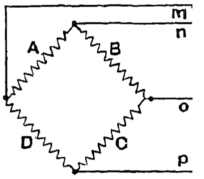

Fig. 40.

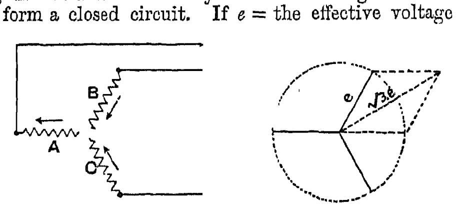

Fig. 41.

phase A, the voltage between any pair of adjacent lines in the diagram is $e$, and between $m$ and $o$ or $n$ and $p$ is $\sqrt{2}\,.\,e$. The current in any line is the resultant of the currents in the two phases connected to it, and its effective value is $\sqrt{2}\,.\,c$, where $c$ is the current of one phase.

**Three-phase alternators.**

When we pass to machines giving three phases differing by 120°, the same methods of star and mesh connexion find their analogies. If the current in coil A (Fig. 41) is flowing away from the centre, and has its maximum value, the currents in coils B and C are flowing towards the centre, and are each of half the magnitude of the current in A; the algebraic sum of the currents is therefore zero, and this will also be the case for all other instants. Hence the three coils can be united together at the centre, and three external wires are alone required. In this star or "Y" connexion, if $e$ be the effective voltage of each phase, or the voltage between any one of the three collecting rings and the common connexion, the volts between any pair of transmitting lines will be $E = \sqrt{3}\,.\,e$ (Fig. 41); if the load be balanced, the effective current C in each of the three lines will be equal, and the total output in watts will be $W = 3Ce = \frac{3CE}{\sqrt{3}} = 1{\cdot}732$ EC, or 1·732 times the product of the effective voltage between the lines and the current in any single line. Next, if the three coils are closed upon themselves in a mesh or *delta* fashion (Fig. 42), the three transmitting wires may be connected to the junctions of the coils (by means of collecting rings if the armature rotates). The voltage E between any pair of wires is evidently that generated by one phase, and the current in a line wire is the resultant of that in two adjacent phases; or in a balanced system, if $c$ be the current in each phase, the current in the line wire beyond a collecting ring is $C = \sqrt{3}\,.\,c$, hence the watts are $W = 3cE = \frac{3EC}{\sqrt{3}} = 1{\cdot}732$ EC, as before. Thus any three-phase winding may be changed over from the star to the delta connexion, and will then give 1·732 times as much current, but only 1/1·732 times the voltage, so that the output remains the same. Any of the alternator windings shown in previous diagrams are equally available for polyphase machines, if the width of the coils be altered to suit the number of phases.

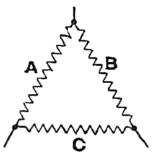

Fig. 42.

**Field-magnets.**

The field-magnet systems of alternators differ from those of continuous-current multipolar machines only in the employment of a larger number of pairs of poles;[1] hence the alternator usually has somewhat more copper in its exciting coils, and a slightly greater loss of watts in the excitation. Four of the most common types of field are shown in Fig. 13, and may be compared with Figs. 24 and 25. In Fig. 13 i. the armature rotates and is internal to the poles, while in Fig. 13 iii. it is stationary and external to the rotating poles; and it may be said that while in continuous-current dynamos it is most usual for the armature to rotate, in alternators it is more common for the magnet to rotate. The coils of the stationary armature, which for high voltages must be heavily insulated, are then not subjected to the additional stresses due to centrifugal force; and further, the collecting rings, which must be attached to the revolving portion, need only be employed to transmit the exciting current at a low voltage. The multipolar form of field-magnet with single exciting coil, shown in Fig. 29, has been very largely used for alternators, since its introduction by Mordey, with disc armature, and by the Oerlikon Co. of Switzerland in connexion with drum armatures; but although advantageous for particular frequencies and speeds, it requires careful designing to avoid a somewhat large armature reaction. A further step brings us to the so-called *inductor alternator*, in which both the armature and the field-magnet coils are stationary, and the E.M.F. is set up in the armature coils by causing the flux through them to be periodically varied by the rotation of iron "inductors." It will be seen that in Fig. 29 it is not really necessary for the field-magnet coil to revolve, and by such a modification as shown in Fig. 43 it can be held stationary, while the iron mass which completes the magnetic system is alone rotated. It is very important in such a machine to keep the reluctance of the magnetic circuit constant, so as to ensure as far as possible an equal flux in the magnet for all positions of the inductor; otherwise eddy-currents are set up in its mass. Even when the total flux alters but little, the pole-tips are usually laminated, owing to the variations in its distribution over their faces.

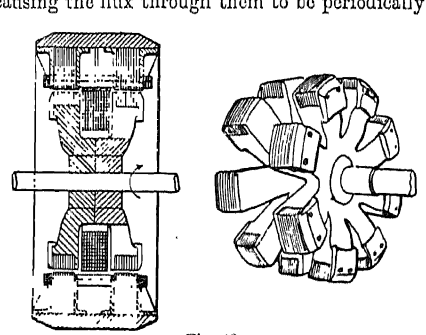
Fig. 43.

Since an alternating current cannot be used for exciting the field-magnet, recourse must be had to some source of a direct current. This is usually obtained from a small auxiliary continuous-current dynamo, called an *exciter*, which may be an entirely separate machine, separately driven and used for exciting several alternators, or may be driven from the alternator itself; in the latter case the armature of the exciter is often coupled directly to the rotating shaft of the alternator, while its field-magnet is attached to the bed-plate. Although separate excitation is the more usual method, the alternator can also be made self-exciting if a part or the whole of the alternating current is "rectified,"

[1] For experiments on high-frequency currents, Nikola Tesla constructed an alternator having 384 poles and giving a frequency of about 10,000 (*Journ. Inst. Elec. Eng.* vol. xxi. p. 82, 1892). The opposite extreme is found in alternators directly coupled to the Parsons steam turbine, in which, owing to its high speed of 3000 revs. per min., only four poles are required to give a frequency of 100. By a combination of a Parsons steam-turbine running at 12,000 revs. per min. with an alternator of 140 poles a frequency of 14,000 has been obtained (*Engineering*, Aug. 25, 1899).

and thus converted into a direct current. Or both methods may be employed simultaneously.

*Armature reaction.*

The reaction of the armature-current upon the field in an alternator is in many ways different from that of the continuous-current dynamo, and requires detailed consideration. Let a single-phase alternator be running on open circuit and giving a sine curve of E.M.F., and let a non-inductive resistance be applied to its terminals. At the instant of closing the circuit, a current arises, and in its growth causes a corresponding self-induced flux to arise, which as it cuts the armature coils generates an E.M.F. of self-inductance; this E.M.F. delays the rise of the current, so that its instantaneous value is not in step with the instantaneous value of the impressed E.M.F., although they gradually become more and more alike in phase. The first few waves of current are therefore distorted, their exact shape depending upon the moment in the period when the circuit is closed, and it is only after some little time that the current curve reaches its final shape and phase relatively to the impressed E.M.F. Since the impressed E.M.F. is always changing in value and never becomes steady, the current-phase can never overtake that of the E.M.F., but must continue to lag behind it by some angle of lag depending on the armature inductance. If the magnetic circuit presented to the armature coils had a constant inductance and no hysteresis, the self-induced flux would vary simultaneously with, and in proportion to, the current; both would be sinusoidal, and so also would be the E.M.F. of self-inductance, which would be in quadrature with either the flux or the current. The phase of the current with reference to the impressed E.M.F. would then be given by a simple vector diagram; since the armature current lags, the E.M.F. of self-inductance will be more than 90° behind the impressed E.M.F., and therefore will partially oppose it, so that the terminal E.M.F. will be less than the impressed E.M.F. minus the loss of volts over the armature resistance. The matter admits, however, of further analysis. The paths of the magnetic circuit presented to the armature coils vary according to the position of the coils relatively to the poles, and hence the reluctance to the self-induced flux is not constant, but varies. When the centre of a ring coil or the side of a drum coil is directly under a pole, all the ampere-turns of the coil act round a cross-circuit, or are *cross* ampere-turns, displacing the maximum density of the resultant field towards the trailing edges. As the coil moves forward, the self-induced flux divides, and some lines pass *through* a pair of field-magnet coils instead of across them. More strictly speaking, the ampere-turns are divisible now into cross and back ampere-turns, of which the latter directly reduce the strength of the symmetrical field, while the former simply distort the weakened symmetrical field. The proportion of back to cross turns gradually increases until the inductors of the coil are exactly mid way between the poles; later, as the coil passes under the next pole, and as soon as the current has reversed its direction, the armature turns become divisible into cross and *forward* ampere-turns. The latter increase the strength of the field, and their proportion relatively to the cross turns is continually increasing. Thus the effect of either the direct or the cross ampere-turns during a whole period can only be calculated by taking into account both the instantaneous values of the current and the magnetizing effect which a constant current would have for the different positions of the coil at corresponding instants. *E.g.*, if there were no difference of phase between current and impressed E.M.F., the dotted curve *mm* (Fig. 44) may be taken to represent the direct magnetizing effect of the coil in various positions for some constant value of current, say one ampere; the current curve being that marked *cc*, the product of simultaneous ordinates of the two curves may be plotted as *mc*, and will show the varying M.M.F. due to the direct ampere-turns, back ampere-turns being plotted below, and forward ampere-turns above, the base line. It is seen that in this case the periodic weakening and strengthening of the symmetrical field balances during a complete period, and the average flux is unaffected. Since, however, in our first case of an armature with self-inductance there must be some lag of current behind impressed E.M.F., Fig. 45 shows that the weakening effect lasts longer and is greater than the strengthening effect, so that the terminal E.M.F. for the same exciting current must decrease. Similarly, the cross flux will be found periodically to vary, or, in other words, the lines will be periodically crowded up into one or other pole-edge, and then resume their symmetrical distribution when either the current in the coil or its cross effect is zero. If there be lag of the current, the displacement towards the leading pole-edge will be less marked than that towards the trailing edge.

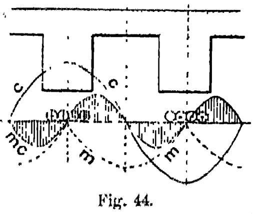

Fig. 44.

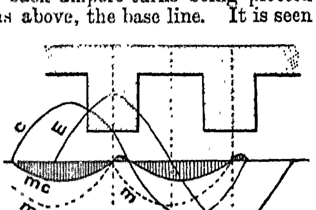

Fig. 45.

If the direct M.M.F. of the armature be taken into account in calculating the resultant flux, the smaller value of the self-induced E.M.F. which is then left simply measures the time-rate of change of the distortion, and has nothing to do with the strengthening and weakening of the field due to the lag or lead of the current. The importance of thus differentiating the armature reaction into the cross and direct magnetizing effect lies in the fact that, for a given terminal voltage under load, the actual density of lines in the magnet cores, for which allowance must be made in their sectional area, will be only that of the resultant flux due to the combined M.M.F. of the magnet winding and the direct ampere-turns. Since, however, both divisions of the armature reaction produce the same class of effect, they may be combined by assigning to the armature a certain inductance, which causes an E.M.F. of self-induction in quadrature with the current. It must then be remembered that the value of the flux corresponding to the impressed E.M.F. is really that which would be due to the same excitation if there were no armature current, and never really exists except at no load. If the external circuit also has self-inductance, the lag of the current is increased and the terminal voltage is further lowered. If, on the other hand, the external circuit has sufficient condenser capacity, the current may be brought back into phase with the E.M.F., or may even be in advance of it; in this case, the above effects are reversed, and the field and terminal E.M.F. are increased for the same exciting current.

Evidently, therefore, the characteristic curve connecting armature current and terminal volts with a constant exciting current depend on the nature of the load, whether inductive or non-inductive, and upon the amount of inductance already possessed by the armature itself. With an inductive load it will fall more rapidly from its initial maximum value, or, conversely, if the initial voltage is to be maintained under an increasing load, the exciting current will have to be increased more than if the load were non-inductive. In practical working many disadvantages result from a rapid drop of the terminal E.M.F. under increasing load, so that between no load and full load the variation in terminal voltage with constant excitation should not exceed 15 per cent. Thus the output of an alternator is limited either by its heating or by its armature reaction, just as is the output of a continuous-current dynamo; in the case of the alternator, however, the limit set by armature reaction is not due to any sparking at the brushes, but to the drop in terminal voltage as the current is increased, and the consequent difficulty in maintaining a constant potential on the external circuit.

***The coupling of alternators.***

The joint operation of several alternators so that their outputs may be delivered into the same external circuit, is sharply distinguished from the corresponding problem in continuous-current dynamos by the necessary condition that they must be in synchronism—*i.e.*, not only must they be so driven that their frequency is the same, but their E.M.F.'s must be in phase or, as it is also expressed, the machines must be *in step*. Although in practice it is impossible to run two alternators in series unless they are rigidly coupled together—which virtually reduces them to one machine—two or more machines can be run in parallel, as was first described by Wilde in 1868, and subsequently redemonstrated by Hopkinson and Adams in 1884. Their E.M.F.'s should be as nearly as possible in synchronism, but as contrasted with series connexion, parallel coupling gives them a certain power of recovery if they fall out of step, or are not in exact synchronism when thrown into parallel. Under such circumstances a synchronizing current passes between the two machines, due to the difference in their instantaneous pressures; and as this current agrees in phase more nearly with the leading than with the lagging machine, the former machine does work as a generator on the latter as a motor. Hence the lagging machine is accelerated and the leading machine is retarded, until their frequencies and phase are again the same.

***Uses of alternators.***

The chief use of the alternator has already been alluded to. Since it can be employed to produce very high pressures either directly or through the medium of transformers, it is specially adapted to the electrical transmission of energy over long distances.[1] In the early days of electric lighting, the alternate-current system was adopted for a great number of central stations, the machines, designed to

[1] In the pioneer three-phase transmission between Lauffen and Frankfort (*Electrician*, vol. xxvi. p. 637, and xxvii. p. 548), the three-phase current was transformed up from about 55 to 8500 volts, the distance

give a pressure of 2000 volts, supplied transformers which were situated at considerable distances and spread over large areas, without an undue amount of copper in the transmitting lines. While there was later a tendency to return to the continuous current for central stations, owing to the introduction of better means for economizing the weight of copper in the mains, the alternating current is again coming into favour in special cases, as rendering it possible to place the central station in some convenient site far away from the district which it is to serve. The pioneer central station in this direction was the Deptford station of the London Electric Supply Corporation, which furnished current to the heart of London from a distance of 7 miles. In this case, however, the alternators were single-phase and gave the high pressure of 10,000 volts immediately, while more recently the tendency has been to employ step-up transformers and a polyphase system.[1] The advantage of the latter is that the current, after reaching the distant sub-stations, can be dealt with by rotary converters, through which it is transformed into a continuous current. The alternator is also used for welding, smelting in electric furnaces, and other metallurgical processes where heating effects are alone required; the large currents needed therein can be produced without the disadvantage of the commutator, and, if necessary, transformers can be interposed to lower the voltage and still further increase the current. The alternating system can thus meet very various needs, and its great recommendation may be said to lie in the flexibility with which it can supply electrical energy through transformers at any potential, or through rotary converters in continuous-current form.

For the further study of the dynamo, the following may be consulted, in addition to the references already given:—**General**:—S. P. THOMPSON. *Dynamo-Electric Machinery.* London, 1896.—E. KITTLER. *Handbuch der Elektrotechnik.* Stuttgart, 1892.—G. KAPP. *Dynamos, Alternators, and Transformers.* London, 1893; *Electric Transmission of Energy.* London, 1894; *Dynamo Construction: Electrical and Mechanical.* English trans. London, 1899.—H. F. PARSHALL and H. M. HOBART. *Electric Generators,* London, 1900; *Armature Windings of Electric Machines.* London, 1895.—J. A. MONTPELLIER. *Les Dynamos.* Paris, 1897.—C. C. HAWKINS and F. WALLIS. *The Dynamo.* London, 1896.—A. WIENER. *Practical Calculation of Dynamo-Electric Machines.* New York, 1898.—C. P. STEINMETZ. *Elements of Electrical Engineering.* New York, 1901. **Continuous-Current Dynamos**:—J. FISCHER-HINNEN. *Continuous-Current Dynamos.* London, 1899.—E. ARNOLD. *Die Ankerwicklungen und Ankerkonstructionen der Gleichstrom-Dynamo-maschinen.* Berlin, 1899.—D. C. JACKSON. *Electromagnetism and the Construction of Dynamos.* New York, 1893.—H. M. HOBART. "Modern Commutating Dynamo Machinery," *Journ. Inst. Elec. Eng.* vol. xxxi. p. 185.—H. J. RYAN. "On the Relation of the Air-Gap and the Shape of the Poles to the Performance of Dynamo-Electric Machinery," *Amer. Inst. Elec. Eng.*, 1891.—W. B. SAYERS. "On the Prevention and Control of Sparking," *Journ. Inst. Elec. Eng.* vol. xxii. p. 377. **Alternators**:—D. C. JACKSON and J. P. JACKSON. *Alternating Currents and Alternating Current Machinery.* New York, 1896.—J. A. FLEMING. *The Alternate Current Transformer.* London, 1899.—C. P. STEINMETZ. *Alternating Current Phenomena.* New York, 1898.—F. LOPPÉ and R. BOUQUET. *Courants Alternatifs Industriels.* Paris, 1894.—R. RÜHLMANN. *Grundzüge der Wechselstrom-Technik.* Leipzig, 1897.—S. P. THOMPSON. *Polyphase Electric Currents.* London, 1900.—J. KRÄMER. *Der Drehstrom.* Jena, 1896.—J. RODET. *Distribution de l'Energie par Courants Polyphasés.* Paris, 1898.—W. M. MORDEY. "Alternate-Current Working," *Journ. Inst. Elec. Eng.* vol. xviii. p. 583.—J. SWINBURNE. "Transformer Distribution," *Journ. Inst. Elec. Eng.* vol. xx. pp. 164–181.

(C. C. H.)

being 110 miles. Between Eichdorf and Grünberg, energy developed at 225 volts is transmitted after transformation up to 10,000 volts (*Electrician,* vol. xxxviii. p. 469, 1897); while in the transmission from Paderno to Milan the three-phase current is generated directly at 13,500 volts (*Elettricità,* vol. xvii. p. 133, 1898). At Kootenay-Rossland the three-phase current is transformed up from 1100 to 20,000 volts.

[1] As at Chicago, *Electrician,* vol. xliv. p. 177.

**Dynamometers.**—If P represent the average value of the component of a force in the direction of the displacement, $s$, of its point of application, the product P$s$ measures the work done during the displacement. When the force acts on a body free to turn about a fixed axis only, it is convenient to express the work done by the transformed product T$\theta$, where T is the average turning moment or torque acting to produce the displacement $\theta$ radians. A dynamometer is used in the process of measuring work to measure the force P, or the torque T. The factors $s$ or $\theta$ are observed independently. Apparatus is added to some dynamometers by means of which a curve showing the variations of P on a distance base is drawn automatically, the area of the diagram representing the work done; with others, integrating apparatus is combined, from which the work done during a given interval may be read off directly. It is convenient to distinguish between absorption and transmission dynamometers. In the first kind the work done is converted into heat; in the second it is transmitted, after measurement, for use.

*Absorption Dynamometers.*—Prony's dynamometer (*Ann. Chim. Phys.* vol. xix., Paris, 1821), which has been modified in various ways, consists in its original form of two symmetrically-shaped timber beams clamped to the engine-shaft. When these are held from turning, their frictional resistance may be adjusted by means of nuts on the screwed bolts which hold them together until the shaft revolves at a given speed. To promote smoothness of action, the rubbing surfaces are lubricated. A weight is moved along the arm of one of the beams until it just keeps the brake steady, midway between the stops which must be provided to hold it when the weight fails to do so. The general theory of this kind of brake is as follows:—Let F be the whole frictional resistance, $r$ the common radius of the rubbing surfaces, W the force which holds the brake from turning and whose line of action is at a perpendicular distance R from the axis of the shaft, N the revolutions of the shaft per minute, $\omega$ its angular velocity in radians per second; then, assuming that the adjustments are made so that the engine runs steadily at a uniform speed, and that the brake is held still, clear of the stops, and without oscillation, by W, the torque T exerted by the engine is equal to the frictional torque F$r$ acting at the brake surfaces, and this is measured by the statical moment of the weight W about the axis of revolution; that is—

$$T = Fr = WR \quad . \quad . \quad . \quad . \quad (1)$$

Hence WR measures the torque T.

If more than one force be applied to hold the brake from turning, F$r$, and therefore T, are measured by the algebraical sum of their individual moments with respect to the axis. If the brake is not balanced, its moment about the axis must be included. Therefore, quite generally,

$$T = \Sigma WR \quad . \quad . \quad . \quad . \quad . \quad (2)$$

The factor $\theta$ of the product T$\theta$ is found by means of a revolution counter. The power of a motor is measured by the rate at which it works, and this is expressed by $T\omega = \frac{T 2\pi N}{60}$ in foot-pounds per second, or $\frac{T 2\pi N}{33,000}$ in horse-power units. The latter is commonly referred to as the brake horse-power. The maintenance of the conditions of steadiness implied in equation (1) depends upon the constancy of F, and therefore of the coefficient of friction $\mu$ between the rubbing surfaces. The heating at the surfaces, the variations in their smoothness, and the variations of the lubrication make $\mu$ continuously variable, and necessitate frequent adjustment of W or of the nuts. Poncelet invented a form of Prony brake which automatically adjusted its grip as $\mu$ changed, thereby maintaining F constant.

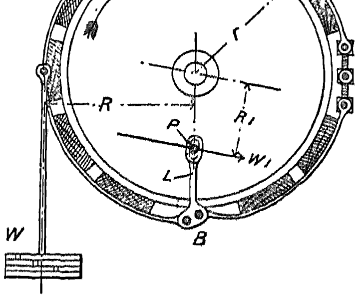

Fig. 1.

The principle of the Appold compensating brake is shown in Fig. 1. A flexible steel band, lined with wood blocks, is

gripped on the motor fly-wheel or pulley by a screw A, which, together with W, is adjusted to hold the brake steadily. Compensation is effected by the lever L inserted at B. This has a slotted end, engaged by a pin P fixed to the framing, and it will be seen that its action is to slacken the band if the load tend to rise and to tighten it in the contrary case. The external forces holding the brake from turning are W, distant R from the axis, and the reaction, $W_1$ say, of the lever against the fixed pin P, distant $R_1$ from the axis. The moment of $W_1$ may be positive or negative. The torque T at any instant of steady running is therefore $\{WR \mp W_1R_1\}$.

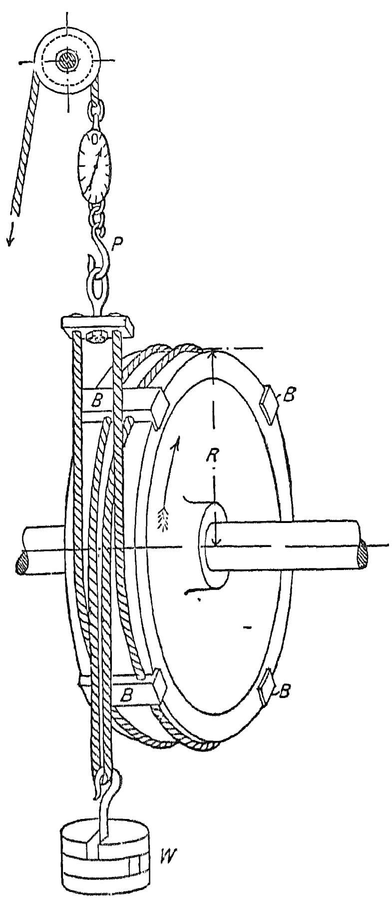


Fig. 2.

Lord Kelvin patented a brake in 1858 (Fig. 2) consisting of a rope or cord wrapped round the circumference of a rotating wheel, to one end of which is applied a regulated force, the other end being fixed to a spring balance. The ropes are spaced laterally by the blocks B, B, B, B, which also serve to prevent them from slipping sideways. When the wheel is turning in the direction indicated, the forces holding the band still are W, and $p$, the observed pull on the spring balance. Both these forces usually act at the same radius R, the distance from the axis to the centre line of the rope, in which case the torque T is $(W-p)R$, and consequently the brake horse-power is $\frac{(W-p)R\times 2\pi N}{33,000}$. When $\mu$ changes the weight W rises or falls against the action of the spring balance until a stable condition of running is obtained. The ratio $\frac{W}{p}$ is given by $e^{\mu\theta}$, where $e=2{\cdot}718$ : $\mu$ is the coefficient of friction and $\theta$ the angle, measured in radians, subtended by the arc of contact between the rope and the wheel. In Fig. 2 $\theta=2\pi$. This ratio increases very rapidly as $\theta$ is increased, and therefore by making $\theta$ sufficiently large, $p$ may conveniently be made a small fraction of W, thereby rendering errors of observation of the spring balance negligible. Thus this kind of brake, though cheap to make, is, when $\theta$ is large enough, an exceedingly accurate measuring instrument, readily applied and easily controlled. It has come into very general use in recent years, and has practically superseded the older forms of block brakes.

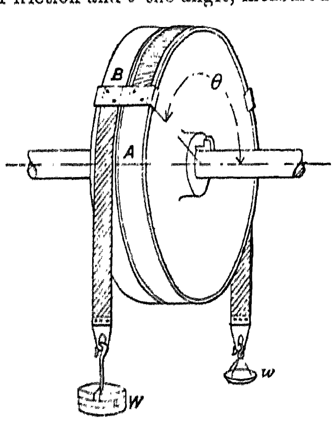


Fig. 3.

It is sometimes necessary to use water to keep the brake wheel cool. Engines specially designed for testing are usually provided with a brake wheel having a trough-shaped rim. Water trickles continuously into the trough, and the centrifugal action holds it as an inside lining against the rim, where it slowly evaporates.

Fig. 3 shows a band-brake invented by Professor James Thomson, suitable for testing motors exerting a constant torque (see *Engineering*, 22nd October 1880). To maintain $e^{\mu\theta}$ constant, compensation for variation of $\mu$ is made by inversely varying $\theta$. A and B are fast and loose pulleys, and the brake band is placed partly over the one and partly over the other. Weights W and $w$ are adjusted to the torque. The band turns with the fast pulley if $\mu$ increase, thereby slightly turning the loose pulley, otherwise at rest, until $\theta$ is adjusted to the new value of $\mu$. This form of brake was also invented independently

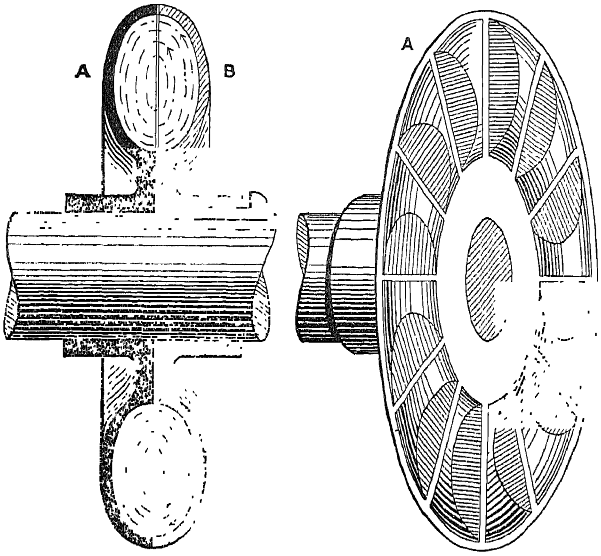


Fig. 4

by Carpentier, and the principle has been used in the Raffard brake. A self-compensating brake of another kind, by Marcel Deprez, was described with Carpentier's in 1880 (*Bulletin de la Société d'Encouragement*, Paris). Ayrton and Perry have used a band or rope brake in which compensation is effected by the pulley drawing in or letting out a part of the band or rope which has been roughened or in which a knot has been tied.

In an effective water-brake invented by W. Froude (see *Proc. Inst. M. E.*, 1877), two similar castings, A and B, each consisting of a boss and circumferential annular channel, are placed face to face on a shaft, to which B is keyed, A being free (Fig. 4). A ring tube of elliptical section is thus formed. Each channel is divided into a series of pockets by equally spaced vanes inclined at 45°. When A is held still and B rotated, centrifugal action sets up vortex currents in the water in the pockets; thus a continuous circulation is caused between B and A, and the consequent changes of momentum give rise to oblique reactions. The moments of the components of these actions and reactions in a plane to which the axis of rotation is at right angles are the two aspects of the torque acting, and therefore the torque acting on B through the shaft is measured by the torque required to hold A still. Froude constructed a brake to take up 2000 H.P. at 90 revs. per min. by duplicating this apparatus. This replaced the propeller of the ship whose engines were to be tested, and the outer casing was held from turning by a suitable arrangement of levers carried to weighing apparatus conveniently disposed on the wharf. The torque corresponding to 2000 H.P. at 90 revs. per min. is 116,772 foot-pounds, and a brake 5 feet in diameter gave this resistance. Thin metal sluices were arranged to slide between the wheel and casing, and by their means the range of action could be varied from 300 H.P. at 120 revs. per min. to the maximum.

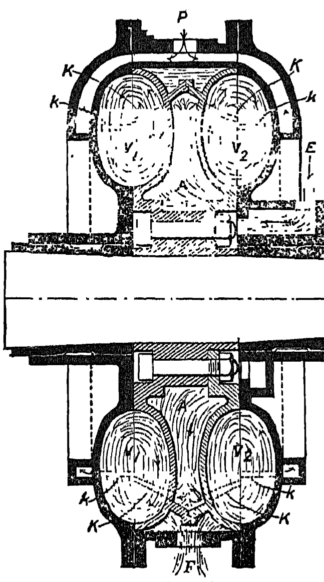


Fig. 5.

Professor Osborne Reynolds in 1887 patented a water-brake (see *Proc. Inst. C. E.* vol. xcix. p. 167), using Froude's turbine to obtain the highly resisting spiral vortices, and arranging passages in the casing for the entry of water at the hub of the wheel and its exit at the circumference. Water enters at E (Fig. 5), and finds its way into the interior of the wheel, A, driving the air in front of it through the air-passages K, K. Then following into the pocketed chambers $V_1$, $V_2$, it is caught into the vortex, and finally escapes at the circumference, flowing away at F. The air-ways *k*, *k*, in the fixed vanes establish communication between the cores of the vortices and the atmosphere. From $\frac{1}{2}$ to 30 H.P. may be measured at 100 revs. per min. by a brake-wheel of this kind 18 inches in diameter. For other speeds the power varies as the cube of the speed. The casing is held from turning by weights hanging on an attached arm. The cocks regulating the water are connected to the casing, so that any tilting automatically regulates the flow, and therefore the thickness of the film in the vortex. In this way the brake may be arranged to maintain a constant torque, notwithstanding variation of the speed. In Alden's brake (see *Trans. Amer. Soc. Eng.* vol. xi.) the resistance is obtained by turning a cast-iron disc against the frictional resistance of two thin copper plates, which are held in a casing free to turn upon the shaft, and are so arranged that the pressure between the rubbing surfaces is controlled, and the heat developed by friction carried away, by the regulated flow of water through the casing. The torque required to hold the casing still against the action of the disc measures the torque exerted by the shaft to which the disc is keyed.

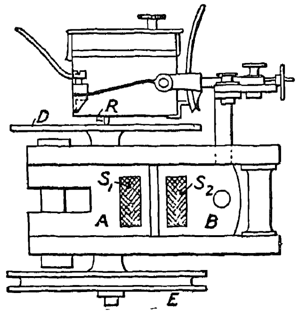

Fig. 6.

*Transmission Dynamometers.*—The essential part of many transmission dynamometers is a spring whose deformation indirectly measures the magnitude of the force transmitted through it. For many kinds of spring the change of form is practically proportional to the force, but the relation should always be determined experimentally. Morin (see *Notice sur divers appareils dynamométriques*, Paris, 1841), in his classical experiments on traction, arranged his apparatus so that the change in form of the spring was continuously recorded on a sheet of paper drawn under a style. For longer experiments he used a "Compteur" or mechanical integrator, suggested by Poncelet, from which the work done during a given displacement could be read off directly. This device consists of a roller of radius *r*, pressed into contact with a disc. The two are carried on a common frame, so arranged that a change in form of the spring causes a relative displacement of the disc and roller, the point of contact moving radially from or towards the centre of the disc. The radial distance *x* is at any instant proportional to the force acting through the spring. The angular displacement, $\theta$, of the disc is made proportional to the displacement, *s*, of the point of application of the force by suitable driving gear. If $d\phi$ is the angular displacement of the roller corresponding to displacements, $d\theta$ of the disc, and $ds$ of the point of application of P, *a*, and C constants, then $d\phi=\frac{xd\theta}{r}=\frac{a}{r}\mathrm{P}ds=\mathrm{C.P}ds$, and therefore $\phi=\mathrm{C}\int_{s_1}^{s_2}\mathrm{P}ds$; that is, the angular displacement of the roller measures the work done during the displacement from $s_1$ to $s_2$. The shaft carrying the roller is connected to a counter so that $\phi$ may be observed. The angular velocity of the shaft is proportional to the rate of working. Morin's dynamometer is shown in Fig. 6. The transmitting spring is made up of two flat bars linked at their ends. Their centres $s_1$, $s_2$, are held respectively by the pieces A, B, which together form a sliding pair. The block A carries the disc D, B carries the roller R and counting gear. The pulley E is driven from an axle of the carriage. In a dynamometer used by Mr F. W. Webb to measure the tractive resistance of trains on the London and North-Western Railway, a tractive pull or push compresses two spiral springs by a definite amount, which is recorded to scale by a pencil on a sheet of paper, drawn continuously from a storage drum at the rate of three inches per mile, by a roller driven from one of the carriage axles. Thus the diagram shows the tractive force at any instant. A second pencil electrically connected to a clock traces a time line on the diagram with a kick at every thirty seconds. A third pencil traces an observation line in which a kick can be made at will by pressing any one of the electrical pushes placed about the car, and a fourth draws a datum line. The spring of the dynamometer car used by Mr Dean on the Great Western Railway is made up of thirty flat plates, 7 ft. 6 in. long, 5 in. × $\frac{5}{8}$ in. at the centre, spaced by distance pieces nibbed into the plates at the centre and by rollers at the ends. The drawbar is connected to the buckle, which is carried on rollers, the ends of the spring resting on plates fixed to the under-frame. The gear operating the paper roll is driven from the axle of an independent wheel which is let down into contact with the rail when required. This wheel serves also to measure the distance travelled. A Morin disc and roller integrator is connected with the apparatus, so that the work done during a journey may be read off. Five lines are traced on the diagram.

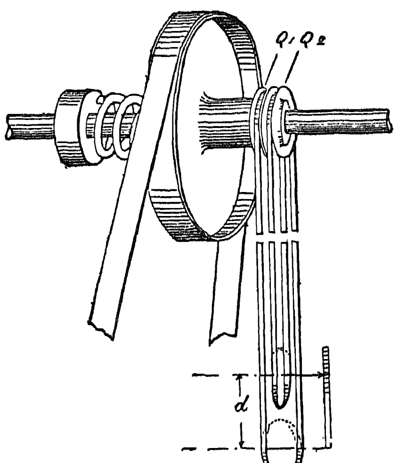

Fig. 7.

In spring dynamometers designed to measure a transmitted torque, the mechanical problem of ascertaining the change of form of the spring is complicated by the fact that the spring and the whole apparatus are rotating together. In the Ayrton and Perry transmission dynamometer or spring coupling of this type, the relative angular displacement is proportional to the radius of the circle described by the end of a light lever operated by mechanism between the spring-connected parts. Prof. Dalby (see *Proc. Inst. C. E.* vol. cxxxii., 1897–98) uses a device shown in Fig. 7, by means of which the change in form of the spring is shown on a fixed indicator, which may be placed in any convenient position. Two equal sprocket wheels $Q_1$, $Q_2$, are fastened, the one to the spring pulley, the other to the shaft. An endless band is placed over them to form two loops, which during rotation remain at the same distance apart, unless relative angular displacement occurs between $Q_1$ and $Q_2$, due to a change in form of the spring. The change in the distance *d* is proportional to the change in the torque transmitted from the shaft to the pulley. To measure this, guide pulleys are placed in the loops guided by a geometric slide, the one pulley carrying a scale, and the other an index. A recording drum or integrating apparatus may be arranged on the pulley frames. A quick variation, or a periodic variation of the magnitude of the force or torque transmitted through the springs, tends to set up oscillations, and this tendency increases the nearer the periodic time of the force variation approaches a periodic time of the spring. Such vibrations may be damped out to a considerable extent by the use of a dash-pot, or may be practically prevented by using a relatively stiff spring.

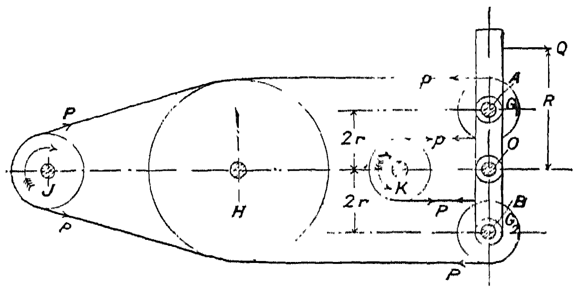

Fig. 8.

Every part of a machine transmitting force suffers elastic deformation, and the force may be measured indirectly by measuring the deformation. The relation between the two should in all cases be found experimentally. Hirn (see *Les Pandynamomètres*, Paris, 1876) employed this principle to measure the torque transmitted by a shaft. Signor Rosio used a telephonic method to effect the same end, and more recently mechanical, optical, and telephonic devices have been utilized by the Rev. F. J. Jervis-Smith. (See *Phil. Mag.*, Feb. 1898.)

When a belt in which the maximum and minimum tensions are respectively *P* and *p* lb, drives a pulley, the torque exerted is $(\mathrm{P}-p)r$ lb ft., *r* being the radius of the pulley plus half the thickness of the belt. P and *p* may be measured directly by leading the belt round two freely hanging guide pulleys,

one in the tight, the other in the slack part of the belt, and adjusting loads on them until a stable condition of running is obtained. In W. Froude's belt dynamometer (see *Proc. Inst. M.E.*, 1858) (Fig. 8) the guide pulleys $G_1$, $G_2$ are carried upon an arm free to turn about the axis O. H is a pulley to guide the approaching and receding parts of the belt to and

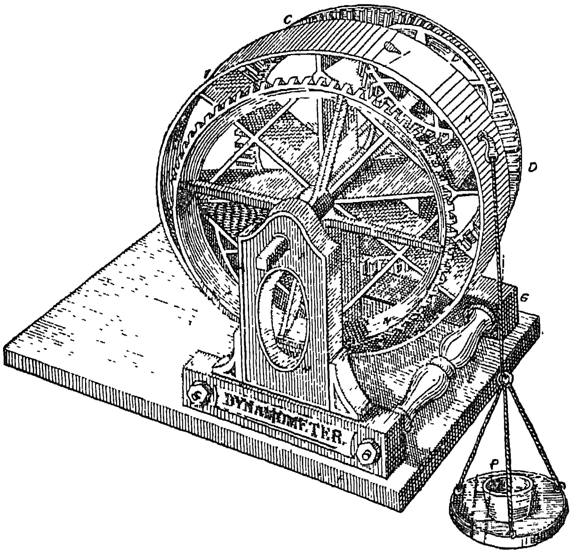


Fig. 9.

from the beam in parallel directions. Neglecting friction, the unbalanced torque acting on the beam is $4r\{P-p\}$ lb ft. If a force Q acting at R maintains equilibrium, $\frac{QR}{4}=(P-p)r=T$. Q is supplied by a spring, the extensions of which are recorded on a drum driven proportionally to the angular displacement of the driving pulley; thus a work diagram is obtained. Farcot has designed a form in which the guide pulleys are attached to separate weighing levers placed horizontally below the apparatus. In a belt dynamometer built for the Franklin Institute from the designs of Mr Tatham, the weighing levers are separate and arranged horizontally at the top of the apparatus. The weighing beam in the Hefner-Alteneck dynamometer is placed transversely to the belt (see *Electrotechnischen Zeitschrift*, Heft 7, 1881). The force Q, usually measured by a spring, required to maintain the beam in its central position is proportional to $(P-p)$. If the angle $\theta_1=\theta_2=120°$, $Q=(P-p)$ neglecting friction.

When a shaft is driven by means of gearing the driving torque is measured by the product of the resultant pressure P acting between the wheel teeth and the radius of the pitch circle of the wheel fixed to the shaft. Fig. 9, which has been reproduced from J. White's *A New Century of Inventions* (Manchester, 1822), illustrates possibly the earliest application of this principle to dynamometry. The wheel D, keyed to the shaft overcoming the resistance to be measured, is driven from wheel N by two bevel wheels L, L, carried in a loose pulley K. The two shafts, though in a line, are independent. A torque applied to the shaft A can be transmitted to D, neglecting friction, without change only if the central pulley K is held from turning; the torque required to do this is twice the torque transmitted.

The torque acting on the armature of an electric motor is necessarily accompanied by an equal and opposite torque acting on the frame. If, therefore, the motor is mounted on a cradle free to turn about knife-edges, the reacting torque is the only torque tending to turn the cradle when it is in a vertical position, and may therefore be measured by adjusting weights to hold the cradle in a vertical position. The rate at which the motor is transmitting work is then $\frac{T2\pi n}{550}$ H.P., where $n$ is the revolutions per second of the armature.

See DREDGE. *Electric Illumination*, vol. ii. London, 1885.—BEAUMONT, W. W. "Dynamometers and Friction Brakes," *Proc. Inst. C.E.* vol. xcv. London, 1889.—BRAUER, E. "Ueber Bremsdynamometer und verwandte Kraftmesser," *Zeitschrift des Vereins deutscher Ingenieure.* Berlin, 1888.—FLATHER, J. J. *Dynamometers and the Measurement of Power.* New York, 1893.

(W. E. D.)

**Dzungaria** or **Jungaria,** the name that may conveniently be given to the broad trench leading from the Mongolian plateau to the lowlands round Lake Balkhash, and limited by the Eastern Altai in the north and the Eastern Tian-shan in the south. It was formerly an independent state, and has played an important part in the history of Mongolia and the great migrations of Mongolian stems westward. Now its territory belongs partly to the Chinese Empire (East Turkestan and North-Western Mongolia) and partly to Russian Turkestan (provinces of Semiryechensk and Semipalatinsk). See MONGOLIA and EAST TURKESTAN.

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**Eads, James Buchanan** (1820–1887), American engineer, was born at Lawrenceburg, Indiana, on 23rd May 1820. His first engineering work of any importance was in raising sunken steamers. In 1845 he established glass works in St Louis. During the Civil War he constructed ironclad steamers and mortar boats for the Federal Government. His next important engineering achievement was the construction of the great steel arch bridge across the Mississippi at St Louis (see *Encyclopædia Britannica*, vol. xxi. p. 185), upon which he was engaged from 1867 till 1874. The work, however, upon which his reputation principally rests was his deepening and fixing the channel at the mouths of the Mississippi by means of jetties, whereby the narrowed stream was made to scour out its own channel and carry the sediment out to sea. (See vol. xx. pp. 580, 581.) Shortly before his death he projected a scheme for a ship railway across the Isthmus of Tehuantepec, in lieu of an isthmian canal. He died at Nassau, in the Bahamas, on 8th March 1887.

**Eaglehawk,** a borough of Victoria, Australia, in the county of Bendigo, 4 miles north-north-west of Bendigo city, with which it is connected by steam tramway. It has a fine park, with lake, of 40 acres. There are valuable gold mines in the district. Altitude, 735 feet. Population (1881), 7362; (1901), 8130.

**Ealing,** a suburb of London, England, in the Ealing parliamentary division of Middlesex, 9 miles west of St Paul's, with two railway stations. There are seven Established churches (in St Mary's, 1770, are buried Oldmixon, the historian, and Horne Tooke). Other buildings are public offices, with library and science and art schools, a high school for girls, a training college for teachers of the deaf, an isolation hospital, and a cottage hospital and dispensary. There is a common and a public park. Among former distinguished residents of Ealing were Henry Fielding, the novelist, and John, first duke of Marlborough. Area of urban district, 2928 acres. Population (1881), 15,769; (1891), 23,979; (1901), 33,040.

**Ear.** See PATHOLOGY and PHYSIOLOGY (*special senses*).

**Early, Jubal Anderson** (1816–1894), American soldier and lawyer, was born in Franklin county, Va., on 3rd November 1816, and graduated at the U.S. military academy in 1837. After a brief service he resigned in July 1838, to practise law in Virginia, but as major in a regiment of state volunteers took part in the Mexican War. In 1861 he entered the Confederate service as a colonel, fought at Bull Run (July 1861), received a wound at Williamsburg (May

1862), and was advanced to brigadier- and major-general. His division held the lines at Fredericksburg during the battle of Chancellorsville (May 1863), and he fought in July at Gettysburg. As lieutenant-general in 1864, Early crossed the Potomac in July, and part of his force advanced as far north as Chambersburg, Pa. He threatened Washington with his main force, but was compelled to retreat upon the arrival of the 6th corps, despatched by Grant from the front. In the ensuing autumn he won a partial success in the Shenandoah valley, but General Sheridan checked him in September at Opequan and Fisher's Hill, and on 19th October he suffered a decisive defeat at Cedar Creek. Wholly routed in March 1865, Early was relieved of command, and took no further active part in the war. After the peace he visited Europe, and later resumed the practice of law, managing for a time with Beauregard the Louisiana lottery. He died at Lynchburg, Va., on 2nd March 1894.

**Earth, Figure of the.**—To complete, to link together into one great network of triangles, the geodetic surveys accomplished in various countries, notably in France, England, Russia, and India, is the actual endeavour of astronomers, in order to reach an exact knowledge of the shape and size of the earth. From this common desideratum the International Geodetic Association was born, which has promoted researches directly or indirectly relating to Geodesy. Planned as early as 1861, the I. G. Association grew slowly, and was definitely constituted by the Conventions of 1886 and 1895. The Association meets at least every third year, with the Central Bureau in Potsdam, and its president is Professor Helmert, Director of the Royal Geodetic Institute, founded in 1868, the resources of which are at the disposal of the Association.

The general meeting of the I. G. Association at Paris in September 1900 gave the delegates an opportunity of knowing the state of the surveys in progress and projected.[1] Among these undertakings may first be quoted the measurement of an arc of 66 degrees of amplitude which crosses Africa from the Delta of the Nile to Cape Town; then the measuring of an arc in Spitzbergen, and the remeasurement of the arc of Peru.

The African arc will be surveyed along the meridian of 30° E. Sir David Gill, director of the Cape Observatory, has already given a report of the operations undertaken in South Africa, which will form a good basis for the realization of his admirable project. The Geodetic Survey of South Africa has established an important chain of triangles between the 20th and 30th meridians; it will not be long before this reaches from Cape Agulhas to the Zambezi, embracing thus more than 20° of latitude. Major Laffan and Lieutenant Wettstein, English and German commissioners, have recently measured, under the direction of Sir D. Gill, a chain of triangles along the 20th meridian, which divides Bechuanaland from German South-West Africa, between Rietfontein and the parallel of 22° south latitude. Mr Alston has united, by a chain along the 28th parallel, through Bechuanaland, those already established along the 20th and 24th meridians. The Chartered Company had a triangulation along the 30th meridian undertaken in Rhodesia, and the Geodetic Survey of Rhodesia achieved, amid great difficulties, the observations between Mangwe and the parallel of –19°, and reconnoitred the northern part of the chain up to the Zambezi, when the war in South Africa caused the interruption of these works. As soon as circumstances permit, the chain of Rhodesia will pass through the Transvaal and be linked with that which the Geodetic Survey of South Africa has already measured in Cape Colony and Natal, along the south-eastern shore of Africa, from Cape Agulhas to Vaal river. It is therefore to be expected that the triangulation will before long extend from the Cape to the Zambezi. From this river to the Bahr-el-Gazal, the 30th meridian passes through the territories of the Congo Free State, of German East Africa, and of British East Africa, which it reaches near Albert Edward Nyanza, crossing Lake Tanganyika, which is surrounded by hills visible from one shore to the other, this being a favourable circumstance to facilitate the work. The northern extremity of the African arc is in Egypt, and a triangulation performed along the Mediterranean shore would afterwards avail to link the African arc to the Rumanian and to the Russian arc, so as to form a continuous chain, ranging over 105° from Cape Agulhas to North Cape.

The question of the measurement of an arc in Spitzbergen had already been raised by General Sabine. After the exploration of that archipelago by Nordenskjöld and some others, it was resumed by Professor Rosén, who prepared a scheme of triangulation, and the solution of the problem was deemed possible, on account of the improvements of the base-apparatus of Jäderin, whose nickel-steel wire makes the measuring of an extended base-line much easier than by previous processes.

During the summer of 1898 a private Swedish expedition, conducted by Jäderin, began the reconnaissance of a meridian chain between the parallels of South Cape and Ross Island, thus embracing about 4° 5′ of latitude, between 76° and 81°. The summits of the triangles were to be marked by signals on the shores of the Storfjord, of the Strait of Hinlopen, and of the Seven Isles; the expedition succeeded in placing the signals from Ross Island to the Storfjord. The continuation of the work was then entrusted to two official commissions named by the Swedish and Russian Governments, who proceeded to compose two missions. Towards the end of June 1899 the Russo-Swedish expedition, on five steamships, went from Tromsö to Spitzbergen. The work was postponed till July, because of the ice and the time lost in erecting the cabins, and was then pursued till September. The Russian mission took charge of the installation of the signals in the Storfjord. This was a very heavy task, on account of the elevation of the mountains around the gulf, and of its width, the two shores being seldom at the same moment free from fogs; the consequence being that the sides of many triangles exceed 100 kilometres in length. It was also possible to do some astronomical and geodetical work for two of the most difficult summits, namely, those of Cape Lee and of Whole Point, where a base-line has to be measured. At the north the condition of ice did not permit reaching the Seven Isles; the Swedish mission has been employed in measuring a base-line at Hekla Hook and determining some summits. In September both missions settled in winter stations; the Russians at Hornsund, on the south-western coast of Spitzbergen, in 77° N., the Swedish in the Treurenberg Bay, towards 80°. They remained there, isolated from the outer world, during nine months, occupied in astronomical and meteorological observations. When the spring of 1900 came, the geodetical work was resumed and pursued till September, amidst very unfavourable circumstances. They succeeded with much ado in building up on Mount Chydenius (alt. 1500 metres) a signal destined to join the chain of the Storfjord to that of Hinlopen Strait.

The revision of the arc of Peru, the opportunity for which had already been pointed to by Mr Davidson, the delegate of the United States to the I. G. Association in 1889, and later by Mr Preston in 1898, has been undertaken,

[1] See the valuable reports of Lieut. Perrier and Professor Helmert.

the French Government having been authorized by the Chambers to appropriate to that work a sum of 500,000 francs. The operation was entrusted to the members of the Geographical Service of the Army, under the direction of General Bassot. The Government of the Republic of Ecuador (on whose territory the arc of Bouguer is now comprised) having shown a disposition to favour the enterprise, two French officers, Captains Maurain and Lacombe, of the Geographical Service, were sent in 1899 to reconnoitre the country. They left Bordeaux at the end of May, and returned in January 1900, after having surveyed, in less than five months (July to November), an arc of 6°, between the Cerro de Pasto (1° 10′ N. lat., Colombian territory) and the Cerro Ereo (4° 55′ S. lat., Peruvian territory), thus lengthening by 1° towards the north and 2° southwardly the arc of Bouguer. In the southern part of the arc they could retain the old stations of the French academicians; in the northern part they had to rise above the former stations, found defective. The obstacles were formidable, for there the twin Cordilleras rise to peaks—some of them volcanoes—of from 5000 to 6000 metres in altitude, namely, Pichincha, Chimborazo, Cotopaxi, &c. MM. Maurain and Lacombe, with a zeal and persistence above all praise, traversed 3500 kilometres and effected about thirty ascents in one of the most difficult countries, investigated the sites of two new base-lines, and determined fifteen geodetical stations; they brought back topographical sketches and plans which give a clear idea of the work to be accomplished. In July 1900 an official report, presented by M. Poincaré in the name of the Academy of Sciences, drew out the lines of the projected revision of the arc of Quito. The system implies a series of 57 triangles and is supported by three base-lines, each of about 8500 metres. The principal base will be situated towards the middle of the arc, near Riobamba, in 1° 30′ S. lat., and 2500 metres above the sea-level; two bases of verification are to be established at both extremities: the one near Cumbal, in Colombia, the other between Quiroz and Sullana (Peru). For measuring the angles, 52 stations (28 from the old chain of Bouguer and La Condamine) will be established along both Cordilleras, their altitude being often of 4000 metres; the sides of the triangles will be of 30 to 40 kilometres. The mission will be divided into two parties, who will proceed in parallel lines, the one along the western range, the other along the eastern. As it would be hazardous to build up signals, always liable to be destroyed by the Indians, optic telegraphy will be resorted to, by means of heliostats, in order to maintain communication between the successive stations.

The difference of longitude of the extremities will be a little less than 3°. In the southern part of the Gulf of Guayaquil the hills are near enough to the coast to make it possible to push on the triangulation to the sea, by connecting it with a point where an old lighthouse stands, and also, perhaps, with a point of Puna Island. The altitude of the principal base (Riobamba) will be obtained by a spirit-levelling, which will follow the line of the future Guayaquil Quito railroad. The sea-level will be obtained by means of a "médimarémètre" placed at Playas, on the Pacific coast, distant about 70 kilometres from Guayaquil. The line of levelling from Playas to Riobamba will attain a development of 280 kilometres and rise to 2500 metres. For the other bases a geodetic levelling by zenith distances may suffice. The astronomical stations for the observation of the fundamental elements (latitude, longitude, azimuth) will be multiplied as much as possible, and likewise the stations for pendulum observations. The principal station will be at Quito, where a perfectly fitted observatory already stands, the direction of which has been entrusted to a French astronomer, M. Gonnessiat. The differences of longitude between Quito, Guayaquil, and several other astronomical stations will be determined with the help of the telegraph.

It is estimated that this programme can be executed within four years by a party of five officers, namely, Commandant Bourgeois, head of the mission, Captains Lacombe, Maurain, Lallemand, and Lieutenant Perrier; the other members are a military physician, a mechanician, and sixteen corporals and privates. A vanguard mission, consisting of Captains Maurain and Lallemand, sailed in December 1900, and reached Guayaquil in January 1901. The rest of the personnel followed in April with the instruments.

It is right to recall here that geodetical studies have recovered, in France, their former expansion under the vigorous impulse of Colonel (afterwards General) Perrier. When occupied with the triangulation of Algeria, Colonel Perrier had conceived the possibility of the geodetic junction of Algeria to Spain, over the Mediterranean; therefore the French meridian line, which was already connected with England, and was thus produced to the 60th parallel, could further be linked to the Spanish triangulation, cross thence into Algeria and extend to the Sahara, so as to form an arc of about 30° in length. But it became, then, urgent to proceed to a new measurement of the French arc, between Dunkirk and Perpignan. In 1869 Perrier was authorized by Maréchal Niel to undertake that revision. He devoted himself to that work till the end of his career, closed by premature death in February 1888, at the very moment when the Dépôt de la Guerre had just been transformed into the Geographical Service of the Army, of which General Perrier was the first director. His work was continued by his assistant, Colonel (afterwards General) Bassot. The operations concerning the revision of the French arc (triangulation, remeasurement of the Perpignan base, measurement of a new base near Melun, which may replace the former, &c.) were completed only in 1896. Meanwhile the French geodesists had accomplished the junction of Algeria to Spain, with the help of the geodesists of the Madrid Institute under General Ibañez (1879), and measured the meridian line between Algiers and El Aghouat (1881). They have since been busy in prolonging the meridians of El Aghouat and Biskra, so as to converge towards Wargla, through Gardaïa and Tuggurt. A careful study of the deflections of the vertical has been commenced in the hills of the Algerian Sahel. In France the Geographical Service of the Army has been entrusted with the triangulations of the first, second, and third orders, to serve as a basis for the new map of France.[1] The Geographical Service has thus been led to undertake the revision of the whole triangulation of France, with methods and instruments of high precision. The parallel of Paris has been connected with the German net by the co-operation of German and French geodesists. The fundamental co-ordinates of the Panthéon have also been obtained anew, by connecting the Panthéon and the Paris Observatory with the five stations of Bry-sur-Marne, Morlu, Mont Valérien, Chatillon, and Montsouris, where the observations of latitude and azimuth have been effected.

The triangulation of Italy is finished and in connexion with the French net on north and south, where it is linked to Tunis. The geodetic junction of Malta to Sicily was executed in 1900 by M. Guarducci. The observations were made by night, by means of light signals. The distances of many of the stations reach to 200 kilometres. The probable error in closing the triangles does not exceed

[1] See the work entitled *La Carte de France*, 1750-1898; *Étude historique*, par le Colonel Berthaut, 2 vols. 4to, 1898-99.

two seconds. The connexion of Corsica with the continent by new measures is also contemplated.

Rumania, which since 1895 has had a Geographical Institute of the Army, has not remained backward.[1] Three base-lines have been measured with Brunner's apparatus: the western base, at Garla Mare (6200 metres); the central base, in Bucarest (9420 metres); and the northern base, at Roman (7400 metres). The astronomical observations have been commenced for the measurement of an arc of parallel, supported by three bases (the western, central, and an eastern one, at Slobozia), which will produce to the Black Sea the mean parallel, already measured from the Atlantic. On the other hand, the meridian arc, depending upon three bases (eastern, northern, and a Russian base near the Dniester), will help to join the Russian arc of Struve with the African arc of Gill, in long. 30° E. For their levellings the Rumanian geodesists have adopted the methods employed in the *Nivellement général de la France*, under the direction of M. Lallemand. It has already been reported that there does not exist any difference of mean level between the Black Sea and the Adriatic, contrary to what has hitherto been generally believed.

Greece, also, is now in possession of a valuable survey, which has been effected under Colonel Hartl.

In Russia the Topographical Section of the General Staff has begun great calculations, for the sake of unification of the various triangulations, executed at very different epochs. As spheroid of reference, the Besselian ellipsoid was made use of, which seems to suit better with the surface of the Russian Empire than that of Clarke, which had been utilized several times since 1880. In fact, General Bonsdorff, by a new calculation of the arc of Struve (long. 30° E.), found the ellipticity 1/298·6, scarcely different from Bessel (1/299). On the other hand, Professor Shdanov, by the arcs of the parallels of 52° and 47°, combined with three meridian arcs which run across, found nearly the same result (1/299·7). The Clarke ellipsoid has, on the contrary, a much stronger ellipticity (1/293·5), which results from the influence of the Indian arc.[2]

In the new mathematical treatment of the Russian triangulations, only the geometrical conditions of the system and the astronomical azimuths have been taken into account, leaving aside astronomical longitudes and latitudes, too much influenced by local attractions. It was therefore decided to compute the geodetical co-ordinates of the stations, starting from Dorpat (Yurief) as a point of reference. Besides the three fundamental chains (meridian arc of Struve, arcs of the parallels of 47° and 52°), four polygonal systems were at hand, formed by these chains, and meridian or parallel arcs, measured in the zone comprised between Warsaw and Saratof. The vastness of these systems prevented the application of a uniform method of simultaneous adjustment, and made it necessary to resort to partial adjustments before the final connexion of the several parts of the network.

The results of the computations relative to the parallel of Central Europe (lat. 52°), that ranges over 69° of longitude, with a linear development of 4730 kilometres, from Valentia (Ireland) to the Ural, are now known. The radius of curvature of this parallel is smaller than that corresponding to the Clarke ellipsoid; it belongs to another ellipsoid; according to Helmert, this might be an ellipsoid with the equatorial radius found by Clarke (which is confirmed by the computation of the meridian arc of Struve), but with a much smaller ellipticity, smaller even than Bessel's, *i.e.*, 1/308. It is true that the parallel of 52° presents a very sensible irregularity: the eastern, or Russian, half would agree well enough with Clarke's ellipsoid, but the western half concords better with Bessel's, its average curvature being greater than that of the eastern half. There lies a strong indication of the attraction of continents; this seems to be confirmed by the curvature of the Anglo-French meridian arc, which proves a little greater than that of the Russian arc of Struve, and by the fact that the polar semi-axes of the ellipses of these two arcs do not coincide; they separate by 4″·5, in such a manner that Russian latitudes are too large by 4″·5, or the others too small by the same amount.

The United States Coast and Geodetic Survey has published an account of the transcontinental triangulation and measurement of an arc of the parallel of 39°, which extends from Cape May (New Jersey), on the Atlantic coast, to Point Arena (California), on the Pacific coast, and embraces 48° 46′ of longitude, with a linear development of about 4225 kilometres (2625 st. miles). The triangulation depends upon ten base-lines, with an aggregate length of 86 kilometres, the longest exceeding 17 kilometres in length, which have been measured with the utmost care. "A characteristic of the triangulation is its rigidity, imparted to it by quadrilaterals and other polygons. In crossing the Rocky Mountains, many of its sides exceed one hundred miles in length, and there is one side reaching to a length of 294 kilometres, or 183 st. miles; the altitude of many of the stations is also considerable, reaching to 4300 metres, or 14,108 feet, in the case of Pike's Peak, and to 14,421 feet at Mount Elbert. All geometrical conditions subsisting in the triangulation are satisfied by adjustment, inclusive of the required accord of the base-lines, so that the same length for any given line is found, no matter from what line one may start."[3]

Over or near the arc were distributed 109 latitude stations, occupied with zenith telescopes; 73 azimuth stations; and 29 telegraphically determined longitudes. It has thus been possible to study in a very complete manner the deviations of the vertical, which in the mountainous regions sometimes amount to 25 seconds, and even to 29 seconds. According to Mr Schott, the average curvature of the surface of the geoid, along the parallel of 39°, approaches closely to that of the Clarke spheroid in the eastern part of the arc, which extends from the Atlantic to the Rocky Mountains, and to that of the Besselian spheroid in the western part, on the Pacific side, which represents $\frac{3}{7}$ of the arc. Thus in North America as well as in Europe the curvature increases from east to west. Some preliminary combinations of this arc with other American arcs lead to spheroids approaching that of Clarke.

The computations relative to another arc, the "eastern oblique arc of the United States," are also available. It extends from Calais (Maine) in the north-east, to the Gulf of Mexico, and terminates at New Orleans (Louisiana), in the south. Its length is 2612 kilometres (1623 st. miles), the difference of latitude 15° 1′, and of longitude 22° 47′. In the main, the triangulation follows the Appalachian chain of mountains, bifurcating once, so as to leave an oval space between the two branches. It includes among its stations Mount Washington (1920 metres) and Mount Mitchell (2038 metres). It depends upon six base-lines, and the adjustment is effected in the same manner as for the arc of the parallel. The astronomical data have been afforded by 71 latitude stations, 17 longitude stations, and 56 azimuth stations, distributed over the whole extent of the arc. For various reasons a selection had, however,

[1] See Report of General Bratiano.

[2] See *Geodesy*, by Colonel A. R. Clarke. Oxford, 1880.

[3] U.S. Coast and Geodetic Survey; H. S. Pritchett, superintendent. *The Transcontinental Triangulation and the American Arc of the Parallel.* By C. A. Schott, assistant C. and G. S. Washington, 1900.

to be made among these data, a part of which only was admitted into the final equations for the determination of the best spheroid (84 data out of 144). The resulting dimensions of an osculating spheroid were found to be

| | |
|---|---|
| Equatorial radius . | . 6,378,157 ± 90 metres. |
| Compression (ellipticity) . | 1/304·5 ± 1·9. |

The equatorial radius differs but little from Clarke's value of 1866, whereas the compression is very different, and comes more nearly to Bessel's value.

The measurement of a great meridian arc, in long. 98° W., has also begun; it has a range of latitude of 23°, and will extend over 50° when produced southwards and northwards by Mexico and Canada. It may afterwards be connected with the new arc of Quito. Geodetical surveys of some extent have also been undertaken in New South Wales and in Queensland.

Differences of longitude were measured along the circuit Greenwich–Pulkowa–Vladivostok–Shanghai–Madras–Tehran–Potsdam–Greenwich.

We transcribe from Mr Schott a comparative table of the dimensions of several spheroids which of late have been often quoted:—

| Ellipsoid of | Equatorial Radius $a$. | Polar Semi-Axis $b$. | Compression $(a-b)/a$. |
|---|---|---|---|
| | m. | m. | |
| Bessel, 1841. From ten meridional arcs, total amplitude 90°·6 . . . . | 6,377,397 | 6,356,079 | 1/299·15 |
| Clarke, 1858. Special spheroid for surface of Great Britain and Ireland; range of lat. 12°, the same in long.; 75 astron. stations | 6,378,494 | 6,355,746 | 1/280·4 |
| Clarke, 1866. From five merid. arcs, total amplitude 76°·6 . . . . | 6,378,206 | 6,356,584 | 1/295·0 |
| Clarke, 1880. From five merid. arcs and longitudinal measures, total amplitude 89°·0 . . . | 6,378,249 | 6,356,515 | 1/293·5 |
| U.S. Coast and Geod. Survey, 1900. Eastern oblique arc; total length 23°·5; 84 astronomic stations . . | 6,378,157 | 6,357,210 | 1/304·5 |
| Bonsdorff, 1899. Russian merid. arc, amplitude 25°·3 | 6,378,344 | 6,356,983 | 1/298·6 |
| Shdanov, 1899. Russian parallels of 47° and 52°, and three merid. arcs . | 6,377,717 | 6,356,437 | 1/299·7 |
| Harkness, 1891. From a variety of sources (*Solar Parallax*, Washington, 1891) . . . . | 6,377,972 | 6,356,727 | 1/300·2 |

It is thus evident that great efforts are now being made by all civilized nations to complete the network of triangles that will ere long cover the whole surface of the continents. In due course we shall be in possession of the results of some of the most important undertakings, now in process of execution. Meantime it may be admitted as highly probable that the dimensions of the geoid are nearly those adopted by Clarke ($a > 6,378,000$ metres), with an ellipticity approaching to Bessel's value (1/299). The ellipsoid of three unequal axes has been abandoned, mainly for theoretical reasons [1] that lead us to prefer an ellipsoid of revolution as a reference spheroid, in relation to which may be stated the prominences and depressions of the true geoid. In Europe, according to Helmert, the deviations of level are scarcely over 100 metres.

But it is necessary to agree precisely on the definition of the geoid. This word is generally understood to mean a level surface coinciding with the mathematical surface of the sea, produced below the continents, which it is imagined to percolate by canals or open cuttings. In that case the reduction of gravity to the sea-level ought to be done simply by the correction for height $\left(+2g\frac{h}{R}\right)$, just as if the superposed strata were condensed upon the surface of the geoid. A somewhat different geoid would be obtained by supposing the surface of the oceans continued below the continents by means of tunnels, or by a levelling in mine galleries, for then the attraction of the upper strata diminishes the gravity at the surface of the geoid, and the latter will be a little below the surface of the former geoid; it has discontinuities of curvature where it enters the continents. If now, according to what is often done, we add to the reduction of gravity Bouguer's correction $\left(-\frac{3}{2}g\frac{\delta}{\Delta}\frac{h}{R}\right)$, which goes to subtract the attraction of the continent, $\delta$ being the density of the ground, and $\Delta$ the mean density of the earth, we thereby suppose the upper layers erased; but the process is inadmissible, since we know that mountain masses are generally compensated by a deficiency of matter in the underlying strata. In Europe the compensation is often found to be incomplete, whereas in the Himalaya range the attracting masses are sometimes over-compensated.

Professor Helmert, who has devoted much labour and time to the calculations of measures of gravity by means of pendulum observations, has proposed another mode of reduction, which is known by the name of "condensation method." He imagines the upper strata condensed upon the surface of a geoid situated at a depth of 21 kilometres (its equatorial radius being, therefore, equal to the polar semi-axis of the earth). This process, conceived with a view to facilitate the development of the potential, presents the inconvenience of introducing many very uncertain data, and may seem somewhat artificial. Professor Helmert has found that it brings into fair agreement the numerous measures of gravity already obtained. The number of stations is about 1400, out of which more than 50 have been connected with the central bureau in Potsdam. A thorough examination of the deflections of the vertical, or local attractions, observed in all parts of Europe has also been undertaken by the central bureau.

According to Helmert, the ellipticity of the earth, as derived from pendulum observations, is 1/299·3 (in his latest paper the corrected result is 1/298·3), and from the lunar theory 1/297·8; Hansen's value is 1/296·2. Lastly, M. Radau has shown [2] that by the introduction of the variable $\eta = \frac{c\,de}{e\,dc}$, where $c, e$ are the mean radius and ellipticity of a spheroid, it becomes possible to integrate approximately the equations of Clairaut, and to establish a relation which affords the means for an independent evaluation of the ellipticity of the earth. The subject is very fully gone into in two important memoirs, one by M. Callandreau,[3] the other by Professor Darwin,[4] whose results point to an ellipticity between 1/296 and 1/298. Professor Darwin further concludes that the level surface of the earth is depressed below the true ellipsoid by 3 metres in latitude 45°. It is highly probable that a value

[1] F. R. Helmert, *Die mathematischen und physikalischen Theorieen der höheren Geodäsie*, 2 vols., 1880–1881. See t. ii. p. 135.

[2] *Comptes Rendus*, t. c., 1885. See also Tisserand, *Traité de Mécanique céleste*, ii. p. 221.

[3] O. Callandreau, "Mémoire sur la Théorie de la figure des planètes," *Annales Obs. Paris*, vol. xix., 1889. See also *Bullet. Astron.*, 1897.

[4] G. H. Darwin, *The Theory of the Figure of the Earth, carried to the Second Order of Small Quantities.* (Monthly Notices R.A.S., vol. lx., December 1899.)

differing but little from Bessel's (1/299) will be finally adopted. It must, of course, be borne in mind that the spheroid here considered is a spheroid of reference, and that the true geoid may present many irregularities.

A question which has much absorbed the attention of geodesists of late years, but which need only be briefly mentioned here, is that of the *variation of latitudes*, resulting from a periodical shift of the axis of rotation on the surface of the earth. Suspected by Bessel (1817), the variability of latitudes was proved by the researches of Peters (1844) and Nyrén (1873), founded on the observations of Pulkowa; but these astronomers had found only a very slight amplitude ($0''\cdot10$) in adopting the ten-months' period, which seemed pointed to by Euler's theory. The researches of Clerk Maxwell (1857), Fergola (1872), Downing (1880), Küstner (1888), having once more attracted attention to this subject, in the year 1889 the observatories of Berlin, Potsdam, Prague, and Strasburg concerted a plan for regular determinations of latitude by Talcott's method; and variations of from $0''\cdot3$ to $0''\cdot5$ were brought to light. Since then many other observatories have taken part in the work, and a special expedition was sent to Honolulu in 1891. Professor Albrecht every year brings together the results of the gathered observations. From his detailed reports it follows that, since 1890, the pole of rotation of the earth has described an irregular spiral, of variable amplitude, around a mean position from which it does not deviate by more than $0''\cdot3$. On the other hand, Mr S. C. Chandler, by a careful discussion of observations from 1825 to 1893, arrived at the conclusion that the latitude variation is composed of two terms, one having a period of 14 months (429 days), the other a mean period of a year, with amplitudes varying from $0''\cdot10$ to $0''\cdot20$; he thinks the annual component may be elliptical. As to the theoretical question of the causes of these variations, Lord Kelvin has already stated that meteorological influences might be the cause of annual variations so great as $0''\cdot5$. M. Radau has further shown[1] that the combination of an annual period with another period, such as the Eulerian one, could result in great amplification of the effects. Finally, Professor Newcomb has explained the existence of the fourteen-months' period by the influence of the elasticity of the earth. It was for the sake of an exhaustive study of these questions that an "International Service of Latitudes" was organized in 1899 by the Geodetic Association in six observatories distributed along the parallel of 39°. (R. RA.)

**Earthquakes.**—Strange as it may appear, the advances that have been made in the study of earthquakes, and the world-wide interest shown in their phenomena, were initiated in work commenced in Japan. When the Japanese Government, desiring to adopt Western knowledge, invited to its shores bodies of men to act as its instructors, the attention of the newcomers was naturally attracted to the frequent shakings of the ground. Interest in these phenomena increased more rapidly than their frequency, and at length it was felt that something should be done for their systematic study. At midnight on 22nd February 1880 movements more violent than usual occurred; chimneys were shattered or rotated, tiles slid down from roofs, and in the morning it was seen that Yokohama had the appearance of a city that had suffered a bombardment. The excitement was intense, and before the ruins had been removed a meeting was convened and the Seismological Society of Japan established. The twenty volumes of original papers published by this body summarize to a large extent the results of the later study of Seismology.

***Attention now given to seismology.***

The attention of the students of earthquakes in Japan was at first directed almost entirely to seismometry or earthquake measurement. Forms of apparatus which then existed, as for example the seismographs, seismometers, and seismoscopes of Mallet, Palmieri, and others, were subjected to trial; but inasmuch as they did little more than indicate that an earthquake had taken place—the more elaborate forms recording also the time of its occurrence—they were rapidly discarded, and instruments were constructed to *measure* earthquake motion. To describe the varieties of apparatus devised in Japan and their purposes would require a special volume on Seismometry. Slightly modified types of the new instruments were adopted throughout the Italian peninsula, and it is fair to say that the seismometry developed in Japan revolutionized the seismometry of the world. The records obtained from the new instruments increased our knowledge of the character of earthquake motion, and the engineer and the architect were placed in a position to construct so that the effects of known movements could be minimized. It was no doubt the marked success, both practical and scientific, attending these investigations that led the Japanese Government to establish a chair of Seismology at its University, to organize a system of nearly 1000 observing stations throughout the country, and in 1893 to appoint a committee of scientific and practical men to carry out investigations which may palliate the effects of seismic disturbances. In the first year this committee received a grant of £5000, and as liberal sums for the same purpose appear from time to time in the parliamentary estimates, it may be assumed that the work has been fraught with good results. In their publications we find records not only of experiences and experiments in Japan, but descriptions and comments upon earthquake effects in other countries. In two of the volumes there are long and extremely well-illustrated accounts of the earthquake which on 12th June 1897 devastated Assam, to which country two members of the above-mentioned committee were despatched to gather such information as might be of value to the architect and builder in earthquake-shaken districts.

***Seismological research.***

A great impetus to seismological investigation in Europe and America was no doubt given by the realization of the fact that a large earthquake originating in any one part of the world may be recorded in almost any other. Italy for many years past has had its observatories for recording earthquakes which can be felt, and which are of local origin, but at the present time at all its fifteen first-class stations we find instruments to record the unfelt movements due to earthquakes originating at great distances, and as much attention is now paid to the large earthquakes of the world as to the smaller ones originating within Italian territory. The Kaiserliche Akademie der Wissenschaften of Vienna has established earthquake observatories in Austria, and the Central Observatorium of St Petersburg has carried out similar work in Russia. Germany, at a cost of £3500 and with an annual allowance of £295, has attached a seismological observatory to its university at Strassburg, whilst provision has been made for a professorship of Earth Physics at Göttingen. In accordance with the recommendation of the British Association of Great Britain, seismographs of a similar character have been installed at the following places:—Isle of Wight, Kew, Paisley, Toronto, Victoria (B.C.), Philadelphia, Mexico, Trinidad, Arequipa, Cordova in Argentina, New Zealand, Hawaii, Japan, Java, Calcutta, Madras, Bombay Mauritius,

[1] *Comptes Rendus*, t. cxi., 1890.

the Cape of Good Hope, Cairo, Beyrout, San Fernando in Spain. The principal objects of this extended and still extending system of stations are to determine the velocity with which motion is propagated over the surface and through the interior of the earth, to locate the positions of sub-oceanic earthquake origins, and generally to extend our knowledge respecting the physical nature of the planet on which we live.

We now know that earthquakes are many times more frequent than was previously supposed. In Japan, for example, between 1885 and 1892 no fewer than 8331 were recorded—that is to say, on the average there were during that time more than 1000 disturbances per year. Although many of these did not cause a sensible shaking over areas exceeding a few hundred square miles, many of them were sufficiently intense to propagate vibrations round and through the globe. If we pick out the well-marked earthquake districts of the world, and give to each of them a seismicity or earthquake frequency per unit area one-third of that in Japan, the conclusion arrived at is that considerable areas of our planet are on the average shaken every half-hour.

***Frequency of earthquakes.***

The knowledge which we now possess respecting the localities where earthquakes are frequent and the forms of the foci from which they have spread, enables us to speak definitely respecting the originating causes of many of these phenomena. It is found, for example, that although in many countries there may be displays of volcanic and seismic activity taking place almost side by side, it is only rarely that there is direct relationship between the two. Now and then, however, before a volcano breaks into eruption there may be a few ineffectual efforts to form a vent, each of which is accompanied by no more than a slight local shaking of the ground. This is true even for the largest and most violent eruptions, when mountains have with practically a single effort blown off their heads and shoulders. Thus the earthquake which accompanied the eruption of Bandaisan, in Central Japan, in 1888 was felt only over a radius of 25 miles. The analyses of the seismic registers of Japan clearly indicate that comparatively few shakings originate near to the volcanoes of the country, the majority of them, like those of many other countries, coming from regions where volcanic rocks are absent. The greatest number spread inland from the Pacific sea-board, the movement becoming more and more feeble as it approaches the backbone of the country, which is drilled with numerous volcanic vents. What is true for Japan is generally true for the western coasts of North and South America.

***Volcanoes and earthquakes.***

Speaking broadly, earthquakes are most frequent along the steeper flexures in the earth's surface, and in those regions where there is geological evidence to show that slow secular movements in the earth's crust are possibly yet in progress. With a unit distance of 2 degrees, or 120 geographical miles, we find that the slopes running eastwards from the highlands of Japan and westwards from the Andean ridges down into the Pacific vary from 1 in 20 to 1 in 30, and it is on the faces or near to the bottom of these slopes that seismic efforts are frequent. The slopes running from Australia, Eastern America, and Western Europe into the neighbouring oceans vary between 1 in 70 and 1 in 250, and in these regions earthquakes are of rare occurrence. The seismic activity met with in the Himalayas and the Alps finds its best explanation in the fact that these mountains are geologically recent, and there are no reasons to doubt that the forces which brought their folds into existence are yet in action.

***Origin of earthquakes.***

This peculiar association of earthquakes with pronounced topographical configuration and certain geological conditions evidently indicates that the origin of many of them is connected with rock folding. Inasmuch as certain large earthquakes have been accompanied by rock fracture, as for example in 1891, when in Central Japan a fault some 50 miles in length was created, whilst the origins of others have been distinctly traced to the line of an existing fault or its continuation, we may conclude that the majority of earthquakes are spasmodic accelerations in the secular movements which are creating (and in some instances possibly obliterating) the more prominent features of the earth's surface. These secular movements, which include upheavals, subsidences, horizontal displacements, all of which are explained on the assumption of a crust seeking support on a nucleus gradually contracting by loss of heat, are collectively referred to as bradyseismical ($\beta\rho\alpha\delta\acute{\upsilon}\varsigma$ = slow) movements. To these may be added movements directly attributable to the influence of gravity. Sub-oceanic districts in a state of seismic strain may be so far loaded by the accumulation of sediments that gentle bending may be accompanied by sudden yieldings. This possibly accounts for the frequency of earthquakes off the mouth of the Tonegawa on the eastern side of Japan. The distortions so frequently observed in fossils and pebbles, the varying thickness of contorted strata, and the "creep" in coal mines, together with other phenomena, indicate that rocks may flow. Observations of this nature lead to the supposition that high plateau-like regions may be gradually subsiding under the influence of their own weight, and that the process of settlement may from time to time be spasmodic in its character. Whether the earthquakes which originate round the submerged basal frontiers of the continents bounding the Pacific are ever attributable to such activities, it is impossible to say. All that we know with certainty is that they are sometimes accompanied by such a vast displacement of material that the ocean has been set into a state of oscillation for periods of 24 hours, that in some instances there have been marked changes in depth, and that enormous sub-oceanic landslips have occurred. These phenomena are, however, equally well explained on the assumption of sudden faulting accompanied by violent shaking, which would dislodge steeply-inclined beds of material beneath the ocean as it does upon the land.

Although the proximate cause of earthquake motion is traced to sudden yieldings in the crust of the earth brought about by some form of bradyseismical action, the existence of at least two distinct types of seismic motion indicates that the mechanical conditions accompanying the fracturing of rocks are not always identical. Ninety or ninety-five per cent. of the earthquakes which can be recorded consist of elastic or quasi-elastic vibrations. The remainder, including the large earthquakes, not only exhibit the elastic movements, but are accompanied by surface undulations which are propagated most certainly for some hundreds of miles round their origin, and then as horizontal movements sweep over the whole surface of the globe. The former of these may accompany the formation of a new fault or the sudden renewal of movement along an old one; they are cracking or rending effects, without any great displacement. The latter are probably fracturings accompanied by vertical and horizontal displacements of masses of the earth's crust sufficiently great to set up the observed surface undulations. These shocks are so frequently followed a few minutes later by disturbances, which from their similarity to the movements which have preceded them may be called earthquake echoes, that we are led to the speculation that we are here dealing

***Two types of earthquake motion.***

with the caving-in of ill-supported portions of the earth's crust, the waves from which are radiated to boundaries and then returned to their origin to coalesce and give rise to a second impulse not unlike the primary. Succeeding the first repetition of motion recorded by the seismograph there is often a rhythmical repetition of similar wave groups, suggesting the existence within our earth of phenomena akin to multiple echoes.

***Seismometry.*** Before considering in greater detail the nature of earthquake motion, something may be said respecting the instruments by which our knowledge of the subject has been gained. Popularly it is supposed that earthquake recorders are instruments so sensitive to slight vibrations that great care is necessary in selecting a site for their installation. Although this supposition is correct for a certain class of apparatus, as for example that which will record rapid elastic vibrations produced by the movement of a train a mile distant, it is far from being so for the ordinary apparatus employed by the seismologist. What he usually aims at is either to record the more or less rapid movements of the ground which we can feel, or the slow but large disturbances which do not appeal to our unaided senses. Generally speaking, the instruments used for these purposes are not disturbed by the vibrations resulting from ordinary traffic. In almost every household something may be found which will respond to a gentle shaking of the ground. Sometimes it is a loosely-fitting shutter or window-frame, a hanging drawer-handle, or a lamp-shade which will rattle; the timbers in a roof may creak, or a group of wine-glasses with their rims in contact may chatter. Any of these sounds may call attention to movements which otherwise would pass unnoticed. Specially arranged contrivances which tell us that the ground has been shaken are called seismoscopes or earthquake indicators. A small column, as for example a lead pencil standing on end, or a row of pins propped up against suitable supports, or other bodies which are easily overturned, may be used as seismoscopes. Experience, however, has shown that contrivances of this order are wanting in sensibility, and often remain standing during movements that are distinctly perceptible. A more satisfactory arrangement is one where the body to be overturned is placed upon a platform which exaggerates the movements of the ground. For example, the platform $h$ (see Fig. 1) may be on the top of a small rod $r$, fixed at its lower end by plaster of Paris in a watch-glass $w$, and carrying a disc or sphere of lead at $l$. When the stand on which $w$ rests is shaken, a multiplied representation of this movement takes place at $h$, and any small body resting on that point, as for example a small screw $s$ standing on its head, may be caused to topple over. If the loaded rod is elastic its lower end may be fixed in a stand, and the spherically curved base $w$ is no longer required. In this case the motion at $h$ is that of elastic switching. Apparatus of this kind may be employed for several purposes beyond merely indicating that an earthquake has taken place. For example, if the falling body $s$ is attached by a thread to the pendulum of a timepiece, it may be used to stop it and indicate the approximate time at which the tremor occurred. In its most sensitive form $r$ is a steel wire, the upper end of which passes freely through a small hole in a metal plate. By the movement of the wire or the movement of the plate, especially if the latter projects from the top of a second and similar piece of apparatus, an electrical contact can be established by means of which an electromagnet may ring a bell, stop a clock, or set free machinery connected with a cylinder or other surface upon which an earthquake machine may record the movement of the ground.

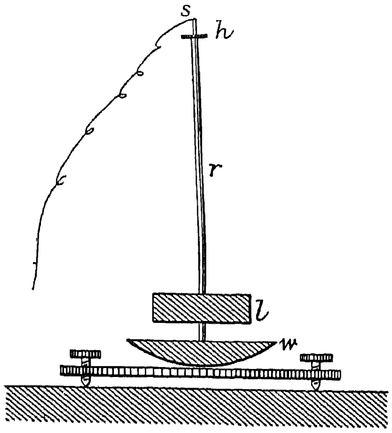

Fig. 1.

The next class of instruments to be considered are seismometers or earthquake measurers, and seismographs, or instruments which give diagrams of earthquake motion. Although a seismograph may be designed that will not only respond to fairly rapid elastic vibrations, but will also record very slow and slight undulatory movements of the ground, experience has shown that the most satisfactory results are obtained when special instruments are employed for special purposes.

First we will consider the types of apparatus which are used to record the rapid back-and-forth movements of earthquakes which can be distinctly felt and at times are even destructive. The essential feature in these seismographs is a fairly heavy mass of metal, so suspended that although its supports are moved, some point in the mass remains practically at rest. For small earthquakes, in which the movement is rapid, the bob of a very long and heavy pendulum will practically comply with these conditions. If a style projecting from this pendulum rests upon say the smoked surface of a glass plate fixed to the ground, the vibratory motion of the ground will be recorded on the glass plate as a set of superimposed vibrations. To obtain an open diagram of these movements the plate must be moved, say by clockwork.

Experience, however, has shown that even when the movements of the ground are alarming the actual range of motion is so small that a satisfactory record can be obtained only by some mechanical (or optical) method of multiplication. This is usually accomplished as shown in Fig. 2. B is the bob of a pendulum, with its style $s$ passing through a slot in the short arm of a light lever, $sop$, pivoted at $o$, and with its outer end resting upon a revolving cylinder covered with smoked paper. As shown in the figure, it is evident that the motion of $o$ in the line $sop$ would not be recorded, and to obtain a complete record of horizontal movements it is necessary to have two levers at right angles to each other. A complete arrangement of this kind is shown in the plan of Fig. 2. Here the style $s$ of the pendulum rests in slots in the short arms of two writing levers pivoted at $o$ and $o'$. Motion of the ground in the direction $os$ actuates only the lever $so'p'$, motion in the direction $o's$ actuates only $sop$, whilst motion in intermediate directions actuates both. The length of the short arms of the levers is usually $\frac{1}{8}$ or $\frac{1}{12}$ of the long arms.

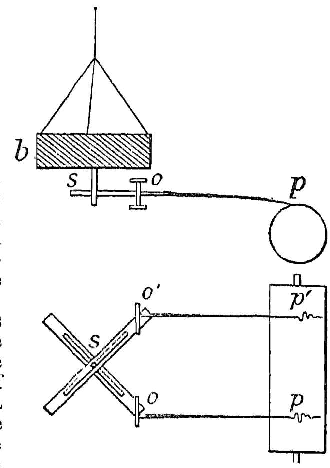

Fig. 2.

Although this type of apparatus is still largely employed in the Italian observatories, it has been replaced in Japan by what are called duplex pendulum seismographs. ***Duplex pendulums.*** The change was made because it frequently happened that in consequence of the movement of the ground agreeing with the period of the pendulum, the latter no longer acted as a steady point, but was caused to swing, and the record became little better than that given by a seismoscope. Very long pendulums (30 to 40 feet) are less subject to this disadvantage, but on the other hand their installation is a matter of some difficulty. A duplex pendulum (Fig. 3) consists of an ordinary pendulum diagrammatically represented by $ab$, connected by a universal joint to an inverted pendulum $dc$. The latter, which is a rod pointed at its lower end and loaded at $c$, would be unstable if it were not connected with $b$. Now imagine this system to be suddenly displaced so that $a$ moves to $a'$ and $d$ moves to $d'$. In the new position $b$ would tend to follow the direction of its point of support, whilst $c$ would tend to fall in the opposite direction, and the bob of one pendulum would exercise a restraint upon the motion of the other. If, as in practice, the moment of $b$ is made slightly greater than that of $c$, the system will come *slowly* to a vertical position beneath $a'd'$. In this way, by coupling together an ordinary pendulum about 3 feet in length with an inverted pendulum 2 ft. 6 in. long, it is easy to obtain the equivalent of a slowly-moving very long pendulum which is too sluggish to follow the back-and-forth movements of its supports.

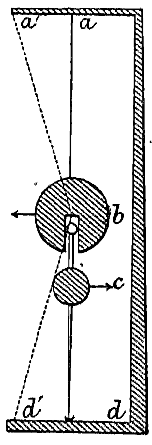

Fig. 3.

To complete an instrument of this description (see Fig. 4) a point in the steady mass $b$ is used as the fulcrum for the short arm of a light-writing index. This has a ball joint at $s$, a universal joint at $o$, and a writing point at $p$, resting upon a piece of smoked glass. Attention was first directed to the possibility of rendering ordinary pendulums more truly astatic by Professor Thomas

Gray, who suggested methods by which this might be accomplished. The method shown in Fig. 4 is that devised by Professor J. A. Ewing. Records obtained from instruments of this description give information respecting the range and principal direction of motion, and show us that in a given earthquake the ground may move in many azimuths.

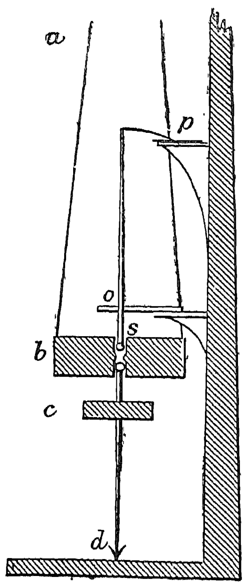


Fig. 4.

For obtaining an open diagram of an earthquake the best type of apparatus consists of a pair of horizontal pendulums writing their movements upon a moving surface. A simple form of horizontal pendulum as shown in Fig. 5, consists of a rod, *op*, free to swing like a gate round a vertical or nearly vertical axis, *cc'*, and loaded at some point *b*. In practice the weight *b* is pivoted on the rod whilst its outer end, *bp*, which writes on a smoked surface, is made extremely light. When the frame of this arrangement is rapidly displaced through a small horizontal range to the right and left of the direction in which the rod points, the weight *b* by its inertia tends to remain at rest, and the motion of the frame, which is that of the earth, is magnified in the ratio *op* to *bp*. This apparatus, of which there are many types, was first introduced into seismometry by Professor Ewing.

***Horizontal pendulums.***

To obtain a complete record of horizontal motion, two of these pendulums are placed at right angles; and by cranking one of the writing levers, *o'p'*, as shown in the plan of Fig. 5, two rectangular components of the earth's movements are written side by side. Since the movements of the ground are frequently accompanied by a slight tilting, which would cause *b* or *b'* to swing or wander away from its normal position, a sufficient stability is given to the weights by inclining the axis of the instrument at *cc'* slightly forwards. Although by compounding corresponding portions of the diagrams given by instruments of this type, it is possible to determine the range and direction of the movement of which they are the resolved parts, their

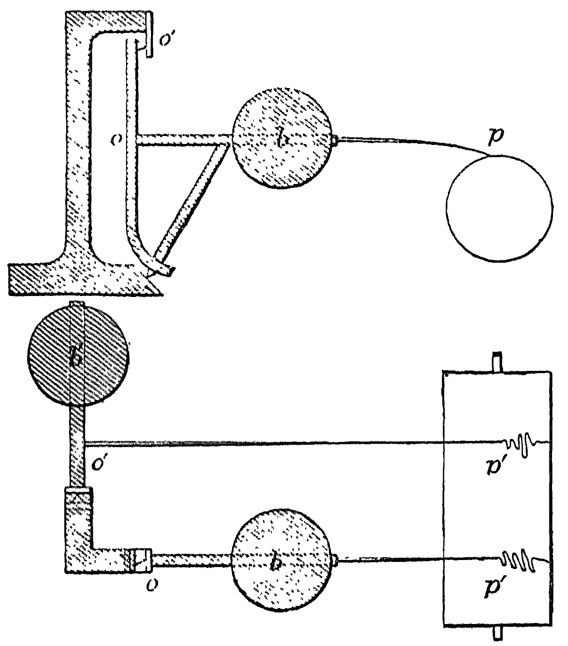


Fig. 5.

chief value is that they enable us to measure with ease the extent of any vibration, half of which is called its amplitude, and the time taken to make any complete back-and-forth movement, or its period. Now if $a$ be the amplitude expressed in millimetres, and $t$ the period expressed in seconds, then the maximum velocity of an earth particle as it vibrates to and fro equals $2\pi a/t$, whilst the maximum acceleration equals $4\pi^2 a/t^2$. The former quantity determines the distance to which a body, as for example the capping of a pillar, may be projected, whilst the latter measures the effort exerted by an earthquake to overturn or shatter various bodies. If after a heavy earthquake we find bodies that have been projected or overturned, then by observing the distance of projection, and the height through which they have fallen, or their dimensions, we can by means of simple formulæ calculate quantities closely agreeing with those obtained from the seismogram. For example, if a body, say a coping-stone, has been thrown horizontally through a distance $a$, and fallen from a height $b$, the maximum horizontal velocity with which it was projected equals $\sqrt{\frac{ga^2}{2b}}$; or if the height of the centre of gravity of a column like a gravestone above the base on which it rests is $y$, and $x$ is the horizontal distance of this centre from the *edge* over which it has turned, then the acceleration or suddenness of motion which caused its overthrow is measured, as pointed out by Mr C. D. West, with fair accuracy by the quantity $g\frac{x}{y}$.

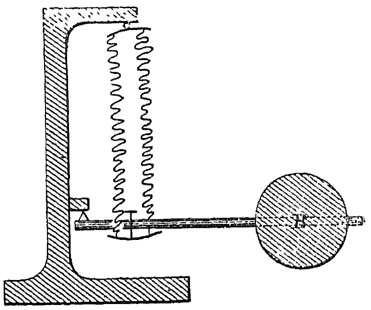


Fig. 6.

To measure vertical motion, which with the greater number of earthquakes is not appreciable, a fairly steady mass to which a multiplying light-writing index can be attached is obtained from a weight carried on a lever held by any form of spring in a horizontal position. Such an arrangement, for which seismologists are indebted to Professor T. Gray, is shown in Fig. 6, in which B is the mass used as the steady point. This, when supported as shown, can be arranged to have an extremely slow period of vertical motion, and in this respect be equivalent to a weight attached to a very long spring, an alternative which is, however, impracticable. The value of these records, as is the case with other forms of seismographs, is impaired by pronounced tiltings of the ground.

***Gray's seismograph.***

We next turn to types of instruments employed to record earthquakes which have radiated from their origins, where they may have been violent, to such distances that their movements are no longer perceptible. In these instruments the same principles are followed as in the construction of horizontal pendulums, the chief difference being that the so-called steady mass is arranged to have a much longer period than that required when recording perceptible earthquakes. Instruments largely employed for this purpose in Italy are ordinary pendulum seismographs as in Fig. 2. The largest of these is one at Catania. It consists of a weight of 300 kilos suspended by a wire 25 metres in length, the movements of which by means of writing indexes are multiplied 12·5 times. With pendulums of shorter length, say 2 metres, it is necessary to have a multiplication 80 to 100 fold by a double system of very light levers, in order to render the extremely slight tilting of their support perceptible. This arrangement, as devised by Professor Vicentini, will yield excellent diagrams of the gentle undulations of earthquakes which have originated at great distances, but for local disturbances, even if the bob of the pendulum acts as a steady point, the displacements are usually too great to be recorded on ordinary record-receiving surfaces when so largely multiplied.

***Instruments to record distant earthquakes.***

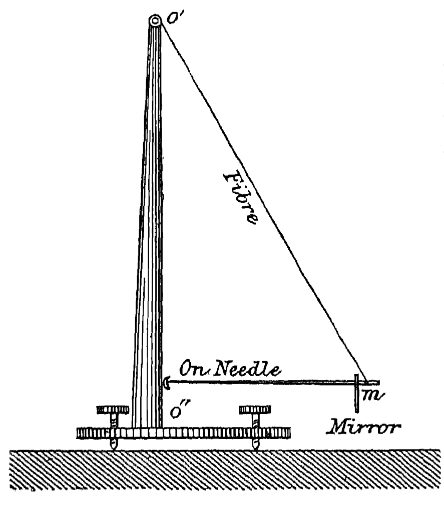


Fig. 7.

In Japan, Germany, Austria, England, and Russia horizontal pendulums of the von Rebeur-Paschwitz type are employed, which by means of levelling screws are usually adjusted to have a natural

period or double swing of from 15 to 30 seconds. These pendulums are usually small. The swinging arm or boom is from 4 to 8 inches long horizontally, and carries at its extremity a weight of a few ounces. A simple form, which is sometimes referred to as a conical pendulum, may be constructed with a large sewing needle carrying a galvanometer mirror, suspended by means of a silk or quartz fibre as shown in Fig. 7. To avoid the possibility of displacements due to magnetic influences, the needle may be replaced by a brass or glass rod. The adjustment of the instrument is effected by means of screws in the bed-plate, by turning which the axis $o'o''$ may be brought into a position nearly vertical. As this position is approached the period of swing becomes greater and greater, and sensibility to slight tilting at right angles to the plane of $o'o''m$ is increased. The movements of the apparatus, which when complete should consist of two similar pendulums in planes at right angles to each other, are recorded by means of a beam of light, which, after reflexion from the mirror or mirrors, passes through a cylindrical lens and is focussed upon a moving surface of photographic paper. The more distant this is from the pendulum the greater is the magnification of the angular movements of the mirror. With a period of 18 seconds, and the record-receiving paper at a distance of about 15 feet, a deflexion of 1 millimetre of the light spot may indicate a tilting of $\frac{1}{100}$ part of a second of arc, or 1 inch in 326 miles. Although this high degree of sensibility, and even a sensibility still higher, may be required in connexion with investigations respecting changes in the vertical, it is not necessary in ordinary seismometry.

A type of instrument which has sufficient sensibility to record the various phases of unfelt earthquake motion, and which, at the suggestion of a committee of the British Association, has been adopted at many observatories throughout the world, is shown in Fig. 8. With an adjustment to give a 15-second period, a deflexion of 1 mm. at the outer end of the boom corresponds to a tilting of the bed-plate of $0''\cdot5$, or 1 inch in 6·4 miles. The record is obtained by the light from a small lamp reflected downwards by a mirror so as to pass through a slit in a small plate attached to the outer end of the boom. The short streak of light thus obtained moves with the movement of the boom over a second slit perpendicular to the first and made in the lid of a box containing clockwork driving a band of bromide paper. With this arrangement of crossed slits a spot of light impinges on the photographic surface and, when the boom is steady, gives a sharp line line. The passage of the long hand of a watch across the end of the slit every hour cuts off the light, and gives hour

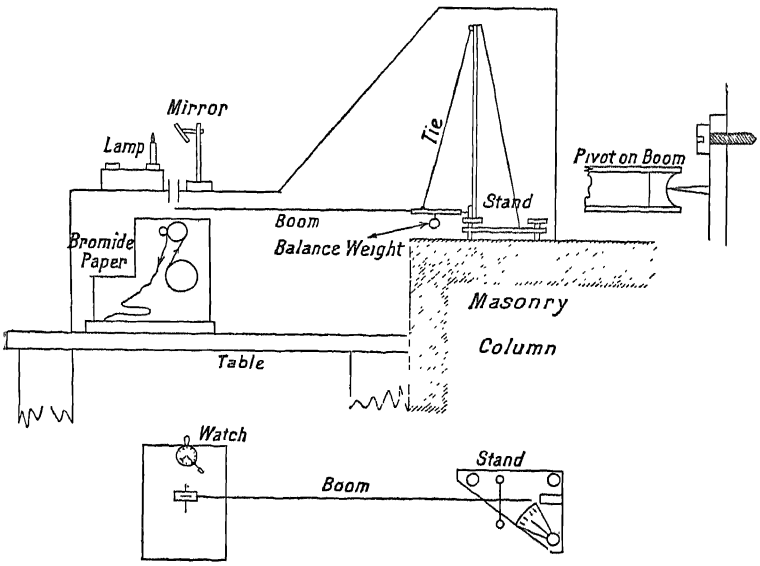


Fig. 8.

marks enabling the observer to learn the time at which a disturbance has taken place. The chief function of the instrument is to measure slow displacements due to distant earthquakes. For local earthquakes it will move relatively to the pivoted balance weight like an ordinary bracket seismograph, and for very rapid motion it gives seismoscopic indications of slight tremors due to the switching of the outer end of the boom, which is necessarily somewhat flexible. If we wish to obtain mechanical registration from a horizontal pendulum of the above type, we may minimize the effect of the friction of the writing index—say a glass fibre touching the smoked surface of moderately smooth paper—by using a considerable weight and placing it near to the outer end of the boom. In the Isle of Wight there is a pair of pendulums arranged as in Fig. 5. The stand is 3 feet in height. Weights of 10 ℔ each are carried at a distance of 10 inches from the pivots of booms which have a total length of 34 inches. With these, or even with booms half the above length, actuating indices arranged as shown in Fig. 2, but multiplying the motion six or seven times, good results may be obtained. At Rocca di Papa near Rome there is a pair of horizontal pendulums with booms 8 feet 9 inches in length, 17 feet in vertical height, which carry near their outer ends weights exceeding half a hundredweight. Although such apparatus is far too cumbersome to be used by ordinary observers, it yields valuable results.

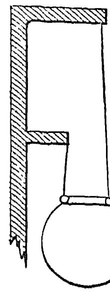

Fig. 9.

An apparatus of great value in measuring slight changes in the vertical which have a bearing upon seismometrical observation is the Darwin bifilar pendulum. This consists of a mirror about half an inch in diameter, which, when it is suspended as shown in Fig. 9, rotates by tilting at right angles to the paper. By this rotation a beam of light reflected from the surface suffers displacement. It is possible to adjust the apparatus so that a tilt of $\frac{1}{1000}$ sec. of arc, or a change of slope of 1 inch in 1000 miles, can be detected.

***Character of earthquake motion.***

The introduction of these new methods into seismometry quickly revolutionized our ideas respecting the character of earthquake motion. Although an earthquake may be strongly felt within a distance of 50 miles from its origin, and although the movements in the upper storeys of buildings within the shaken area may be large, the actual range of the horizontal motion of the ground is usually less than $\frac{1}{10}$ of an inch. With such earthquakes ordinary seismographs for recording vertical motion do not show any disturbance. When the movement reaches $\frac{1}{2}$ inch it becomes dangerous, and a back-and-forth movement of an inch is usually accompanied by destructive effects. In this latter case the amplitude of the vertical record which indicates the existence of surface waves will vary between $\frac{1}{2}$ and $\frac{1}{100}$ of an inch. In the earthquake which devastated Central Japan on 26th October 1891, nearly every building within the epifocal district fell, the ground was fissured, forests slipped down from mountain sides to dam up valleys, whilst the valleys themselves were permanently compressed. The horizontal movements seem to have reached 9 inches or a foot, and the surface undulations were visible to the eye.

***Period and duration.***

The rapidity with which the movements are performed varies throughout a disturbance. A typical earthquake usually commences with minute elastic vibrations, the periods of which vary between $\frac{1}{5}$ and $\frac{1}{20}$ of a second. These are recorded by seismographs, and are noticed by certain of the lower animals like pheasants, which before the occurrence of movement perceptible to human beings scream as if alarmed. When an earthquake is preceded by a sound we have evidence of preliminary tremors even more rapid than those recorded by seismographs. Following these precursors there is a shock or shocks, the period of which will be 1 or 2 seconds. From this climax the movements, although irregular in character, become slower and smaller until finally they are imperceptible. The duration of a small earthquake usually varies from a few seconds to a minute, but large earthquakes, which are accompanied by surface undulations, may be felt for 2 or 3 minutes, whilst an ordinary seismograph indicates a duration of from 6 to 12 minutes. A free horizontal pendulum tells us that with severe earthquakes the ground comes

to rest by a series of more or less rhythmical surgings continuing over 1 or 2 hours. Although the maximum displacement has a definite direction, the successive vibrations are frequently performed in many different azimuths. The predominating direction at a given station in certain instances is apparently at right angles to the strike of the neighbouring strata, this being the direction of easiest yielding.

Earthquake motion as recorded at stations several thousands of miles distant from its origin exhibits characteristics strikingly different from those just described. The precursors now show periods of from 1 to 5 seconds, whilst the largest movements corresponding to the shocks may have periods of from 20 to 40 seconds. The interval of time by which the first tremors have outraced the maximum movement has also become greater. Within a few hundreds of miles from an origin this interval increases steadily, the velocity of propagation of the first movements being about 2 km. per second, whilst that of the latter may be taken at about 1·6 km. per second. Beyond this distance the velocity of transmission of the first movements rapidly increases, and for great distances, as for example from Japan to England, it is higher than we should expect for waves of compression passing through steel or glass. This observation precludes the idea that these preliminary tremors have travelled through the heterogeneous crust of the earth, and since the average velocity of their transmission increases with the length of the path along which they have travelled, and we but rarely obtain certain evidence that a seismograph has been disturbed by waves which have reached it by travelling in opposite directions round the world, we are led to the conclusion that earthquake precursors pass through our earth and not round its surface. The following table relating to earthquakes which originated off the coast of Borneo on 20th and 27th September 1897, is illustrative of the velocities here considered:—

***Velocity.***

| Localities. | Distance from origin in degrees. | Velocity in kms. per sec. if on chord. | $\frac{1}{4}\sqrt{\text{Average depth of chord in kms.}}$ |
|---|---|---|---|
| Nicolaieff . . . . | 81° | 8·1 | 8·0 |
| Potsdam . . . . . | 92° | 8·4 | 9·1 |
| Catania, Ischia, Rocca di Papa, Rome . . . | 96° | 9·0 | 9·5 |
| Isle of Wight . . . | 103° | 9·8 | 10·2 |

The chords referred to here are those joining the earthquake origins and distant observing stations, and it will be noted that one-quarter of the square root of the average depths at which these run closely corresponds to observed average velocities if wave paths followed chords. This increase of velocity with average depth shows that the paths followed through the earth must be curved with their convexity towards the centre of the earth. These observations do not directly tell us to what extent a true wave path is deflected from the direction of a chord, but they suggest as an extremely plausible assumption that the square of the speed is a linear function of the depth below the surface of the earth. With this assumption Dr C. G. Knott shows that the square of the speed ($v^2$) can be expressed linearly in terms of the average depth of the chord $d$, thus: $v^2 = 2{\cdot}9 + {\cdot}026\ d$, the units being miles and seconds. The formula applies with fair accuracy to moderate and high values of $d$, but it gives too high a value for short chords. It follows that the square of the speed increases 0·9 per cent. per mile of descent in the earth. The conclusion we arrive at is that the preliminary tremors which pass through the earth do so in the vicinity of their origin at the rate of almost 2·3 km. per second. This velocity increases as the wave path plunges downwards, attaining in the central regions a velocity of 16 to 17 kms., whilst the highest average velocity which is across a diameter lies between 10 and 12 kms. per second.

The large surface waves radiating from an origin to a distant place have velocities lying between 1·6 and 4 kms. per second, and it has been observed that when the higher velocity has been noted this refers to an observation at a station very remote from the origin. One explanation of this is the assumption that only very large waves indicating a large initial disturbance are capable of travelling to great distances, and, as pointed out by Mr R. D. Oldham, large waves under the influence of gravity will travel faster than small waves. These waves (which may be gravitational or distortional) are recorded as slow tiltings of the ground measured by angles of 0·5 to 10 or 15 seconds of arc, or as horizontal displacements of 0·5 or several millimetres. Their calculated lengths have reached 50 kms. (31 miles).

***Frequency.***

In the section of this article relating to the cause of earthquakes a little has been said about their frequency or the number of times these phenomena are repeated during a given interval of time. It has been shown that all countries are very often moved by earthquakes which have originated at great distances. Great Britain, for example, is crossed about 100 times a year by earthquake waves having durations of from 3 minutes to 3 hours, whilst the vibratory motions which originate in that country are not only small but of rare occurrence. In the earlier stages of the world's history, because the contraction of its nucleus was more rapid than it is at present, it is commonly inferred that phenomena accompanying bradyseismical activity must have been more pronounced and have shown themselves upon a grander scale than they do at the present time. Now, although the records of our rocks only carry us back over a certain portion of this history, they certainly represent an interval of time sufficiently long to furnish some evidence of such enfeeblement if it ever existed. So far from this being the case, however, we meet with distinct evidences in the later chapters of geological history of plutonic awakenings much more violent than those recorded at its commencement. During Palæozoic times many mountain ranges were formed, and accompanying these orogenic processes there was marked volcanic activity. In the succeeding Secondary period plutonic forces were quiescent, but during the formation of the early Tertiaries, when some of the largest mountain ranges were created, they awoke with a vigour greater than had ever been previously exhibited. At this period it is not improbable that Scotland was as remarkable for its volcanoes and its earthquakes as Japan is at the present day. If the statement relating to the general decrease in bradyseismical changes referred merely to their frequency, and omitted reference to their magnitude, the views of the geologist and physicist might harmonize. One explanation for this divergence of opinion may rest on the fact that too little attention has been directed to all the conditions which accompany the adaptation of the earth's crust to its shrinking nucleus. As the latter grows smaller the puckerings and foldings of the former should grow larger. Each succeeding geological epoch should be characterized by mountain formations more stupendous than those which preceded them, whilst the fracturing, dislocation, caving-in of ill-supported regions, and creation of lines of freedom for the exhibition of volcanic activity which would accompany these changes, would grow in magnitude. The written records of many countries reflect but on a smaller scale the crystallized records in their hills. In 1844, at Comrie, in Perthshire, as many as twelve earthquakes were recorded in a

single month, whilst now there are but one or two per year. Earthquake frequency varies with time. A district under the influence of hypogenic activities reaches a condition of seismic strain which usually is relieved rapidly at first, but subsequently more slowly.

The small shocks which follow an initial large disturbance are known as after-shocks. The first shock which in 1891 devastated Central Japan was accompanied by the formation of a large fault, and the 3364 small shocks which succeeded this during the following two years are regarded as due to intermittent settlements of disjointed material. The decreasing frequency with which after-shocks occur may be represented by a curve. Dr F. Omori points out that the continuation of such a curve gives the means of determining the length of time which will probably elapse before the region to which it refers will return to the same seismic quiescence that it had prior to the initial disturbance.

***Periodicity.*** The positive results that we have respecting the periodicity of earthquakes are but few. Generally earthquakes are somewhat more frequent during winter than during summer, and this applies to both the northern and southern hemispheres. This annual periodicity, which, however, does not show itself if only destructive earthquakes are considered, finds an explanation, according to Dr Knott, in the annual periodicity of long-continued stresses, as for example those due to the accumulation of snow and to barometric gradients. For certain earthquake regions there appears to be a distinct semi-annual period for which no satisfactory explanation has yet been adduced. Although the elaborate registers of Japan, which have enabled us to group earthquakes according to their respective origins and varying intensities, and to separate after-shocks from initial disturbances, have been subjected by Dr Knott to most careful analysis, with the object of discovering periodicities connected with the ebb and flow of the tides, the lunar day or lunar months, nothing of marked character has been found. Certainly there is slight evidence of a periodicity connected with the times of conjunction and opposition of the sun and moon, and a maximum frequency near the time of perigee, but the effect of lunar stresses is comparatively insignificant. Ordinary earthquakes, and especially after-shocks, show a diurnal period, but we cannot say that there are more earthquakes during the night than during the day.

***Magnetic phenomena.*** Many experiments and investigations have been made to determine a possible relationship between earthquakes and electrical phenomena, but beyond drawing attention to the fact that luminous appearances may accompany the friction of moving masses of rock, and that a temporary current may be established in a line by the disturbance of an earth plate, these inquiries have yielded but little of importance. The inquiries respecting a possible relationship between adjustments so frequently taking place within and beneath that region called the crust of the earth and magnetic phenomena are, however, of a more promising nature. We have seen that at or near the origin of earthquakes which for several hours disturb continents, and occasionally cause oceans to oscillate for longer periods, we sometimes have direct evidence of the bodily displacement of many cubic miles of material. When this material is volcanic it is almost invariably magnetic, and we perceive in its sudden rearrangement causes which should produce magnetic effects within an epifocal district. In Japan, where attention is being directed to phenomena of this description, not only have such effects been observed, but unusual magnetic disturbances have been noted prior to the occurrence of large earthquakes. These may, of course, be regarded as mere coincidences, but when we consider volcanic and seismic activities as evidences of physical and chemical changes, together with mechanical displacements of a magnetic magma, it is reasonable to suppose that they should have at least a local influence upon magnetic needles. Another form of disturbance to which magnetic needles are subjected is that which accompanies the passage of large earth-waves beneath certain observatories situated at great distances from earthquake origins. At Utrecht, Potsdam, and Wilhelmshaven the magnetographs are frequently disturbed by seismic waves, whilst at many other European observatories such effects are absent or only barely appreciable. To explain these marked differences in the behaviour of magnetic needles at different stations we are at present only in a position to formulate hypotheses. They may be due to the fact that different needles have different periodic times of oscillation; it is possible that at one observatory the mechanical movements of the ground are much greater than at others; we may speculate on the existence of materials beneath and around various observatories which are different in their magnetic characters; and, lastly, we may picture a crust of varying thickness, which from time to time is caused to rise and fall upon a magnetic magma, the places nearest to this being the most disturbed.

***Effects on the human mind.*** A subject to which but little attention has hitherto been directed is the effect which displays of seismic and volcanic activities have had upon the human mind. The effects are distinctly dual and opposite in character. In countries like England, where earthquakes are seldom experienced, the prevailing idea is that they are associated with all that is baneful. For certain earthquakes, which fortunately are less than 1 per cent. of those which are annually recorded, this is partially true. A disastrous shock may unnerve a whole community. Many become hysterical, and all are seized with terror, behaving for a time as if they have lost their reason. While the shakings continue, the "Ora pro nobis," or its equivalent, will be heard on many sides. Effects of this nature, however, differ in a marked manner with different nationalities. After the shock of 1891, when Japan lost 9960 of its inhabitants, amongst the wounded indications of mental excitement were shown in spinal and other trouble. The cases of tetanus which were found may be attributed to contamination of open sores. Those who had escaped unhurt and were living in ruined buildings, on hearing the sounds which preceded very many hundreds of after-shocks, and realizing the possibility of a repetition of what had gone before, simply rushed for the open, to return a minute or so later laughing and joking at the continued recurrence of so many false alarms. Notwithstanding the lightheartedness of this particular nation, it is difficult to imagine that the long series of seismic effects chronicled in Japanese history, which culminated in 1896 in the loss of 29,000 lives by sea-waves, has been without some effect upon its mental and moral character. Several earthquakes are annually commemorated by special services at temples. In bygone times governments have recognized earthquakes as visitations of an angry deity, whom they have endeavoured to appease by repealing stringent laws and taxes. In other countries the sermons which have been preached to show that the tremblings of the world were visitations consequent on impiety, and the prayers which have been formulated to ward off disasters in the future, far exceed in number the earthquakes which gave rise to them. In 1755 many of the English clergy held the view that Lisbon was destroyed because its inhabitants were Catholics, whilst the survivors from that disaster attributed their misfortune to the fact that they

had tolerated a few Protestant heretics in their midst. To avoid a recurrence of disaster certain of these were baptized by force. In the myths relating to underground monsters and personages that are said to be the cause of earthquakes we see the direct effects which exhibitions of seismic and volcanic activity have produced upon the imagination. The beliefs, or more properly, perhaps, the poetical fancies thus engendered have exhibited themselves in various forms. Beneath Japan there is said to be a catfish, which in other countries is replaced by a mole, a hog, an elephant, or other living creature, which when it is restless shakes the globe. The Kamchadales picture a subterranean deity called Tuil, who in Scandinavian mythology is represented by the evil genius Loki. To come still nearer home, we have only to think of the reference in the Decalogue forbidding the making of graven images of that which is in the earth beneath, to see in early Biblical history evidence of a subterranean mythology. It cannot be positively stated how this arose, but it seems probable that the same causes which led to the creation of Pluto, Vulcan, and Poseidon gave rise to practices condemned by Moses. The marked effect which these imaginary deities and creatures have had upon the literature and the pictorial and other arts of many nations hardly requires comment. The mental effects which accompany and follow small earthquakes may be compared to those we pay for when we ride upon a switchback. When an earthquake commences there is perhaps a little anxiety as to what may happen next, but when it is over the imagination is excited as to its cause, and there is a feeling of satisfaction that a new sensation has been experienced. Small earth-shiverings have often thawed the formalities of a dinner-party, and made strangers in hotels acquainted with each other.

***Building to withstand earthquakes.***

Perhaps the greatest practical benefits derived during the last few years from seismological investigations relate to important changes and new principles which have been introduced into the arts of the engineer and builder when constructing in earthquake countries. The new rules and formulæ, rather than being theoretical deductions from hypotheses, are the outcome of observation and experiment. True measures of earthquake motion have been given to us by modern seismometers, with the result that seismic destructivity can be accurately expressed in mechanical units. From observation we now know the greatest acceleration and maximum velocity of an earth particle likely to be encountered; and these are measures of the destructivity. The engineer is therefore dealing with known forces, and he has to bear in mind that these are chiefly applied in a horizontal direction. A formula connecting the acceleration requisite to overturn bodies of different dimensions has been given. The acceleration which will fracture or shatter a column firmly fixed at its foundation to the moving earth may be expressed as follows:—

$$a = \frac{1}{6} \cdot \frac{g\text{FAB}}{fw},$$

where

$a$ = the acceleration per sec. per sec.

F = the force of cohesion, or force per unit surface, which when gradually applied produces fracture.

A = area of base fractured.

B = thickness of the column.

$f$ = height of centre of gravity of column above the fractured base.

$w$ = the weight of the portion broken off.

With this formula and its derivatives we are enabled to state the height to which a wall, for example, may be built capable of resisting any assumed acceleration. Experience has shown that yielding first shows itself at the base of a pier, a wall, or a building, and it is therefore clear that the lower portion of such structures should be of greater dimensions or stronger than that above. Piers having these increased dimensions below, and tapering upwards in a proper manner, so that every horizontal section is sufficiently strong to resist the effects of the inertia of its superstructure, are employed to carry railways in Japan. In that country cast-iron piers are things of the past, whilst piers of masonry, together with their foundations, no longer follow the rules of ordinary engineering practice.

After flood, fire, earthquake, or when opportunity presents itself, changes are introduced in the construction of ordinary buildings. In a so-called earthquake-proof house, although externally it is similar to other dwellings, we find rafters running from the ridge pole to the floor sills, an exceedingly light roof, iron straps and sockets replacing mortices and tenons, and many other departures from ordinary rules. Masonry arches for bridges or arched openings in walls (unless protected by lintels), heavy gables, ornamental copings, cappings for chimneys, have by their repeated failure shown that they are undesirable features for construction in earthquake countries. As sites for buildings it is well to avoid soft ground, on which the movement is always greater than on hard ground. Excessive movement also takes place along the face of unsupported openings, and for this reason the edges of scarps, bluffs, cuttings, and river banks are localities to be avoided. In short, the rules and precautions which have to be recognized so as to avoid or mitigate the effects of earthquake movement are so numerous that students of engineering and architecture in Japan receive a special course of lectures on this subject. When it is remembered that a large earthquake may entail a loss of life greater than that which takes place in many wars, and that for the reconstruction of ordinary buildings, factories, and public works an expenditure of several million pounds sterling is required, the importance of these studies cannot be overrated. Severe earthquakes are fortunately unknown in the British Isles, but we have simply to turn our eyes to earthquake-shaken colonies and lands in close commercial touch with Great Britain to realize the importance of mitigating such disasters as much as possible, and any endeavour to obviate the wholesale destruction of life should appeal to the civilized communities of the world.

***Applications of seismometry.***

An unexpected application of seismometry has been to record the vibration of railway trains, bridges, and steamships. An instrument of suitable construction will give records of the more or less violent jolting and vibratory movements of a train, and so localize irregularities due to changes in the character of ballast and sleepers, to variation in gauge, &c. An instrument placed on a locomotive throws considerable light upon the effects due to the methods of balancing the wheels, and by alterations in this respect a saving of fuel of from 1 to 5 lb of coal per mile per locomotive has sometimes been effected.

By mapping the centres from which earthquakes originate off the coast of Japan, we have not only determined districts where geological activity is pronounced, but have placed before the cable engineer well-defined localities which it is advisable to avoid; and in the records of unfelt earthquakes which originate far from land similar information is being collected for the deeper parts of the oceans. Occasionally these records have almost immediately made clear the cause of a cable failure. From lack of such information in 1888, when three cables

connecting Australia with the outer world were simultaneously broken, the sudden isolation was regarded as a possible operation of war, and the colonists called out their naval and military reserves. Records of earthquakes originating at great distances have also frequently enabled us to anticipate, to correct, to extend, or to disprove telegraphic accounts of the disasters. Whatever information a seismogram may give is certain, whilst the information gathered from telegrams may in the process of transit become exaggerated or minimized. Otherwise unaccountable disturbances in records from magnetographs, barographs, and other instruments employed in observatories, are frequently explained by reference to the traces yielded by seismometers. Perhaps the greatest triumph in seismological investigation has been the determination of the varying rates at which motion is propagated through the world. These measurements have already thrown new light upon its effective rigidity, and if we assume that the density of the earth increases uniformly from its surface towards its centre, so that its mean density is 5·5, then, according to Knott, the coefficient of elasticity which governs the transmission of preliminary tremors of an earthquake increases at a rate of nearly 1·2 per cent. per mile of descent. These, then, are a few of the results which seismologists have attained, and considering how much has been accomplished during the last few years, we may surely claim for the study of the changes in progress within the planet on which we live as much attention as is devoted to the study of the ocean, the atmosphere, and the stars.

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**East Africa, British.**—British East Africa, in its widest sense, includes all the territory placed under British influence on the eastern side of the continent between the latitudes, roughly speaking, of 6½° S. and 10° N. It is bounded on the S. by German East Africa, on the W. by the Congo State, and on the N., where its limits are still in part undefined, by the Egyptian Sudan, Abyssinia, and Italian Somaliland. The total area is estimated at about 670,000 square miles. Administratively it comprises the protectorates of Zanzibar (consisting of the islands of Zanzibar and Pemba), British East Africa, and Uganda. Apart from a narrow belt of lowlands along the coast, the mainland area, which extends from the Umba river in the south to the Juba in the north, belongs almost entirely to the great lake plateau of East Africa, rarely falling below an elevation of 2000 feet, while extensive sections rise to a height of 6000–8000 feet. The primary surface features run generally in zones from north to south. From the coast lowlands a series of steps with intervening plateaux leads to a broad zone of high ground remarkable for the abundant traces of volcanic action. This broad upland is furrowed by the great East African "rift-valley," formed by the subsidence of its floor, and occupied in parts by lakes without outlet. Towards the west a basin of lower elevation is partially occupied by Victoria Nyanza, drained north to the Nile, while still farther inland the ground again rises to a second volcanic belt, culminating in Mount Ruwenzori (18,000 feet), and traversed by a line of depression occupied by Lakes Albert Edward and Albert, the Western Nile reservoirs. The western boundary of British East Africa is mainly formed, beyond the western rift-valley, by the crest of the watershed between the Nile and Congo basins.

*Coast Zone and Eastern Plateaux.*—The first of the parallel zones—the coast plain or "Temborari"—is generally of insignificant width, varying from 2 to 10 miles, except in the valleys of the main rivers. It consists largely of coral rock partially covered with deposits of alluvium or sand, the latter forming ridges sometimes 400 feet high. The shore line is broken by bays and branching creeks, often cutting off islands from the mainland. Such are Mvita or Mombasa in 4° 5′ S., and the larger islands of Lamu, Manda, and Patta, between 20° 20′ and 2°. Farther north the coast becomes straighter, with the one indentation of Port Durnford in 1° 10′ S., but skirted seawards by a row of small islands. The northern interior east of the rift-valley is still little known, and a detailed description must therefore be confined to the more southern parts. Beyond the coast plain the country rises in a generally well-defined step or steps to an altitude of some 800 feet, forming the wide level plain of the "Nyika" (uplands), largely composed of quartz. In the south this zone has a width of some 80 miles, but it widens out northwards, and seems to occupy a large part of the northern interior. The next stage in the ascent is marked by an intermittent line of mountains—gneissose or schistose—running generally north-north-west, sometimes in parallel chains, and representing the primitive axis of the continent. Their height varies from 5000 to 8000 feet. The principal units are the Bura Mountains in 3¼° to 3½° S., the Julu or Dyulu range between 2¼° and 2¾° S., the Iveti Mountains in 1½° S., and various ranges in the districts of Kikuyu and Ukamba. East of the latter the plateau itself seems to consist of a wide extent of grass. Farther inland wide uplands, largely grass-covered, and known to the inhabitants as Rangatan, extend to the eastern edge of the rift-valley, though varied with cultivated ground and forest, the former especially in Kikuyu, the latter between 0° and 0° 40′ S. The most extensive grassy plains are those of Kapte or Kapote and Athi, between 1° and 2° S. The general altitude of these uplands, the surface of which is largely composed of lava, varies from 5000 to 8000 feet, the highest portion occurring on or near the equator, beyond which the high Laikipia plateau falls gradually to the north. This zone contains the highest elevations in British East Africa, including the volcanic pile of Kenya (17,200 feet), Settima (13,400 feet), and Nandarua (12,900 feet). To the west the fall to the rift-valley is marked by a line of cliffs, of which the best defined portions are the Kikuyu escarpment (800 feet), just south of 1° S.; the Kinangop escarpment, a little north of the same parallel; the Laikipia escarpment, on the equator; and the cliffs of Morongop, a little south of 1° N. In the intervals the descent is often much more gradual.

*Rivers of the East Coast.*—One of the main watersheds of East Africa runs in close proximity to this eastern wall of the rift-valley, separating the basins of inland drainage from the rivers of the east coast, of which the two largest, wholly within British East Africa, are the Sabaki and Tana. The Sabaki rises (as the Athi) in 1° 42′ S., and after flowing north-east for 70 miles across the Kapote and Athi plains, turns south-south-east under the wooded slopes of the Yatta ridge, which shuts in its basin on the east. In 3° S. it turns east, and in its lower course (known as the Sabaki) traverses the sterile quartz-land of the outer plateau. The actual valley is in parts low and flat, covered with forest and scrub, and containing small lakes and backwaters connected with the river in the rains. At this season the stream is deep and strong, and of a turbid yellow colour, but navigation is interrupted by the Lugard falls, about 100 miles from its mouth. Its total length is about 400 miles, but, apart from the numerous small feeders of the upper river, almost the only tributary is the Tzavo, from the

east side of Kilimanjaro, which enters in about 3° S. The Tana is both longer and larger than the Sabaki. One series of its numerous headstreams traverses the Kikuyu plateau north of the Athi, while others flow down the southern and eastern slopes of Kenya, uniting with the former to form the Kiloluma, a rapid stream traversing a broken rocky country, with many falls. Beyond 39° E. no tributary of any importance is known to join the main stream, which flows in a wide curve east and south, its course being very tortuous, the current rapid, and the channel much obstructed by snags. Its width varies, as a general rule, between 100 and 200 yards. The banks are generally low, in part forested and inundated at high water, but away from the river the country appears to consist of dry plains covered with mimosa scrub. Adjoining the Lower Tana are many backwaters, which seem to show that the course has been subject to great changes. In 2° 20′ S. the river again turns east, but during the last 10 miles it flows south-west, parallel to the coast, finally entering the sea across a dangerous bar. Some 20 miles from the mouth the narrow Belasoni canal connects the Tana with the Ozi, the intervening country being deltaic in character, and at high water a discharge takes place in this direction. Observations made at Golbanti by the Rev. W. Ormerod show that the Tana rises twice in the year, being high in June and July and again in November and December, these periods coinciding with the rainy seasons in the Kenya region.

*The Eastern Rift-Valley.*—Coming next to the rift-valley, this, though with a generally level floor, is divided by transverse ridges into a series of basins, each containing a lake without outlet. The southernmost section within British East Africa is formed by the arid Dogilani plains, drained south towards German territory. At their north end rise the extinct volcanos of Suswa (7800 feet) and Longonot (8700), the latter on the ridge dividing off the next basin—that of Lake Naivasha. This is a small fresh-water lake, 6312 feet above the sea, measuring some 13 miles each way. Its basin is closed to the north by the ridge of Mount Buru, beyond which is the basin of the still smaller Lakes Nakuro (5845 feet) and Elmenteita (5860 feet), followed in turn by that of Baringo. This lake (15 miles long by 8 broad, altitude 3300 feet) lies at the north end of the basin, the southern parts being drained north by the Nyuki river, which, however, is lost in a swamp just before reaching Baringo. At the foot of the eastern escarpment, and separated from the Baringo basin by subsidiary ridges, are Lakes Kibibi (4820 feet) and Losuguta (3050 feet). Beyond Baringo the valley is again drained north into Lake Sugota, in 2° N., some 35 miles long, while north of this lies the much larger Lake Rudolf, the valley becoming here somewhat less defined.

*The Western Escarpments and Plateaux.*—On the west of the rift-valley the wall of cliffs is best marked between the equator and 1° S., where it is known as the Mau escarpment, and about 1° N., where the Elgeyo escarpment falls to a longitudinal valley separated from Lake Baringo by the ridge of Kamasia. Opposite Lake Naivasha the total height of the Mau escarpment is some 3000 feet. At the top occurs a vast forest, in great part unexplored. To the south the woods become more open, and the plateau falls towards an open country drained towards the Dogilani plains. On the west the cultivated districts of Sotik and Lumbwa, broken by wooded heights, fall towards Victoria Nyanza. The Mau plateau reaches a height of 9000 feet on the equator, north of which is the somewhat lower Nandi country, well watered and partly forested. In the treeless "red-plain" of Guash Ngishu, abreast of Elgeyo, it again rises to a height of over 8000 feet, and to the west of this is the great mountain mass of Elgon. All these plateaux west of the rift-valley are included in the Uganda Protectorate.

*Climate, Fauna, Flora.*—In its climate and vegetation British East Africa again shows an arrangement of zones parallel to the coast. Close to the sea, where the rainfall is fairly plentiful, the low plain is covered with thick bush. The outer plateaux, especially the "Nyika," have a scanty rainfall, and form arid steppes with a sparse scrub vegetation. The uplands beyond are generally fertile, clothed with rich pastures alternating with cultivated ground and forest, the latter covering a large part of the Mau plateau. Farther west the rainfall increases, and in Uganda and neighbouring countries cultivated land and pasture are varied with luxuriant groves of bananas, which form a chief item in the food of the inhabitants. The higher mountains have a distinct flora, representing the remnants of the flora of a cooler period. Large mammals are plentiful, especially on the drier steppes. They include the elephant (more and more restricted to unfrequented districts), rhinoceros, many kinds of antelope, giraffe, hippopotamus, lion and other carnivora. In many parts the rhinoceros is particularly abundant and dangerous.

*Natives.*—The inhabitants include representatives of various stocks, as the country forms a borderland between the Negro and Hamitic races, and contains many tribes of mixed or doubtful affinities. The Bantu division of the former is represented chiefly in the south, the principal tribes being the Wakamba, Wakikuyu, Wa-Giriama, Wapokomo, Waboni, &c. In the west the Bantu peoples (Waganda, Wanyoro, &c.) have been subject to intruders of Galla stock (Wahuma), who are cattle-rearers, while the subject population practise agriculture. In the north-west—on the Upper Nile—the tribes are more nearly related to the true Negroes, though sometimes placed in a distinct group as "Nilotic." Of Hamitic race are the Masai, a race of cattle-rearers speaking a Nilotic language, who in decreasing numbers occupy the uplands bordering on the eastern rift-valley. Farther north they are represented by the Turkana and other tribes dwelling between Lake Rudolf and the Nile. A section of the Masai, which has adopted the settled life of agriculturists, is known as the Wakwafi. The Galla section of the Hamites is represented, among others, by the Borans of the plains east of Lake Rudolf, while Somalis occur in the coast-lands between the Tana and Juba rivers. Primitive hunting tribes are the Wandorobo in Masailand and scattered tribes of small stature in various parts. The immediate coast-land contains a mixed population of Arab and Hindu immigrants, with representatives of numberless interior tribes. Missions have been at work for many years, both on the coast and in the Uganda region, and increasing numbers of native children are being educated in mission schools.

*Annexation and Administration.*—The Portuguese held posts on the coast during the 16th and 17th centuries, but finally abandoned Mombasa in 1729. The interior was first made known in the middle of the 19th century by the journeys of Krapf, Rebmann, Von der Decken, and others, followed a little later by the great expedition of Speke and Grant to the Upper Nile region. The countries east of Victoria Nyanza (Masailand, &c.) were, however, first traversed throughout their whole extent by Joseph Thomson in 1883–84.[1] When, almost immediately afterwards, Germany secured a footing on the coast opposite Zanzibar, a British claim, ratified by an agreement with Germany in 1886, was made to the districts behind Mombasa, the administration of the coast towns being ceded by the sultan of Zanzibar. In 1888 the British East Africa Company obtained a charter placing the government of the territory in its hands, but, after doing much to open up the country, and securing Uganda for Great Britain, was forced by lack of resources to make over its rights to the British Government (1895). Uganda was then declared a British protectorate, and in 1896 the districts between the latter and the coast were formally taken over by the Foreign Office as the British East Africa Protectorate. The islands of Zanzibar and Pemba had been taken over in 1890 by agreement with Germany.

*British East Africa Protectorate.*—The British East Africa Protectorate, which, roughly speaking, extends to the rift-valley, has been divided into the four provinces of Seyyidieh (the coast province, capital Mombasa), Ukamba (capital Nairobi), Tanaland (capital Lamu), and Jubaland (capital Kismayu), each being in turn divided into districts and subdistricts. These are—in Seyyidieh, districts: Vanga, Mombasa, and Melindi; subdistricts, Rabai and Takaungu. In Ukamba, districts: Teita, Kitui, Masailand, Ulu, and Kenya; subdistricts, Kikumbului and Taveta. In Tanaland, districts: Lamu, Port Durnford, and Tana river. In Jubaland, districts: Upper and Lower Jubaland. The area (apart from the northward extension not yet organized or under control) is estimated at 80,000 square miles, and population 2,500,000, including 25,000 Asiatics and 450 Europeans and Eurasians. The revenue

[1] For further details on exploration, see AFRICA.

for 1897–98 amounted to £43,481; for 1898–99, to £69,400; and for 1899–1900 was estimated at from £75,000 to £80,000. The capital of the protectorate is Mombasa, which is also the largest town (population, 27,000). It has two excellent harbours, one on each side of the island of Mvita or Mombasa, on the eastern side of which the town is placed. The harbour on the south-west side is known as Port Kilindini, and here, on the west side of the island, is the terminus of the Uganda Railway, with a pier and other works. On the mainland, nearly opposite Mombasa town, is the settlement of freed slaves called Freretown, after Sir Bartle Frere. The second largest town is Lamu, on the island of the same name, besides which the most important are Melindi, Patta, Kipini, Port Durnford, and Kismayu. Much has been done to open up the country by means of roads, including a trunk road from Mombasa by Kibwezi in the upper Sabaki basin and Lake Naivasha to Berkeley Bay on Victoria Nyanza. But the most important work taken in hand is the construction of a railway from Mombasa to that lake, for which a survey was executed in 1892, and on which work was commenced in 1896. The line chosen roughly coincides with that of the road just mentioned, until the equator is reached, after which it will strike by a more direct route across the Mau plateau to Lake Victoria, which it will reach at Port Florence on Kavirondo Bay; total length, 582 miles. The most serious difficulty has been the descent of the escarpment of Kikuyu to the rift-valley, which has necessitated the most skilful engineering. The total length of the line constructed up to April 1901 was 488 miles.

*Resources and Commerce.*—The resources of British East Africa are still little developed. The coast-lands, however, contain much fertile soil suitable for the cultivation of cotton, jute, the cocoanut, oil-seeds, fibres, &c., while the jungle products include rubber, copal, orchilla, &c. The grassy uplands of the interior are eminently suited for cattle-rearing, and at the higher elevations European crops might be grown with success. The comparative healthiness of these plateaux might possibly allow of their settlement by white men. The imports, which in 1897–98 reached a total of about 4½ million rupees, and in 1898–99 about 7 millions, were valued at 6,642,000 rupees in 1899–1900; the exports, which in the former two years were little over 1 million rupees, in 1899–1900 rose to 1,825,000. The chief articles imported are piece and trade goods, rice, grain, and flour, while the exports consist principally of ivory (which showed a large increase in 1899–1900), rubber, hides and horns, and grains. Shipping entered, in 1897–98, to the extent of 196,630 tons; in 1898–99, 321,440 tons; in 1899–1900, 332,882 tons.

See also UGANDA, ZANZIBAR.

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(E. HE.)

**East Africa, German,** occupying the east centre of the African continent, was acquired for Germany by treaties which Dr Peters, Graf Pfeil, and Dr Jühlke concluded with a number of chiefs in November and December 1887. An imperial charter was granted on the 27th of February 1885, and on the 28th of October 1890 the sultan of Zanzibar ceded his suzerainty over the coast and the island of Mafia to the German emperor. The protectorate extends from 1° S. lat. to 11° S. lat. and 30° to 40° E. long. On the E. it is bounded by the Indian Ocean, on the N.E. and N. by British East Africa. The boundary line runs from the mouth of the Umbe river to Lake Jipe and Mount Kilimanjaro, including both in the protectorate, and thence to Victoria Nyanza, crossing it on 1° S. lat., which parallel it follows till it reaches 30° E. long. On the 1st of July 1890 it was stipulated that this line should be subject to an alteration in case it included Mount Mfumbiro, which was to fall into the British sphere of influence. In the west it is separated from the Congo Free State as follows, according to the agreement of 1st to 25th August 1885. From the point of intersection of 1° S. lat. and 30° E. long., nearly straight to the north end of Lake Tanganyika, along the middle line of the lake to where this is intersected by the south boundary line of the Congo Free State in about 8° 30′ S. lat. In November 1900 a disputed boundary on Lake Kivu was decided by the King of the Belgians in favour of Germany. The agreement of 30th July 1890 arranged the boundary between Lakes Tanganyika and Nyasa as follows. From Tanganyika along the river Kilamba to the junction of its two arms; thence in a line which is not fixed with absolute precision to the point where 35° E. long. intersects the river Songwe, which it follows to the lake. Round the northern end it follows the shore of the lake, which it leaves on that degree of S. lat. on which the river Msinge enters the Rovuma; joining these two points, it follows the latter river to the Indian Ocean, according to the agreement between Portugal and Germany of 30th December 1886. These boundaries include an area of about 385,000 square miles, with a population roughly estimated at 3,000,000 to 8,000,000.

*Physical Features.*—The coast of German East Africa is chiefly composed of coral, and is generally low, partly sandy, partly covered with bush or mangroves. Only where the Arabs have established settlements the cocoa-palm and mango tree introduced by them give character to the vegetation. The coast, though little indented, has several good harbours, amongst them Tanga (5000), Dar-es-Salaam (13,000), Kilwa (10,000), Kisiwani, Lindi, Mikindani, Bagamoyo (13,000). The littoral plain is from 10 to 30 miles wide and 620 miles long; it is bordered on the west by the precipitous eastern side of the interior plateau of Central Africa. As a whole this plateau, considerably tilted from its horizontal position, attains its highest elevation north of Lake Nyasa, where several peaks rise to 8000 feet, one to 9000, while its mean altitude is about 3000 to 4000 feet. From this region the country slopes gently towards the north-west, and is not distinguished by any considerable mountain ranges. A deep narrow gorge, the so-called "rift-valley," traverses the middle of the plateau in a meridional direction. In the northern part of the country it spreads into several side valleys, from one of which rises the extinct volcano Mount Kilimanjaro (19,200 feet), the highest mountain in all Africa. Its glacier sends down a thousand rills which combine to form the Pangani river. East of Mount Kilimanjaro are the Paré Mountains, separated from the coast only by a comparatively narrow strip of plain. The Pangani is navigable for 12 to 18 miles, the Rufiji for more than 60 miles from the coast, and its tributary, the Ulanga, for a much greater distance. The Wami and Kingani spring from the plateau border and the mountains fringing it; only the latter river has been ascended by a steam launch. The Rovuma, though broader than the other rivers, is very shallow, so that all attempts at navigation have proved failures. West of the rift-valley the plateau sends its water through the Malagarazi to Lake Tanganyika and thence to the Atlantic, through the Kagera and other smaller rivers to Lake Victoria and the Nile. Lake Nyasa in the southern part of the country and Lake Tanganyika fill the deepest part of the Central African rift-valley. Several smaller lakes occur in parts of the eastern rift. Lake Rikwa is presumably only the remnant of a huge swamp, the extent of which varies with the rainfall of each year. Lake Victoria, the largest of all African lakes, is the reservoir which gives rise to the Nile.

*Meteorology.*—The climate derives its chief characteristic from the monsoons. On the coast the south-east monsoon sets in in April,

and the north-east monsoon in November. In the interior April brings south-east winds, which continue until about the beginning of October. During the rest of the year changing winds prevail. These winds are charged with moisture, which they part with on ascending the precipitous side of the plateau. The heat, though scarcely greater here than in the interior, is sometimes oppressive. Rain comes with the south-east monsoon, and on the northern part of the coast the rainy season is divided into two parts, the great and the little Masika: the former falls in the months of September, October, November; the latter in February and March. In the interior the climate has a more continental character, and is subject to considerable changes of temperature; the rainy season sets in a little earlier the farther west and north we proceed, and is well marked, the rain beginning in November and ending in April; the rest of the year is dry. On the highest parts of the plateau the climate is almost European, the nights being sometimes exceedingly cold. Kilimanjaro has a climate of its own; the west and south sides of the mountain receive the greatest rainfall, while the east and north sides are dry nearly all the year. On a mountain of such height all degrees of temperature are to be met with. Malarial diseases are rather frequent, more so on the coast than farther inland. The Kilimanjaro region is said to enjoy immunity. Smallpox is frequent on the coast, but is diminishing before vaccination; cases of other epidemic diseases are extremely rare.

*Flora and Fauna.*—The character of the vegetation varies with and depends on moisture, temperature, and soil. On the low littoral zone the coast produces a rich tropical bush, in which the mangrove is very prominent. Cocoa-palms and mango trees have been planted in great numbers, and also many varieties of bananas. The bush is grouped in copses on meadows, which produce a coarse tall grass. The river banks are lined with belts of dense forest, in which useful timber occurs. The *Hyphæna* palm is frequent, as well as various kinds of gum-producing mimosas. The slopes of the plateau which face the rain-bringing monsoon are in some places covered with primeval forest, in which timber is plentiful. The silk-cotton tree (*Bombax ceiba*), miomba, tamarisk, copal tree (*Hymenæa courbaril*) are frequent, besides sycamores, banian trees (*Ficus indica*), and the deleb palm (*Borassus æthiopum*). It is here we find the *Landolphia florida*, which yields the best rubber. The plateau is partly grass land without bush and forest, partly steppe covered with mimosa bush, which sometimes is almost impenetrable. Mount Kilimanjaro exhibits on a vertical scale the various forms of vegetation which characterize East Africa (see Kilimanjaro). East Africa is rich in all kinds of antelope, and the elephant, rhinoceros, and hippopotamus are still plentiful in parts. Characteristic are the giraffe, the chimpanzee, and ostrich. Buffaloes and zebras occur in two or three varieties. Lions and leopards sometimes stray down to the coast. Crocodiles are found in all the larger rivers. Snakes, many venomous, are frequent. Of birds there are comparatively few on the steppe, but rivers, lakes, and swamps abound with them. Locusts have often been observed in late years, and ants of various kinds are often a plague. The tsetse fly (*Glossina morsitans*) infests several districts; the sand-flea has been imported by labourers returning from the west coast. Land and water turtles are frequent.

*Ethnography.*—On the coast we find Arab and Indian immigrants, who are agriculturists and merchants. The Waswaheli are a tribe sprung from a mixture of these immigrants with Bantu natives. They are Islamites. In the interior can be distinguished two classes of Bantu negroes; one with a migratory tendency towards the north and an addition of Zulu immigrants, the other with a similar tendency towards southward expansion and an admixture of Hamitic and Nilotic elements. The older groups of Bantu are chiefly agriculturists and live in conical houses, while the others comprise the cattle-raising tribes, who live in square mud-plastered houses called *tembe*, which can be easily fortified and defended. The agriculturists are good labourers, and willingly take service with the whites; they form the great caravans. The cattle-raising tribes are less sociably inclined, and often very warlike. In 1891 the rinderpest brought to the verge of ruin those who, like the Masai, would not adopt agriculture as a means of livelihood.

*Government.*—The coast is divided into six districts (*Bezirksaemter*), Tanga, Pangani, Bagamoyo, Dar-es-Salaam, Kilwa, Mikindani. In the interior there are ten stations (*Stationsbezirke*), Victoria Nyanza, Kilimanjaro, Tabora, Kilimatinde, Mpwapwa, Kilossa, Tanganyika, Langenburg, Ulanga, and Lindi. Each station has a chief, who is subordinate to the official of his district, these in their turn being under the governor, who resides in Dar-es-Salaam. The lieutenant-governor is also commander of the colonial force, consisting (1901) of 1635 regular and 168 irregular coloured soldiers, with 44 commissioned, 110 non-commissioned white officers, 12 coloured non-commissioned officers) and 18 medical officers. There are 61 field-guns. The stations have to maintain communication with the native chiefs, and peace in the interior; they have to introduce as far as possible cultivation of valuable products, and to establish and maintain roads. The district chiefs on the coast administer their districts in the ordinary way, with the assistance of a police force and a regular staff of officials. They have to keep an eye on the suppression of slavery and on the regulation of the supply of labour. They are entrusted with the functions of judges in all cases of litigation between coloured people; in cases involving amounts exceeding 1000 rupees, appeal to the governor is admissible. There are two ordinary judges and one chief justice in the colony; the latter conjointly with the governor presides over a court of appeal.

*Finance.*—The revenue is raised by taxes on imports and exports, on consumption and from licences for the sale of spirituous liquors, and wood-cutting, harbour and other dues, and the natives have to pay a hut tax. Receipts for the sale of lands are also beginning to swell the revenue. The expenditure is for civil and military administration, the small fleet of steamers maintained by the colonial government, and the caravans, which keep up communication with the stations in the interior and supply them with European necessaries. In the budget for 1899–1900 the revenue (including Imperial contribution of 5,985,000 marks) and expenditure balanced at 8,495,000 marks. The Imperial contribution for 1900–1901 was 6,830,000 marks.

*Missions.*—There are ten missionary societies—six German, one French, three English. Three of the ten are Roman Catholic. One of the latter, the *Mission du Sacré Cœur* in Bagamoyo, the oldest mission, has been very successful in training young negroes to be useful mechanics. There are several schools, and the number of young people who can read and write is increasing rapidly. On the coast the inhabitants profess to be Moslems.

*Communications.*—The German East Africa line of Hamburg runs a fleet of first-class steamers to East Africa, which touch at Tanga, Dar-es-Salaam, and Zanzibar. Two steamers go to Bombay once in three weeks; and of other lines, the Messageries Maritimes and British East India Steam Navigation Company call once a month at Zanzibar. Proper roads only exist where constant traffic keeps them open. A railway has been laid from Tanga to Korogwe. Regular postal communication is maintained with the stations in the interior, through native runners, twice a month. There is a submarine cable from Dar-es-Salaam to Zanzibar, and an overland line connecting all the coast stations.

*Production.*—The country is rich in natural products which are found in the forest or cultivated by the natives. The former are chiefly rubber, copal, bark, various kinds of fibres, orseille, timber, pepper, honey; the latter cocoanuts, tobacco, sugar-cane, cotton, vanilla, sorghum, panicillaria, eleusine, arachis, sesame, maize, rice, beans, peas, bananas, batatas and yams, manioc and hemp. Animal products are ivory, hides, tortoiseshell, and pearls. On the plateau in the interior large herds of cattle are reared by the natives, who in the lowlands are chiefly agriculturists. The people have many small native smithies. Useful minerals exist, but are not yet exploited. Coal, iron, graphite, and salt have been found, and gold too, though not in paying quantities.

The imports and exports have been as follows, in marks:—

| | 1888. | 1895. | 1898. |
|---|---|---|---|
| Imports . . | 2,485,163 | 7,629,000 | 16,401,705 |
| Exports . . | 4,270,653 | 3,257,584 | 5,995,930 |

The chief exports were ivory, rubber, sesame, and gum.

No sooner was German East Africa annexed than companies were formed for the purpose of exploiting the country by trading, planting, and mining. The first was the Deutsch Oestafricanische Gesellschaft, founded in 1885, which now owns large capital, has trading stations in each seaport, and seven flourishing plantations in various parts of the country. It is the owner of vast tracts of land, which in time are expected to become extremely valuable. No fewer than forty trading companies have been established since then, and all are in a more or less thriving condition; a comparatively large number of private individuals have laid out plantations, from which they are beginning to derive a considerable return. Coffee and tobacco are the chief products, and thrive so well in the northern parts of the littoral zone of the protectorate, that Usambara and Paré have become favourite districts for agricultural enterprise.

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**East Africa, Portuguese,** or **Mozambique,** a province of the East Coast of Africa, belonging to Portugal, stretching 1430 miles along the Indian Ocean, between 10° 40′ and 26° 52′ S. lat.

*Boundaries and Physical Geography.*—By treaties with Germany in 1886 and in 1894, and with Great Britain in 1891, the boundaries are as follow:—On the N. by 10° 40′ S. lat. to the Rovuma, and this river as far as the confluence of the M'Singe, and thence due W. to the E. shore of Lake Nyasa; on the W. along the E. shore of the lake southwards as far as 13° 30′ S. lat., thence S.E. to the E. shore of Lake Shiuta, along this lake and in a straight line from its S. extremity to the E. side of Lake Shiré, down its E. side to the S. end, and straight on to the most E. affluent (M'losa) of the river Ruo, which stream it then follows as far as its confluence with the Shiré. From that point it coincides with the Shiré as far as a point a little below Shiwanga, thence due W. until it intersects the watershed between the Shiré and the Zambezi; then it follows this watershed, and the watershed between the Zambezi and Lake Nyasa as far as 14° S.; after that it turns S.W. and goes to the point where the river Arwangua is cut by 15° S. lat., and thence follows this river to its confluence with the Zambezi. On the S. of the Zambezi the Portuguese boundary strikes from a point opposite the mouth of the Arwangua and goes due S. to 16° S. lat., which it follows as far as 31° E. long., thence E. to the outer section of the river Mazoe and 33° E. long., continues along this meridian to 18° 30′ S. lat., then follows southwards along the upper edge of the Manica plateau as far as the river Save, and follows the course of this river to its confluence with the Lunde. From that point it makes for the N.E. corner of the Transvaal Colony, then goes S. over the Lebombos and Swaziland frontier to the river Maputo, follows this river to the confluence of the Pongolo, and finally runs thence due E. to the Indian Ocean near Oro Point. Portugal at one time claimed almost unlimited areas in the interior of the continent, but by the extension of British enterprise in the south and west, and German enterprise in the north, the limits of the territory have been defined as above.

Orographically the backbone of the province south of the Zambezi is formed by the Lebombo Mountains, which, however, nowhere exceed 2070 ft. in height; the Manica plateau, where Mount Doe rises to 7875 ft. and Mount Panga to 7610 ft.; and the Gorongosa plateau, with Mount Miranga (6550 ft.), Enhatete (6050 ft.), and Gogogo (5900 ft.). The chief mountain range, however, lies north of the Zambezi, namely, the Namuli Mountains, in which Namuli Peak rises to 8860 ft., and Molisani, Mruli, and Mresi attain to altitudes of 6500 to 8000 ft. These mountains are covered with vegetation and have a temperate and healthy climate, a decided contrast to the unhealthy, malaria-haunted lowlands along the coast. At Tete, on the Lower Zambezi, the annual mean temperature is 77°·9 Fahr.; the hottest month being November, 83°·3, and the coldest July, 72°·5. At Quilimane, on the coast, the mean temperature is 85°·1, maximum 106°·7, and minimum 49°·1. The rainy season lasts from December to March, and the dry season from May to September. During the monsoons the districts bordering on the Mozambique Channel enjoy a tolerably even mean temperature of 76°·1, maximum mean 88°·7, and minimum mean 65°·3. Besides the Zambezi, the principal rivers that water the territory are the Limpopo, Save, Pungwe, Lurio, Rovuma, Shiré, and Luia. In 1891 the colony, which used to be known as Mozambique, was designated the State of East Africa, and was divided into a northern and southern province, Mozambique and Lourenço Marques; and further, instead of that division, into the districts of Mozambique, Zambezia, Gaza, and Inhambane, Lourenço Marques forming one province. There is a governor-general, appointed for three years, residing at Lourenço Marques, now the capital. There is a force of 3180 regular troops. The Manica and Sofala regions are administered by the Mozambique Company, which has a royal charter granting sovereign rights for fifty years from 1891. Another company administers the region on the east of Lake Nyasa, and the Companhia da Zambezia holds a concession in the Quilimane, Tete, and Zumbo regions. For 1900–1901 the estimated revenue was 2,838,000 milreis, and expenditure 2,993,000 milreis.

*Products and Trade.*—The chief vegetable products of the low coast region are the cocoanut and various other palms, ironwood (*Casuarina*), indigo, orchil, tobacco, coffee, and several oleaginous plants. The higher zone above the coast-lands abounds in timber trees, as the *mutembate* and the *morepa*, which yield timber similar to teak; cutch and cedra serve as supports for the climbing *m'bungo* (*L*[illegible] *florida*) and calumba (*Jateorhiza palmata*). The [illegible] their attention chiefly to the cultivation of oleaginous crops, *e.g.*, almonds, sesamum, cocoanuts, copra, cashew nuts, and carapa. At Mopeia and other places the sugar-cane is cultivated. In the north of the province, on the Zambezi, and at Inhambane, rice, millet, and beans are grown, also coffee in the two districts last named; indiarubber in Quilimane. Wheat and other cereals grow in the delta of the Zambezi and in the valley of the Busi. Coal exists chiefly in Tete and between the Rovuma, Lujenda, and M'Salu, in Medo, and alongside the Umbelusi; iron is abundant in the Serra Shinga, and is extracted by the Makwas; gold exists in Medo, Mashinga, Missale, and Manica. In Manica the gold-mining country has been taken up mainly by British subjects. Fish are plentiful along the coast, and pearls are fished in the Bazaruto Isles. Spirits, sugar, and pottery are the only commodities manufactured. The imports in 1898 were valued at £19,894,000, exports at £402,400, besides a transit trade, mainly by Beira and Lourenço Marques, of about £2,500,000. The total trade in 1899 was £29,662,500. Lourenço Marques, Beira, and Chinde are the chief ports. The chief exports are oil, seeds, indiarubber, wax, gum, orchil, coffee, tobacco, Indian hemp, manioc, ivory. The imports (£108,670 from Portugal in 1895, £466,000 in 1897) consist principally of wine, with cottons, woollens, linen, silk, preserved foods, flour, ironmongery. Trade is carried on chiefly with Bombay, Marseilles, England, Zanzibar, and Lisbon. The province possesses only two railways, one running from Lourenço Marques to the Transvaal frontier, 57 miles (Ressano Garcia), and so on to Pretoria, and the other from Beira to the frontier of Rhodesia, 222 miles, and to Salisbury. Beira is connected by telegraph with Salisbury, and Lourenço Marques with the Transvaal system, and there are 2661 miles of line.

*Population, &c.*—The area is estimated at 301,000 square miles, and the population at 3,120,000. Of the native races the most important in the north are the Makwas and the Ajaus, both belonging to the Bantu stock. The dominant race between the Zambezi and the Mazoe are the Tavalas, other tribes in the same region being the Maraves, Sengas, Muzimbas, and Muzuzuros. On the south of the Zambezi the ruling race are the Zulu tribe of the Vatwa in Gasa; all other tribes of different stock being known as Tongas. The province forms a bishopric (Mozambique), belonging to the ecclesiastical province of Goa.

The principal towns are as follow:—Mozambique, the old capital, on an island off the coast to the north of the Zambezi; population about 8000. In 1898 it was visited by 416 vessels, of 188,665 tons. Quilimane or Kelimane, at the mouth of a supposed former branch of the Zambezi, which is silting up. Chinde, a new port at the mouth of the Chinde branch of the Zambezi, in which Great Britain has a lease of land for a bonded warehouse; it is connected by telegraph with Blantyre in British Central Africa; population (1898), 1675. Beira, at the mouth of the Pungwe, south of the Zambezi, connected by rail and telegraph with Salisbury in Mashonaland, and an important port for transit trade with the interior; in 1898, 270 vessels, of 434,684 tons, visited the port; population (1898), 4223. Lourenço Marques, on Delagoa Bay, of importance as the terminus of the railway to the Transvaal, with good harbour and excellent anchorage in the bay; in 1898, 505 vessels, of 1,032,543 tons, visited the port; population, 5130. Towns on the Zambezi of little importance are Zumbo, Tete, and Sena.

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**Eastbourne,** a municipal borough (1883) and flourishing watering-place in the Eastbourne parliamentary division of Sussex, England, 65 miles south-south-east of London by rail. The ancient church of St Mary has been restored, and with that there are now eight parish churches, a Roman Catholic and various Nonconformist churches. Recent erections otherwise are the town-hall and municipal buildings, the Princess Alice Memorial Hospital, the children's branch of All Saints' Convalescent Hospital, and a free library. There are also public baths and many high-class schools. The pier has been provided with a handsome pavilion and a new landing stage. Devonshire Park (13 acres) contains a large pavilion and a theatre. Area, 5410 acres. Population (1881), 22,014; (1901), 43,357.

**Easthampton,** a town of Hampshire county, Mass., U.S.A., in the Connecticut valley. It is entered by two railways, and is the seat of Williston Academy. Population (1890), 4395; (1900), 5603, of whom 1731 were foreign-born and 42 negroes.

**East Hartford,** a town of Hartford county, Connecticut, U.S.A., on the Connecticut opposite Hartford, and entered by two railways. Population (1890), 4455; (1900), 6406, of whom 1191 were foreign-born and 78 negroes.

**East Liverpool,** a city of Columbiana county, Ohio, U.S.A., on the Ohio river and on the Pennsylvania railroad, at an altitude of 692 feet. Pottery is the chief manufacture. Population (1880), 5568; (1890), 10,956; (1900), 16,485, of whom 2112 were foreign-born and 219 negroes.

**East London,** a town and seaport of Cape Colony, at the mouth of the Buffalo river, between the Keiskamma and Great Kei estuaries, with a population of about 7000. The harbour is one of the most dangerous on the south coast, and is still often inaccessible for days together, despite the breakwaters and other extensive works that have been constructed to improve the approaches. The bar, which formerly shifted with every storm and freshet, is now fixed, but has seldom more than a depth of 9 or 10 feet at the flow, whereas before the works were carried out it could be crossed by vessels drawing 20 feet of water. Nevertheless East London, being the natural outlet for the rich pasturages of the eastern districts, is the second port in the colony for the shipment of wool. It is the seaward terminus of the railway which runs through Queenstown and Molteno north to the Orange River Colony. The imports, chiefly textiles, hardware, and provisions, were valued at £3,456,000 in 1896, £3,121,000 in 1897, and £3,520,000 in 1898; and the exports (wool, angora hair, hides, and skins) at £851,000, £817,000, and £955,000 for the same years.

**Easton,** capital of Northampton county, Pennsylvania, U.S.A., in 40° 43′ N. lat. and 75° 16′ W. long., at an altitude of 215 feet, at the junction of the Lehigh and Delaware rivers. It is a railway centre of importance, since it is entered by five lines, the Bangor and Portland, the New Jersey Central, the Delaware, Lackawanna, and Western, the Lehigh and Hudson Rivers, and the Lehigh Valley. It is divided into twelve wards. It is the seat of Lafayette College, a Presbyterian institution which in 1899 had a faculty of 28, and was attended by 309 students; its property was valued at nearly $1,000,000, and its income for the year was $40,315. Population (1880), 11,924; (1890), 14,481; (1900), 25,238, of whom 2135 were foreign-born and 325 negroes. The death-rate in 1900 was 16·7.

**East Orange,** a township of Essex county, New Jersey, U.S.A., on branches of the Delaware, Lackawanna, and Western and the Erie Railways, by which it is connected with New York, 12 miles distant. It is a suburban residential town for New York business men. Population (1880), 8349; (1890), 13,282; (1900), 21,506, of whom 3950 were foreign-born and 1420 negroes.

**Eastport,** a city and port of entry of Washington county, Maine, U.S.A., the most easterly point of the United States, on Moose Island, in Passamaquoddy Bay. It has a good harbour, although the rise and fall of the tide is great, 25 feet, and it is connected in summer with Boston and Portland by daily steamers. It has considerable industry in the canning of so-called sardines. Certain of the neighbouring islands in Passamaquoddy Bay are well-known summer resorts, among which are Campo Bello and Grand Manan, on the Canadian side of the boundary. Population (1880), 4006; (1890), 4908; (1900), 5311, of whom 1554 were foreign-born.

**East Portland,** formerly a city of Multnomah county, Oregon, U.S.A., annexed to Portland in 1891, on the east bank of the Willamette river. Population (1880), 2934; (1890), 10,532.

**East Providence,** a town of Providence county, Rhode Island, U.S.A., on the east side of the Providence river, opposite Providence. Within its area of 12½ square miles are several villages, the largest of which bears the same name as the town. A branch of the New York, New Haven, and Hartford railroad crosses the town. Population (1880), 5056; (1890), 8422; (1900), 12,138, of whom 2067 were foreign-born and 369 negroes.

**East St Louis,** a city of St Clair county, Illinois, U.S.A., in 38° 38′ N. lat. and 90° 10′ W. long., on the east bank of the Mississippi, at an altitude of 418 feet. Its site is in the American Bottom, little above the high-water mark of the river. This bottom stretches a long distance up and down the river, with a breadth of 10 or 12 miles. It is intersected by many sloughs and crescent-shaped lakes, which indicate former courses of the river. East St Louis is one of the great railway centres of the country. Into it enter from the east fourteen lines of railway, which cross to St Louis by the celebrated steel arch bridge, designed and built by J. B. Eads, and by the Merchants' Bridge. It has also extensive dockyards. Population (1880), 9185; (1890), 15,169; (1900), 29,655, of whom 3920 were foreign-born and 1799 negroes.

**Eau Claire,** capital of Eau Claire county, Wisconsin, U.S.A., in 44° 51′ N. lat. and 91° 30′ W. long., at the junction of the Eau Claire and Chippewa rivers, at the head of navigation on the latter, at an altitude of 789 feet. It is on branches of the Chicago, Milwaukee, and St Paul, the Chicago, St Paul, Minneapolis, and Omaha, and the Wisconsin Central Railways. It is an important city in the lumber trade, and has many saw and planing mills. Population (1880), 10,119; (1890), 17,415; (1900), 17,517.

**Ebbw Vale,** an urban district in the Western parliamentary division of Monmouthshire, England, 9 miles west-south-west of Abergavenny by rail. There is a library and scientific institute. The district contains large collieries and important iron and steel works. Area of urban district, 6817 acres. Population (1881), 14,700; (1901), 20,993.

**Ebers, Georg** (1837–1898), German Egyptologist and novelist, was born in Berlin on the 1st of March 1837. He was a posthumous child, and was chiefly educated by his mother. The rupture of a blood-vessel, occasioned by a chill caught in returning lightly clad from a ball in the depth of winter, led him to turn his thoughts seriously to study. At Göttingen he studied jurisprudence, and at Berlin Oriental languages and archæology. By the advice of Brugsch and Lepsius he devoted himself mainly to Egyptology. In 1865 he became *docent* in Egyptian language and antiquities at Jena, and in 1870 he was appointed professor in these subjects at Leipzig. He had made two scientific journeys to Egypt, and his first great work, *Egypt and the Books of Moses*, appeared in 1867–68. Having discovered the celebrated medical papyrus which bears his name, he edited it in 1874, and a translation was published in 1890 by H. Joachim. At an early period of his career Ebers conceived the idea of popularizing Egyptian lore through the medium of historical romances. *An Egyptian Princess* was published in 1864, and obtained great success. Ebers's subsequent experiments in the same style—*Uarda* (1877), *The Sisters* (1880), *Serapis* (1885), *Homo Sum* (1887)—were also well received, and deservedly so, for, although not belonging to a very exalted class of literature, they did much to render the discoveries of Egyptologists common property throughout Europe. When this vein was exhausted Ebers turned to ordinary historical fiction, and many of his novels were translated into English and obtained considerable popularity; but his efforts in this department, though not inferior in talent, lacked the special recommendation of his Egyptian romances. He also wrote the life of his old preceptor Lepsius, and an autobiography. The state of his health led him in 1889 to retire on a pension from his chair at Leipzig, without, however, interrupting his literary activity. He died in August 1898.

**Eberswalde,** till 1877 named NEUSTADT-EBERSWALDE, a town of Prussia, 28 miles north-east of Berlin by rail; on the Finow Canal. The town has, besides the school of forestry, a gymnasium, a higher-grade girls' school, and two schools of domestic economy. Population (1890), 16,114; (1900), 21,654.

**Eccles,** a municipal borough (1892) in the Eccles parliamentary division of Lancashire, England, 4 miles west of Manchester by rail. The Manchester Ship Canal passes the town. The chief additions comprise a town-hall, magistrates' court-house, sewage disposal works, town's yard, electric light works, theatre, two recreation grounds (1892), and several open spaces; three Established churches, one Roman Catholic church; and the Wesleyan, Congregational, and Unitarian bodies possess handsome edifices. Eccles wakes, abolished in 1881, are held on private ground. Silk-throwing and the manufacture of fustians and ginghams are among the industries, and there are also large engine works. Area, 2008 acres. Population (1881), 21,850; (1901), 34,369.

**Ecclesfield,** a township in the Hallamshire parliamentary division of Yorkshire, England, 5 miles north of Sheffield by rail. There are remains of a Benedictine priory. The parish church (about 1470) has been restored. Cutlery and tools are largely manufactured, and there are coal-mines, paper mills, and iron and fire-clay works. Area of township, 10,893 acres. Population (1881), 21,156; (1901), 34,153.

**Ecclesiasticus,** or BEN SIRA (Hebrew Fragments).—That the book called in Latin *Ecclesiasticus*, in Greek Σειράχ, and by Jerome *Jesu filii Sirach liber*, was composed in Hebrew was known to Jerome (*d.* A.D. 420), who testified "Hebraicum repperi." Saadiah Gaon (*fl. circ.* A.D. 930) of the Fayyum in the *Sepher haggalui* refers to Ben Sira's work as written in pointed and accented Hebrew. After this all trace of a Hebrew Ecclesiasticus disappeared until Dr S. Schechter identified a loose leaf from Palestine, and published it in the *Expositor* for July 1896. More leaves were soon discovered at Oxford and at Cambridge, in the British Museum, and at Paris. Probably all these leaves came from the cellar (*gĕnīzah*) of the old synagogue at Cairo. The beginning of the book is still missing, but three colophons are preserved. The most ancient of these was attached to chap. l., before the supplementary chap. li. was added to the original book. It runs: *The Instruction of Understanding and the Proverbs fitly spoken of Simeon son of Jeshua son of Eleazar son of Sira. . . . Happy is the man who meditateth on these; and he that layeth them to heart shall be wise: for the fear of Jehovah is life.* From this colophon (and from the *Sepher haggalui*) we learn that the author's name was *Simeon son of Jeshua* (Jesus), though the LXX and Syriac seem to call him *Jesus*. (The writer of the Greek prologue may be wrong in attributing the book he "found" in Egypt to his ancestor Jesus, and not to Simeon, perhaps his uncle.) This ancient colophon also tells us (in agreement with Jerome) that the title of the book was "Proverbs." In Talmudic and Rabbinic literature it is called simply the *Book of Ben Sira*. G. Bickell, Israel Lévi, and D. S. Margoliouth have argued that the Hebrew is only a retranslation from a Version. Most Hebrew scholars, however, believe that though the text has suffered much, especially by the addition of glosses, the fragments as a whole are a survival from the Hebrew original. The following portions have been published in Hebrew: Chaps. iii. 6–xvi. 26 a; [gap]; xxv. 8–xxvi. 2 (text abbreviated); [gap]; xxx. 11–xxxiii. 3; [gap]; xxxv. 9–xxxviii. 27 a; [gap]; xxxix. 15 b–*ad fin.* These fragments were published by S. Schechter and C. Taylor (Cambridge, 1899); E. N. Adler, *J.Q.R.*, April 1900; S. Schechter (*ibid.*); G. Margoliouth, *J.Q.R.*, October 1899; and by A. E. Cowley and A. Neubauer (Oxford, 1897). In addition to these, Isr. Lévi published (*R.E.J.* tom. xl. No. 79) chaps. xxxvi. 24–xxxviii. 1 from a MS. which shows some variations from the text previously published. At the present time four different MSS. are known, of which the largest (called "B" by Schechter-Taylor) contains (with some gaps) chaps. xxx. 11–*ad fin.* A complete edition in collotype facsimile of all the above-mentioned fragments was published jointly by the two University Presses (Oxford and Cambridge, 1901). The Hebrew contains interpolations, but it also preserves original passages missing from the Versions. One of these is a Psalm of 15 verses found between verses 12 and 13 of chap. li. (This passage is doubtless pre-Maccabean, for it gives honourable mention to the priestly House of Zadok, which fell into disrepute during the Maccabean struggle.) The Hebrew often agrees strikingly with the Syriac; when it agrees with the Greek, it is more often with a cursive MS. (H. and P. No. 248[1]) than with the uncials. The English R.V., following the uncials, often disagrees with the Hebrew. "The language is classical Hebrew," wrote Cowley and Neubauer in 1897, "though the vocabulary has an admixture of late or Aramaic words or expressions" (preface, xiii). But the discovery of further fragments made a qualification of this verdict necessary. In 1899 Dr Schechter wrote, "Strained as [Ben Sira's] efforts were in imitating [the Scriptures], he failed in the end"; a tell-

[1] *Ecclesiasticus* is published from this MS. by the Cambridge University Press, under the editorship of Mr J. H. A. Hart, St John's College.

ing list of Rabbinic expressions which follows justifies this judgment (Schechter and Taylor, pp. 33, 34). Ben Sira's book is an echo of books greater than itself. (W. E. B.)

**Echegaray y Eizaguirre, José** (1833– ——), Spanish mathematician, statesman, and dramatist, was born at Madrid in March 1833, and was educated at the grammar school of Murcia, whence he proceeded to the Escuela de Caminos at the capital. His exemplary diligence and unusual mathematical capacity were soon noticed. In 1853 he passed out at the head of the list of engineers, and, after a brief practical experience at Almería and Granada, was appointed professor of pure and applied mathematics in the school where he had lately been a pupil. His *Problemas de geometría analítica* (1865) and *Teorías modernas de la física unidad de las fuerzas materiales* (1867) are said to be esteemed by competent judges. He became a member of the Society of Political Economy, helped to found *La Revista*, and took a prominent part in propagating Free Trade doctrines in the press and on the platform. He was clearly marked out for office, and when the popular movement of 1868 overthrew the monarchy, he resigned his post for a place in the revolutionary cabinet. Between 1867 and 1874 he acted as Minister of Education and of Finance; upon the restoration of the Bourbon dynasty he withdrew from politics, and won a new reputation as a dramatist. As early as 1867 he wrote *La hija natural*, which was rejected, and remained unknown till 1877, when it appeared with the title of *Para tal culpa tal pena*. Another play, *La última noche*, also written in 1867, was produced in 1875; but in the latter year Echegaray was already accepted as the successful author of *El Libro talonario*, played at the Teatro de Apolo on 18th February 1874, under the transparent pseudonym of Jorge Hayaseca. Later in the same year Echegaray won a popular triumph with *La Esposa del vengador*, in which the good and bad qualities—the clever stagecraft and unbridled extravagance—of his later work are clearly noticeable. From 1874 onwards he has written, with varying success, a prodigious number of plays. Among the most favourable specimens of his talent may be mentioned *En el puño de la espada* (1875); *Ó locura ó santidad* (1877), which has been translated into Swedish and Italian; *En el seno de la muerte* (1879), of which there exists an admirable German version by Fastenrath. *El gran Galeoto* (1881), perhaps the best of Echegaray's plays in conception and execution, has been translated into several languages, and still holds the stage. The humorous proverb, *¿ Piensa mal y acertarás ?* exemplifies the author's limitations, but the attempt is interesting as an instance of ambitious versatility. His susceptibility to new ideas is illustrated in such pieces as *El hijo de Don Juan* (1892) and *El loco Dios* (1900): both of these plainly prove a close reading of Ibsen, and *El loco Dios* more especially might be taken for an unintentional parody of Ibsen's symbolism. Confirmatory signs of a new departure are noticeable in *Mariana* (1892), in *Mancha que limpia* (1895), and in many other productions. Echegaray has succeeded to the literary inheritance of López de Ayala and of Tamayo y Baus; and though he possesses neither the poetic imagination of the first nor the instinctive tact of the second, it is impossible to deny that he has reached a larger audience than either. Not merely in Spain, but in every land where Spanish is spoken, and in cities as remote from Madrid as Munich and Stockholm, he has met with an appreciation incomparably beyond that accorded to any other Spanish dramatist of the 19th century. But it would be more than usually rash to prophesy that this exceptional popularity will endure. There have been signs of a reaction in Spain itself. Echegaray applies his mathematics to the drama: no writer excels him in artful construction, in the arrangement of dramatic scenes, in mere theatrical technique, in the focussing of attention on his chief personages. These are valuable gifts in their way, and it is just to say that Echegaray has a singularly powerful, gloomy imagination, which is momentarily impressive. In the drawing of character, in the invention of felicitous phrase, in the contrivance of verbal music, he is deficient. He alternates between the use of verse and prose; and this hesitancy in choosing a medium of expression is amply justified, for the writer's prose is not more distinguished than his verse. These serious shortcomings may explain the diminution of his vogue in Spain; they will certainly tell against him in the estimate of posterity.

**Echinodermata.**—Since the article on Echinoderms in the 9th edition of the *Encyclopædia Britannica* was published, our knowledge of this phylum of the animal kingdom has greatly increased, and our views on many important points have correspondingly changed. In 1877 the researches of Johannes Müller formed the groundwork of scientific conceptions of the group, and they had thus far been confirmed rather than added to. The distinction of Echinoderms from such radiate animals as jelly-fish and corals (see Cœlentera), by their possession of a body-cavity ("cœlom") distinct from the gut, was fully realized; while their severance from the worms (especially Gephyrea), with which some Echinoderms were long confused, had been necessitated by the recognition in all of a radial symmetry, impressed on the original bilateral symmetry of the larva through the growth of a special division of the cœlom, known as the "hydrocœl," and giving rise to a set of water-bearing canals—the water-vascular or ambulacral system. There was also sufficient comprehension of the differences between the main classes of Echinoderms—the sea-urchins or Echinoidea, the starfish or Asteroidea, the brittle-stars and their allies known as Ophiuroidea, the worm-like Holothurians, the feather-stars and sea-lilies called Crinoidea, with their extinct relatives the sac-like Cystidea, the bud-formed Blastoidea, and the flattened Edrioasteroidea—while within the larger of these classes, such as Echinoidea and Crinoidea, fair working classifications had been established. But the study that should elucidate the fundamental similarities or homologies between the several classes, and should suggest the relations of the Echinodermata to other phyla, had scarcely begun. Indeed, the time was not ripe for such discussions, still less for the tracing of lines of descent and their embodiment in a genealogical classification. Since then exploring expeditions have made known a host of new genera, often exhibiting unfamiliar types of structure.

Among these the abyssal starfish and holothurians described by Sladen and Théel respectively, in the Report of the "*Challenger*" Expedition, are most notable. The sea-urchins, ophiuroids, and crinoids also have yielded many important novelties to A. Agassiz (*Challenger*, *Blake*, and *Albatross* Expeditions), Lyman (*Challenger*), Sladen ("Astrophiura," *Ann. Mag. Nat. Hist.*, 1879), Bell (numerous papers in *Ann. Mag. Nat. Hist.* and in *Proc. Zool. Soc.*), E. Perrier (*Travailleur* and *Talisman*, Cape Horn, and Monaco Expeditions), P. H. Carpenter (*Challenger* Reports), and others. The anatomical researches of these authors, as well as those of Lovén ("On Pourtalesia" and "Echinologica," published by the Swedish Academy of Science), Ludwig (*Morphologische Studien*, Leipzig, 1877–1882), Hamann (*Histologie der Echinodermen*, Jena, 1883–1889), Cuénot ("Études morphologiques," *Arch. Biol.*, 1891, and papers therein referred to), Duncan ("Revision of the Echinoidea," *Journ. Linn. Soc.*, 1890), Prouho ("Sur Dorocidaris," *Arch. Zool. Exper.*, 1888), and many more, need only be mentioned to recall the great advance that has been made. In physiology may be instanced W. B. Carpenter's proof of the nervous nature of the chambered organ and axial cords of crinoids (*Proc. Roy. Soc.*, 1884), the researches of Durham (*Quart. Journ. Micr. Sci.*, 1891) and others into the wandering cells of the body-cavity, and the study of the deposition of the

skeletal substance ("stereom") by Théel (in *Festskrift för Lilljeborg*, 1896). Knowledge of the development has been enormously extended by numerous embryologists, *e.g.*, Ludwig (*op. cit.*), MacBride ("Asterina gibbosa," *Quart. Journ. Micr. Sci.*, 1896), Bury (*Quart. Journ. Micr. Sci.*, 1889, 1895), Seeliger (on "Antedon," *Zool. Jahrb.*, 1893), Goto ("Asterias pallida," *Journ. Coll. Sci. Japan*, 1896), Grave ("Ophiura," *Mem. Johns Hopkins Univ.*, 1899), Théel ("Echinocyamus," *Nov. Act. Soc. Sci. Upsala*, 1892), Semon ("Synapta," *Jena. Zeitschr.*, 1888), and Lovén (*opp. citt.*); and though the theories based thereon may have been fantastic and contradictory, we are now near the time when the results can be co-ordinated and some agreement reached. But the scattered details of comparative anatomy are capable of manifold arrangement, while the palimpsest of individual development is not merely fragmentary, but often has the fragments misplaced. The morphologist may propose classifications, and the embryologist may erect genealogical trees, but all schemes which do not agree with the direct evidence of fossils must be abandoned; and it is this evidence, above all, that gained enormously in volume and in value during the last quarter of the 19th century. The Silurian crinoids and cystids of Sweden have been illustrated in Angelin's *Iconographia Crinoideorum*, 1878; the Palæozoic crinoids and cystids of Bohemia are dealt with in Barrande's *Système Silurien*, 1887 and 1899; P. H. Carpenter published important papers on fossil crinoids in the *Journal* of the Geological Society, on Cystidea in that of the Linnean Society, 1891, and, together with R. Etheridge, jun., compiled the large *Catalogue of Blastoidea in the British Museum*, 1886; O. Jaekel, in addition to valuable studies on crinoids and cystids appearing in the *Zeitschrift* of the German Geological Society, has published the first volume of *Die Stammesgeschichte der Pelmatozoen* (Berlin, 1899), a richly suggestive work; the Mesozoic Echinoderms of France, Switzerland, and Portugal have been made known by P. de Loriol, G. H. Cotteau, J. Lambert, V. Gauthier, and others (see *Paléontologie Française*, *Mem. Soc. Paléontol. de la Suisse*, *Trabalhos Comm. Geol. Portugal*, &c.); a beautiful and interesting Devonian fauna from Bundenbach has been described by Follmann, Jaekel, and especially Stürtz (see *Verhandl. nat. Verein preuss. Rheinlande*, *Palæont. Abhandl.*, and *Palæontographica*); while the multitude of North American palæozoic crinoids has been attacked by Wachsmuth and Springer in the *Proceedings* of the Philadelphia Academy and the *Memoirs* of the Harvard Museum (1897).

The vast mass of material made known by these and many other distinguished writers has to be included in our classification, and that classification itself must be controlled by the story it reveals. Thus it is that a change, characteristic of modern systematic zoology, is affecting the subdivisions of the classes. It is not long since the main lines of division corresponded roughly to gaps in geological history: the orders were Palæocrinoidea and Neocrinoidea, Palechinoidea and Euechinoidea, Palæasteroidea and Euasteroidea, and so forth. Or divisions were based upon certain modifications of structure which, as we now see, affected assemblages of diverse affinity: thus both Blastoidea and Euechinoidea were divided into Regularia and Irregularia; the Holothuroidea into Pneumophora and Apneumona; and Crinoids were discussed under the heads "stalked" and "unstalked." The barriers between these groups may be regarded as horizontal planes cutting across the branches of the ascending tree of life at levels determined chiefly by our ignorance; as knowledge increases, and as the conception of a genealogical classification gains acceptance, they are being replaced by vertical partitions which separate branch from branch. The changes may be appreciated by comparing the systematic synopses in the *Treatise on Zoology*, edited by Ray Lankester, with the classification adopted in the article in *Ency. Brit.*, 9th ed., vol. vii., or in any zoological text-book contemporary therewith. In the present stage of our knowledge these minor divisions are the really important ones. For, whereas to one brilliant suggestion of far-reaching homology another can always be opposed, by the detailed comparison of individual growth-stages in carefully selected series of fossils, and by the minute application to these of the principle that individual history repeats race history, it actually is possible to unfold lines of descent that do not admit of doubt. The gradual linking up of these will manifest the true genealogy of each class, and reconstruct its ancestral forms by proof instead of conjecture. The problem of the interrelations of the classes will thus be reduced to its simplest terms, and even questions as to the nature of the primitive Echinoderm and its affinity to the ancestors of other phyla may become more than exercises for the ingenuity of youth. Work has been and is being done by the laborious methods here alluded to, and though the diversity of opinion as to the broader groupings of classification is still restricted only by the number of writers, we can point to an ever-increasing body of assured knowledge on which all are agreed. Unfortunately such allusion to these disconnected certainties as alone might be introduced here would be too brief for comprehension, and we are forced to select a few of the broader hypotheses for a treatment that may seem dogmatic and prejudiced.

*Calycinal Theory.*—The theory which had most influence on the conceptions of Echinoderms in the two concluding decades of the 19th century was that of Lovén, elaborated by P. H. Carpenter, Sladen, and others. This, which may be called the *calycinal* theory, will be appreciated by comparing the structure of a simple crinoid with that of some other types. A crinoid reduced to its simplest elements consists of three principal portions—(i.) a theca or test enclosing the viscera; (ii.) five arms stretching upwards or outwards from the theca, sometimes single, sometimes branching; (iii.) a stem stretching downwards from the theca and attaching it to the sea-floor (see Fig. 1). That part of the theca

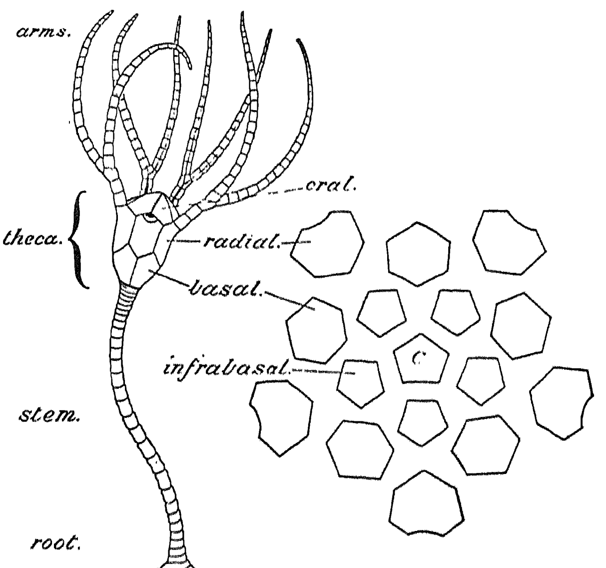


**Fig. 1.—Diagram of a simple form of Crinoid, with five arms, each forking once; the one nearest the observer is removed to expose the tegmen of five orals. This crinoid has only two circlets of plates in the cup, but the cup analysed in the adjoining diagram has in addition infrabasals and a centrale C.**

below the origins of the free arms is called the "dorsal cup"; the ventral part above the origins of the arms, serving as cover to the cup, is known as the "tegmen." All these parts are supported by plates or ossicles of crystalline carbonate of lime. The cup, in its simplest form, consists of two circlets of five plates. Each plate of the upper circlet supports an arm, and is called a "radial"; the plates of the lower circlet, the "basals," rest on the stem and alternate with those of the upper circlet, *i.e.*, are interradial in position. Some crinoids have yet another circlet below these, the constituent plates of which are called "infrabasals," and are situated radially. The tegmen in most primitive forms, as well as in the embryonic stages of the living *Antedon* (Fig. 2), consists of five large triangular plates, alternating with the radials, and called "orals," because they roof over the mouth. In addition to these three or four circlets of plates, two other elements were once supposed essential to the ideal crinoid: the dorso-central and the oro-central. The former term was applied to a flattened plate observed in the embryonic stage of a single genus (*Antedon*) at that end of the stem attached to the sea-floor, and comparable to

the foot of a wine-glass (Fig. 2). In some crinoids which have no trace of a stem (*e.g.*, *Marsupites*) a pentagonal plate is found at the bottom of the cup, where the stem would naturally have arisen ("centrale" in Fig. 1); and since it was believed that the stem always grew by addition of ossicles immediately below the infra-basals, it was inferred that this pentagonal plate was the centro-dorsal in its primitive position, as though the wine-glass had been evolved from a tumbler by pulling the bottom out to form the foot. The oro-central was, it must be admitted, a theoretical conception due to a desire for symmetry, and was not confirmed by anything better than some erroneous observations on certain fossils, which were supposed to show a plate at the oral pole between the five orals; but this plate, so far as it exists at all, is now known to be nothing but an oral shifted in position. The theory was that all the plates just described, and more particularly those of the cup, which were termed "the calycinal system," could be traced, not merely in all crinoids, but in all Echinoderms, whether fixed forms such as cystids and blastoids, or free forms such as ophiuroids and echinoids, even—with the eye of faith—in holothurians. It was admitted that these elements might atrophy, or be displaced, or be otherwise obscured; but their complete and symmetrical disposition was regarded as typical and original. Thus the genera exhibiting it were regarded as primitive, and those orders and classes in which it was least obscured were supposed to approach most nearly the ancestral Echinoderm. Everyone knows that an "apical system," composed of two circlets known as "genitals" or basals and "oculars" or radials, occurs round the aboral pole of echinoids (Fig. 3, A), and that a few

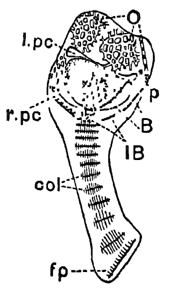


FIG. 2.—An early stage in the development of *Antedon*, showing the foot-plate or "dorso-central" *fp* at the end of the stem *col*. Some of the thecal plates, infrabasals *IB*, basals *B*, and orals *O* are forming around the body-cavities *r.pc* and *l.pc*; *p* is the water-pore. (*After Seeliger*.) × 33 diam.)

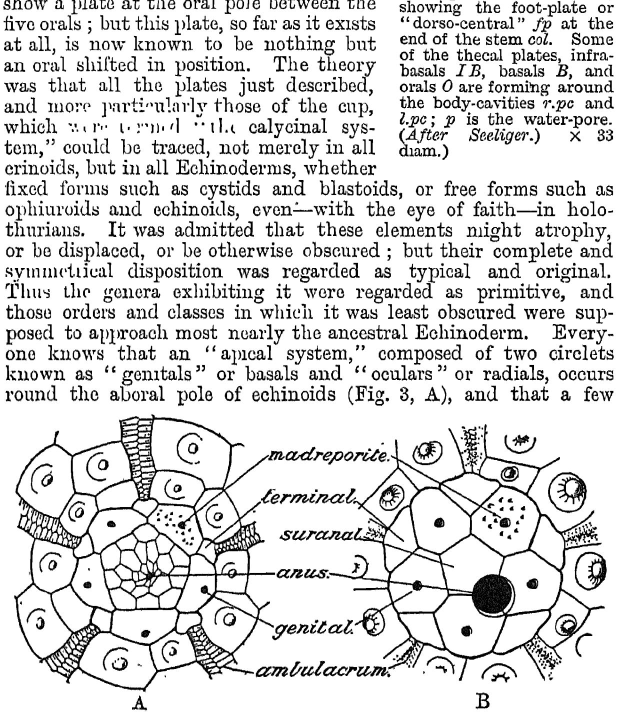


FIG. 3.—Supposed calycinal systems of free-moving Echinoderms. A, regular sea-urchin (*Cidaris*); B, sea-urchin with a sur-anal plate (*Salenia*); C, developing ophiurid (*Amphiura*); D young starfish (*Zoroaster*).

genera (*e.g.*, *Salenia*, Fig. 3, B) possess a sub-central plate (the "sur-anal"), which might be identified with the centro-dorsal. It is also the case that many asterids (Fig. 3, D) and ophiurids (Fig. 3, C) have a similar arrangement of plates on the dorsal (*i.e.*, aboral) surface of the disc. Accepting the homology of these apical systems with the calycinal system, the theory would regard the aboral pole of a sea-urchin or starfish as corresponding in everything, except its relations to the sea-floor, with the aboral pole of a fixed echinoderm.

The theory has been vigorously opposed, notably by Semon (*op. cit.*), who saw in the holothurians a nearer approach to the ancestral form than was furnished by any calyculate echinoderm, and by the Sarasins, who derived the echinoids from the holothurians through forms with flexible tests (Echinothuridæ, which, however, are now known to be specialized in this respect). The support that appeared to be given to the theory by the presence of supposed calycinal plates in the embryo of echinoids and asteroids has been, in the opinion of many, undermined by MacBride (*op. cit.*), who has insisted that in the fixed stage of the developing starfish, *Asterina*, the relations of these plates to the stem are quite different to those which they bear in the developing and adult crinoid. But, however correct the observations and the homologies of MacBride may be, they do not, as Bury (*op. cit.*) has well pointed out, afford sufficient grounds for his inference that the abactinal (*i.e.*, aboral) poles of starfish and crinoids are not comparable with one another, and that all conclusions based on the supposed homology of the dorso-central of echinoids and asteroids with that of crinoids are incorrect. Bury himself, however, has inflicted a severe blow on the theory by his proof that the so-called oculars of Echinoidea, which were supposed to represent the radials, are homologous with the "terminals" (*i.e.*, the plates at the tips of the rays) in Asteroidea and Ophiuroidea, and therefore not homologous with the radially disposed plates often seen around the aboral pole of those animals. For, if these radial constituents of the supposed apical system in an ophiurid have really some other origin, why can we not say the same of the supposed basals? Indeed, Bury is constrained to admit that the view of Semon and others may be correct, and that these so-called calycinal systems may not be heirlooms from a calyculate ancestor, but may have been independently developed in the various classes owing to the action of similar causes. That this view must be correct is urged by students of fossils. Palæontology lends no support to the idea that the dorso-central is a primitive element; it exists in none of the early echinoids, but its origin from the minor plates around the anus is seen in the Saleniidæ. There is no reason to suppose that the central apical plate of certain free-swimming crinoids has any more to do with the distal foot-plate of the larval *Antedon* stem than has the so-called centro-dorsal of *Antedon* itself, which is nothing but the compressed proximal end of the stem. As for the supposed basals of Echinoidea, Asteroidea, and Ophiuroidea, they are scarcely to be distinguished among the ten or more small plates that surround the anus of *Bothriocidaris*, which is the oldest and probably the most ancestral of fossil sea-urchins (Fig. 5). A calycinal system may be quite apparent in the later Ophiuroidea and in a few Asteroidea, but there is no trace of it in the older Palæozoic types, unless we are to transfer the appellation to the terminals. Those plates are perhaps constant throughout sea-urchins and starfish (though it would puzzle any one to detect them in certain Silurian echinoids), and they may be traced in some of the fixed echinoderms; but there is no proof that they represent the radials of a simple crinoid, and there are certainly many cystids in which no such plates existed. Lovén and M. Neumayr adduced the Triassic sea-urchin *Tiarechinus*, in which the apical system forms half of the test, as an argument for the origin of Echinoidea from an ancestor in which the apical system was of great importance; but a genus appearing so late in time, in an isolated sea, under conditions that dwarfed the other echinoid dwellers therein, cannot seriously be thought to elucidate the origin of pre-Silurian Echinoidea, and the recent discovery of an intermediate form suggests that we have here nothing but degenerate descendants of a well-known Palæozoic family (Lepidocentridæ). But to pursue the tale of isolated instances would be wearisome. The calycinal theory is not merely an assertion of certain homologies, a few of which might be disputed without affecting the rest: it governs our whole conception of the echinoderms, because it implies their descent from a calyculate ancestor—not a "crinoid-phantom," that bogey of the Sarasins, but a form with definite plates subject to a quinqueradiate arrangement, with which its internal organs must likewise have been correlated. To this ingenious and plausible theory the revelations of the rocks are more and more believed to be opposed.

*Pentactœa Theory*.—In opposition to the calycinal theory has been the *Pentactœa* theory of Semon. There have always been many zoologists prepared to ascribe an ancestral character to the holothurians. The absence of an apical system of plates; the fact that radial symmetry has not affected the generative organs, as it has in all other recent classes; the well-developed muscles of the body-wall, supposed to be directly inherited from some worm-like ancestor; the presence on the inner walls of the body in the family Synaptidæ of ciliated funnels, which have been rashly compared to the excretory organs (nephridia) of many worms; the outgrowth from the rectum in other genera of cæca (Cuvierian organs and respiratory trees), which recall the anal glands of the Gephyrean worms; the absence of podia (tube-feet) in many genera, and even of the radial water-vessels in Synaptidæ; the absence of that peculiar structure known in other echinoderms by the names "axial organ," "ovoid gland," &c.; the simpler form of the larva—all these features have, for good reason or bad, been

regarded as primitive. Some of the more striking of these features are confined to Synaptidæ; in that family too the absence of the radial water-vessels from the adult is correlated with continuity of the circular muscle-layer, while the gut runs almost straight from the anterior mouth to the posterior anus. Early in the life-history of *Synapta* occurs a stage with five tentacles around the mouth, and into these pass canals from the water-ring, the radial canals to the body-wall making a subsequent, and only temporary, appearance (Fig. 4). Semon called this stage the *Pentactula*, and supposed that, in its early history, the class had passed through a similar stage, which he called the *Pentactæa*, and regarded as the ancestor of all Echinoderms. It has since been proved that the five tentacles with their canals are interradial, so that one can scarcely look on the *Pentactula* as a primitive stage, while the apparent simplicity of the Synaptidæ, at least as compared with other holothurians, is now believed to be the result of regressive changes. The *Pentactæa*, at all events as it sprang from the brain of Semon, must pass to the limbo of mythological ancestors.

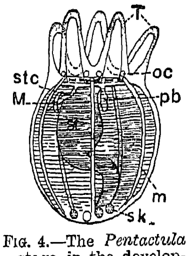

FIG. 4.—The *Pentactula* stage in the development of *Synapta*. T, the five interradial tentacles; M, the water-pore, leading by the stone-canal *stc* to the water-ring, from which hangs a Polian vesicle *pb*; *oc*, supposed otocysts; *m*, longitudinal muscles; *sk*, calcareous spicules; *st*, stomach. (*After Semon.*) × 24 diameters.

*Pelmatozoic Theory*.—The rejection of the calycinal and *Pentactæa* theories need not scatter our conceptions of Echinoderm structure back into the chaos from which they seemed to have emerged. The idea of a calyculate ancestor, though by no means connoting fixation, turned men's minds in the direction of the fixed forms, simply because in them the calyx was best developed. The *Pentactæa* again suggested a search for some primitive type in which quinqueradiate symmetry was exhibited in circumoral appendages, but had not affected the nervous, water-vascular, muscular, or skeletal systems to any great extent, and the generative organs not at all. Study of the earliest larval stages has always led to the conclusion that the Echinoderms must have descended from some freely-moving form with a bilateral symmetry, and, connecting this with the ideas just mentioned, we reach the conception that this supposed bilateral ancestor (or *Dipleurula*) may have become fixed, and may have gradually acquired a radial symmetry in consequence of its sedentary mode of life. The different extent of quinqueradiate symmetry in the different classes would thus depend on the period at which they diverged from the sedentary stock. The tracing of this history, and the explanation of the general characters of Echinoderms and of the differentiating features of the classes in accordance therewith, constitutes the *Pelmatozoic* theory.

The word "Pelmatozoa" literally means "stalked animals," but the name is now used to denote all Cystidea, Blastoidea, Crinoidea, and Edrioasteroidea, as opposed to the other classes, which may be called Eleutherozoa. Many Pelmatozoa have, it is true, no stalk, while some are freely-moving, but all agree in the possession of certain characters obviously connected with a fixed mode of life. Thus, the mouth is central and turned away from the sea-floor; the animal does not seize its food by tentacles, limbs, or jaws, neither does it move in search of it, but a series of ciliated grooves which radiate from the mouth sweep along currents of water, in the eddies of which minute food-particles are caught up and carried down into the gullet; the undigested food is driven out through an anus which is on the upper or oral side of the theca, but as far distant as practicable from the mouth and ciliated grooves. Such characters are found in any primitive, sedentary group. More peculiarly Echinoderm features, in which the Pelmatozoan nature is manifest, are the enclosing of the viscera in a calcified and plated theca, for protection against those enemies from which a fixed animal cannot flee; the development, at the aboral pole of this theca, of a motor nerve-centre giving off branches to the stroma connecting the various plates of the theca and of its brachial, anal, and columnar extensions, and thus co-ordinating the movements of the whole skeleton; the absence of suckers from the podia, which, when present, are respiratory, not locomotor, in function. There are other features of most, if not all, Pelmatozoa that appear to be due to a fixed existence, but those are also found in the Eleutherozoa. The Pelmatozoic theory thus regards the Pelmatozoa as the more ancestral forms, and the Pelmatozoan stage as one that must have been passed through by all Echinoderms during their evolution from the *Dipleurula*. It might be possible to prove the origin of all classes from Pelmatozoa, without thereby explaining the origin of such fundamental features as radial symmetry, the developmental metamorphosis, and the torsion that affects both gut and body-cavities during that process; but the acceptance of a *Dipleurula* as the common ancestor necessitates an explanation of these features. Such explanation is an integral part of the Pelmatozoic theory, but is provided by no other.

The evidence for the Pelmatozoic theory is supplied by palæontology, embryology, the comparative anatomy of the classes, and a consideration of other phyla. Palæontology, so far as it goes, is a sure guide, but some of the oldest fossiliferous rocks yield remains of distinctly differentiated crinoids, asteroids, and echinoids, so that the problem is not solved merely by collecting fossils. Two lines of argument appear fruitful. First, a comparison of the relative numbers of the representatives of the various classes at different epochs; according to this they may be placed in the following order, with the oldest first: Cystidea, Crinoidea, Blastoidea, Asteroidea, Ophiuroidea, Echinoidea. As for Holothuroidea, the fossil evidence allows us to say no more than that the class existed in early Carboniferous times, if not before. The second method is to work out by slow and sure steps the lines of descent of the different families, orders, and classes, and so either to arrive at the ancestral form of each class, or to plot out the curve of evolution, which may then legitimately be projected into "the dark backward and abysm of time." In this way the many highly modified orders of Cystidea may be traced back to a simple, many-plated ancestor with little or no radiate symmetry (see below). All the complicated structures of Blastoidea are evolved from a fairly simple type, which in its turn is linked on to one of the cystid orders. That the crinoids are all deducible from some such simple form as that above described under the head "calycinal theory," is now generally admitted. Although, in the extreme correlation of the radial food-grooves, nerves, water-vessels, and so forth, with a radiate symmetry of the theca, such a type differs from the Cystidea, while in the possession of jointed processes from the radial plates, bearing the grooves and the various body-systems outwards from the theca, it differs from all other Echinoderms, nevertheless ancient forms are known which, if they are not themselves the actual links, suggest how the crinoid type may have been evolved from some of the more regular cystids. The fourth class of Pelmatozoa—the Edrioasteroidea—differs from the others in the structure of its ambulacra. As in all Pelmatozoa, these seem to have borne ciliated food-grooves protected by movable covering-plates (Fig. 11). Beneath each food-groove was a radial water-vessel and probably a nerve and blood-vessel, all which structures passed either between certain regularly arranged thecal plates, or along a furrow floored by those plates, which were then in two alternating series. The important and distinctive feature is the presence of pores between the flooring-plates, on either side of the groove; and these, we cannot doubt, served for the passage of podia. Thus in a highly developed edrioasteroid, such as *Edrioaster* itself (Fig. 11), there was a true ambulacrum, apparently constructed like that of a starfish, but differing in the possession of a ciliated food-groove protected by covering-plates. The simpler forms of Edrioasteroidea, with their more sac-like body and undifferentiated plates, may well have been derived from early Cystidea of yet simpler structure, and there seems no reason to follow Jaekel in regarding the class as itself the more primitive. Turning to fossil Asteroidea, we find the earlier ophiurids scarcely distinguishable from the asterids, while in the alternation of the ambulacrals, which undoubtedly correspond to the flooring-plates of *Edrioaster*, both groups approach the Pelmatozoan type. These facts have been expressed by Stürtz in his names Encrinasteriæ and Ophio-encrinasteriæ. There is no difficulty in deducing the highly differentiated asterids and ophiurids of a later day from these simpler types. The evolution of the modern Echinoidea from their Palæozoic ancestors is also well understood, but in this case the ancestral form to which the palæontologist is led does not at first sight present many resemblances to the Pelmatozoa. It is, however, characterized by simplicity of structure, and a short description of it will serve to clear the problem from unnecessary difficulties. *Bothriocidaris* (Fig. 5), a small echinoid from the

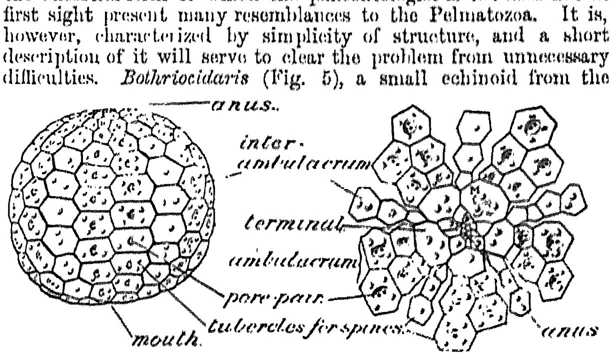

FIG. 5.—*Bothriocidaris globulus*. A, from the side; B, the plates around the aboral pole. (*After Jaekel.*) The short spines which were attached to the tubercles are not drawn.

Ordovician rocks of Esthonia, is in essential structure just the form demanded by comparative palæontology to make a starting-point. It is spheroidal, with the mouth and anus at opposite

poles; there are five ambulacra, and the ambulacral plates are large, simple, and alternating, each being pierced by two podial pores which lie in a small oval depression; the ambulacrals next the mouth form a closed ring of ten plates; the interambulacrals lie in single columns between the ambulacra, and are separated from the mouth-area by the proximal ambulacrals just mentioned, and sometimes by the second set of ambulacrals also; the ambulacra end in the five oculars or terminals, which meet in a ring around the anal area and have no podial pores, but one of them serves as a madreporite; within this ring is a star-shaped area filled with minute irregular plates, none of which can safely be selected as the homologues of the so-called basals or genitals of later forms; within the ring of ambulacrals around the mouth are five somewhat pointed plates, which Jaekel regards as teeth, but which can scarcely be homologous with the interradially placed teeth of later echinoids, since they are radial in position; small spines are present, especially around the podial pores. The position of the pores near the centre of the ambulacrals in *Bothriocidaris* need not be regarded as primitive, since other early Palæozoic genera, not to mention the young of living forms, show that the podia originally passed out between the plates, and were only gradually surrounded by their substance; thus the original structure of the echinoid ambulacra differed from that of the early asteroid in the position of the radial vessels and nerves, which here lie beneath the plates instead of outside them. To this point we shall recur; palæontology, though it suggests a clue, does not furnish an actual link either between echinoidea and asteroidea, or between those classes and Pelmatozoa.

The argument from embryology leads farther back. First, as already mentioned, it outlines the general features of the *Dipleurula*; secondly, it indicates the way in which this free-moving form became fixed, and how its internal organs were modified in consequence; but when we seek, thirdly, for light on the relations of the classes, we find the features of the adult coming in so rapidly that such intermediate stages as may have existed are either squeezed out or profoundly modified. The difficulty of rearing the larvæ in an aquarium towards the close of the metamorphosis may account for the slight information available concerning the stages that immediately follow the embryonic. Another difficulty is due to the fact that the types studied, and especially the crinoid *Antedon*, are highly specialized, so that some of the embryonic features are not really primitive as regards the class, but only as regards that particular genus. Thus inferences from embryonic development need to be checked by palæontology, and supplemented by comparison of the anatomy of other living genera.

Minute anatomical research has also aided to establish the Pelmatozoic theory by the gradual recognition in other classes of features formerly supposed to be confined to Pelmatozoa. Thus the elements of the Pelmatozoan ventral groove are now detected in so different a structure as the echinoid ambulacrum, while an aboral nervous system, the diminished representative of that in crinoids, has been traced in all Eleutherozoa except Holothurians. The broader theories of modern zoology might seem to have little bearing on the Echinoderma, for it is not long since the study of these animals was compared to a landlocked sea undisturbed by such storms as rage around the origin of the Vertebrata. This, however, is no more the case. The conception of the *Dipleurula* derives its chief weight from the fact that it is comparable to the early larval forms of other primitive cœlomate animals, such as *Balanoglossus*, *Phoronis*, Chætognatha, Brachiopoda, and Bryozoa. So too the explanation of radial symmetry and torsion of organs as due to a Pelmatozoic mode of life finds confirmation in many other phyla. Instead of discussing all these questions separately, with the details necessary for an adequate presentation of the argument, we shall now sketch the history of the Echinoderms in accordance with the Pelmatozoic theory. Such a sketch must pass lightly over debatable ground, and must consist largely of suggestions still in need of confirmation; but if it serves as a frame into which more precise and more detailed statements may be fitted as they come to the ken of the reader, its object will be attained.

*Evolution of the Echinoderms.*—It is reasonable to suppose that the Cœlomata—animals in which the body-cavity is divided into a gut passing from mouth to anus and a hollow (cœlom) surrounding it—were derived from the simpler Cœlentera, in which the primitive body-cavity (archenteron) is not so divided, and has only one aperture serving as both mouth and anus. We may, with Sedgwick, suppose the cœlom to have originated by the enlargement and separation of pouches that pressed outwards from the archenteron into the thickened body-wall (such structures as the genital pouches of some Cœlentera, not yet shut off from the rest of the cavity), and they would probably have been four in number and radially disposed about the central cavity. The evolution of this cavity into a gut is foreshadowed in some Cœlentera by the elliptical shape of the aperture and by the development at its ends of a ciliated channel along which food is swept; we have only to suppose the approximation of the sides of the ellipse and their eventual fusion, to complete the transformation of the radially symmetrical Cœlenterate into a bilaterally symmetrical Cœlomate with mouth and anus at opposite ends of the long axis. We further suppose that of the four cœlomic pouches one was in front of the mouth, one behind the anus, and one on each side. Such an animal, if it ever existed, probably lived near the surface of the sea, and even here it may have changed its medusoid mode of locomotion for one in the direction of its mouth. Thus the bilateral symmetry would have been accentuated, and the organism shaped more definitely into three segments, namely, (1) a preoral segment or lobe, containing the anterior cœlomic cavity; (2) a middle segment, containing the gut, and the two middle cœlomic cavities; (3) a posterior segment, containing the posterior cœlomic cavity, which, however, owing to the backward prolongation of the anus, became divided into two—a right and left posterior cœlom. Each of these cavities presumably excreted waste products to the exterior by a pore. There was probably a nervous area, with a tuft of cilia, at the anterior end; while, at all events in forms that remained pelagic, the ciliated nervous tracts of the rest of the body may be supposed to have become arranged in bands around the body-segments. Such a form as this is roughly represented to-day by the *Actinotrocha* larva of *Phoronis*, the importance of which has been brought out by Masterman. But only slight modifications are required to produce the *Tornaria* larva of the Enteropneusta and other larvæ, including the special type that is inferred from the *Dipleurula* larval stages of recent forms to have characterized the ancestor of the Echinoderms. We cannot enter here into all the details of comparison between these larval forms; amid much that is hypothetical a few homologies are widely accepted, and the preceding account will show the kind of relation that the Echinoderms bear to other animals, including what are now usually regarded as the ancestors of the Chordata (to which back-boned animals belong), as well as the nature of the evidence that their study has been, or may be, made to yield. How the hypothetical *Dipleurula* became an Echinoderm, and how the primitive Echinoderms diverged in structure so as to form the various classes, are questions to which an answer is attempted in the following paragraphs:—

Confining our attention to that form of *Dipleurula* (Fig. 6) which, it is supposed, gave rise to the Echinoderma, we infer

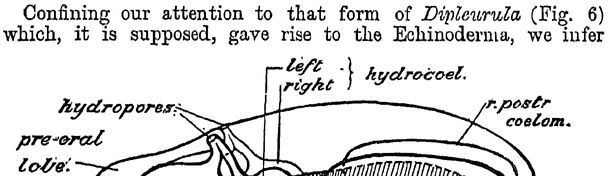


FIG. 6.—Diagrammatic reconstruction of *Dipleurula*. The creature is represented crawling on the sea-floor, but it may equally well have been a floating animal. The ciliated bands are not drawn.

from embryological data that its special features were as follow:—The anterior cœlomic cavity was wholly or partially divided, and from each half a duct led to the exterior, opening at a pore near the middle line of the back. The middle cavities were smaller, and the ducts from them came to unite with those from the anterior cavities, and no longer opened directly to the exterior; whether these cavities were already specialized as water-sacs cannot be asserted, but they certainly had become so at a slightly later stage. The posterior cavities were the largest, but what had become of their original opening to the exterior

is uncertain. The genital products were derived from the lining of the cœlomic cavities, but it would not be safe to say that any particular region was as yet specialized for generation. The epithelium of the outer surface was probably ciliated, and a portion of it in the preoral lobe differentiated as a sense-organ, with longer cilia and underlying nerve-centre, from which two nerves ran back below the ventral surface. Into the space between the walls of the cœlom and the outer body-wall, originally filled with jelly, definite cells now wandered, chiefly derived from the cœlomic walls. Some of these cells produced muscles and connective tissue; others absorbed and removed waste products, iron salts, calcium carbonate, and the like, and so were ready to be utilized for the deposition of pigment or of skeletal substance. In some of these respects the *Dipleurula* may have diverged from the ancestor of Enteropneusta and of other animals, but it could not as yet have been recognized as echinodermal by a zoologist, for it presented none of the structural peculiarities of the modern adult echinoderm.

Now ensued the great event that originated the phylum—the discovery of the sea-floor. This being apprehended by the sensory anterior end, it was by that end that the *Dipleurula* attached itself; not, however, by the pole, since that would have interfered at once with the sensory organ, but a little to one side, the right side being the one chosen for a reason we cannot now fathom; it may be that fixation was facilitated by the presence of the pore on that side, and by the utilization of the excretion from it as a cement. The first result was that which is always seen to follow in such cases—the passage of the mouth towards the upper surface (Fig. 7). As it passed up along the left side, the gut caught hold of the left water-sac and pulled it upwards, curving it in the process; this being attached to the left duct from the anterior body-cavity, this structure with its water-pore was also pulled up, and

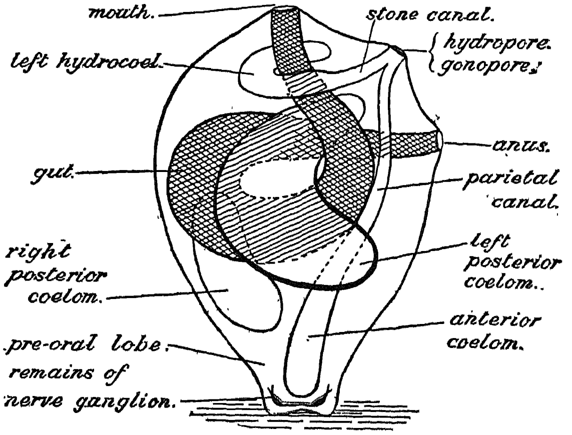


Fig. 7.—Diagrammatic reconstruction of primitive Pelmatozoön, seen from the side. The plates of the test are not drawn; their probable appearance may be gathered from Fig. 8.

the pore came to lie between mouth and anus. The forward portion of the anterior cœlom shared in the constriction and elongation of the preoral lobe; but its hinder portion was dragged up along with the water-pore and formed a canal lying along the outer wall (the parietal canal). As the gut coiled, it pressed inwards the middle of the left posterior cœlom of the *Dipleurula*, and drew the whole towards the mouth, while the corresponding cavity on the right was pressed down by the stomach towards the fixed end of the animal and became involved in the elongation of that region. These changes, which may still be traced in the development of *Antedon*, resulted in the primitive Pelmatozoön (Fig. 7), represented in the rocks by such a genus as *Aristocystis* (Fig. 8). The pear-shaped body is encased in a theca formed by a number of polygonal plates, and is attached by its narrow end. On the broad upper surface are four openings, that nearest the centre being the mouth, which

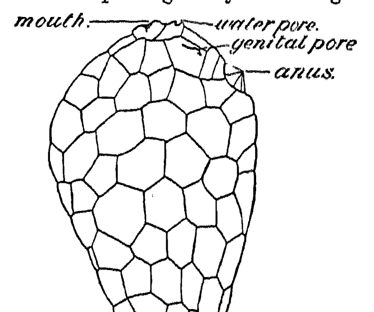


Fig. 8.—*Aristocystis bohemicus*; side-view of the theca. The internal structure may be gathered from Fig. 7. (×⅔ diam.)

is slit-like, and that nearest the periphery being the anus. The two other openings are minute, and placed between those two; one close to the mouth is almost certainly the water-pore, while that nearer the anus is regarded as a genital aperture. Which of the cœlomic cavities this last is connected with is uncertain, for there is considerable doubt as to the origin of the genital glands in the embryonic development of recent echinoderms. It seems clear, however, that there was but a single duct and a single bunch of reproductive cells, as in the holothurians, though perhaps bifurcate, as in some of those animals. The line between mouth and anus, along which these openings are situate, corresponds with the plane of union between the two horns of the curved left posterior cœlom, the united walls of which form the "dorsal mesentery." Since this must have, on our theory, enclosed the parietal canal from the anterior cœlom, it is possible that the genital products were developed from the lining cells of that cavity, and that the genital pore was nothing but its original pore not yet united with that from the water-sac. The concrescence of these pores can be traced in other cystids; but as the genital organs became affected by radial symmetry the original function of the duct was lost, and the reproductive elements escaped to the exterior in another way. *Aristocystis* may have had ciliated food-grooves leading to its mouth, but these have left no traces on the structure of the test. Traces, however, are perceptible in genera believed to be descended from such a simple type, and the majority may be grouped under two heads. One group includes those in which the grooves wander outwards from the mouth over the thecal plates, which gradually become arranged regularly on either side of the grooves, while further extensions ascend from the grooves on small jointed processes called "brachioles" (Fig. 9). In the other group the grooves do not tend so much to stretch over the theca as to be raised away from it on relatively larger brachioles, arising close around the mouth (Fig. 10).

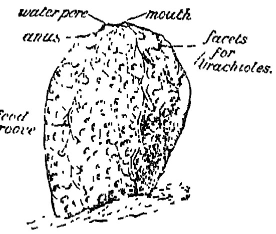


Fig. 9.—*Fungocystis rarissima*, one of the Diploporita, in which the thecal plates bordering the food-grooves are not yet regularly arranged. The brachioles are not drawn.

These two types are, in the main, correlated with two gradual differentiations in the minute structure of the thecal plates. Originally the calcareous substance of the plates (stereom) was pierced by irregular canals, more or less vertical, and containing strands of the soft tissue (stroma) that deposited the stereom, as well as spaces filled with fluid. In the former group (Fig. 9) these canals became connected in pairs (diplopores) still perpendicular to the surface, and this structure, combined with that of the grooves, characterizes the order — Diploporita. In the latter group (Fig. 10) the canals, that is to say, the stroma-strands, came to lie parallel to the surface and to cross the sutures between the plates, which were thus more flexibly and more strongly united; since the canals crossing each suture naturally occupy a rhombic area, the order is called Rhombifera. At first the grooves were three, one proceeding from each end of the mouth-slit, and the third in a direction opposed to the anus; with reference to the Pelmatozoan structure, the anal side may be termed posterior, and this groove anterior. Eventually each lateral groove forked, so that there were five grooves. These gradually impressed themselves on the theca and influenced the arrangement of the internal organs: it is fairly safe to assume that nerves, blood-vessels, and branches from the water-sac stretched

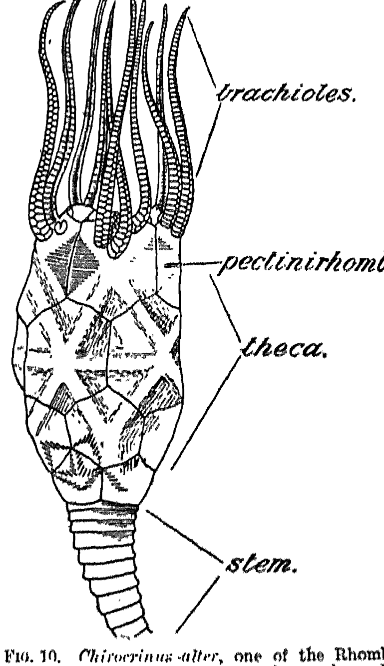


Fig. 10. *Chirocrinus alter*, one of the Rhombifera, showing the reduced number and regular arrangement of the thecal plates, and the concentration of the brachioles. (*Adapted from Jaekel.*)

out along with these grooves, each system starting from a ring around the gullet. At last a quinqueradiate symmetry influenced the plates of the theca, partly through the development of a plate at the end of each groove (terminal), partly through plates at the aboral pole of the theca (basals and infrabasals) arising in response to mechanical pressure, but soon intimately connected with the cords of an aboral nervous system. Before the latter plates arose, the stem had developed by the elongation and constriction of the fixed end of the theca, the gradual regularization of the plates involved, and their coalescence into rings. The crinoid type was differentiated by the extension of the food-grooves and associated organs along radial outgrowths from the theca itself. These constituted the arms (brachia), and five definite radial plates of the theca were specialized for their support. These radials may be homologous with the terminals already mentioned, but this is neither necessary nor certain. In this development of brachial extensions of the theca the genital organs were involved, and their ripe products formed at the ends of the brachia or in the branches therefrom. The remains of the original genital gland within the theca became the "axial organ" surrounded by the "axial sinus" derived from the anterior cœlom, and this again by structures derived from the right posterior cœlom, which, as explained above, had been depressed to the aboral pole. These last structures formed a nervous sheath around the axial sinus with its blood-vessels, and became divided into five lobes correlated with the five basals (the "chambered organ") and forming the aboral nerve-centre. Before these changes were complete the Holothurioidea must have diverged, by the assumption of a crawling existence. Thus in them the mouth and anus reverted to opposite poles, and only the torsion of the gut and cœlom, and the radial extensions of the nervous, water-vascular, and blood-vascular systems, testified to their Pelmatozoan ancestry. The ciliated grooves, no longer needed for the collection of food, closed over, and are still traceable as ciliated canals overlying the radial nerves. At the same time the thecal plates degenerated into spicules. The Edrioasteroidea followed a different line to that of the cystids above mentioned and their descendants. The theca became sessile, and in its later developments much flattened (Fig. 11). Mouth, water-pore, and

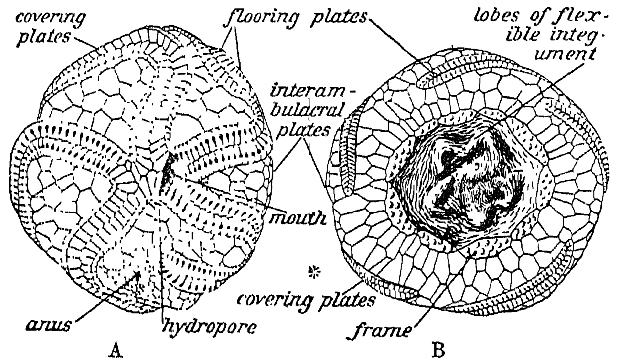


FIG. 11.—*Edrioaster.* A, upper or oral surface of *E. Bigsbyi*, with the covering-plates on the anterior and left posterior food-grooves, but removed from the others, which show only the flooring-plates, between which are pores; B, under surface of *E. Buchianus*, with covering-plates on right posterior and right anterior food-grooves (left hand in the drawing). The ✻ denotes the position of the anal interradius.

anus remained as in *Aristocystis*, but the five ciliated grooves radiated from the mouth between the thecal plates rather than over them, and were, as usual, protected by covering-plates. The important feature was the extension of radial canals from the water-sac along these grooves, with branches passing between the flooring-plates of the grooves (Fig. 12, A). The resemblance of the flooring-plates to the ambulacral ossicles of a starfish is so exact that one can explain it only by supposing similar relations of the water-canals and their branches (podia). On the thinly-plated under surface of well-preserved specimens of *Edrioaster* are seen five interradial swellings (Fig. 11, B). These are likely to have been produced by the ripe genital glands, which may have extruded their products directly through the membranous integument of the under side. No other way out for them is apparent, and it is clear that *Edrioaster* was not permanently and solidly fixed to the sea-floor.

Now comes a great change, unfortunately difficult to follow whether in the fossils or in the modern embryos. We suppose some such form as *Edrioaster*, which appears to have lived near the shore, to have been repeatedly overturned by waves. Those that were able to accommodate themselves to this topsy-turvy existence, by taking food in directly through the mouth, survived, and their podia gradually specialized as sucking feet. Such a form as this, when once its covering-plates had atrophied, would be a starfish without more ado (Fig. 12, B); but the sea-urchins present a more difficult problem. We may suppose that the radial water-canals sank beneath the flooring-plates of the grooves, and that the covering-plates disappeared, in which case the plates that in the echinoid are pierced by podia would be homologous with the ambulacral ossicles of an asteroid and the flooring-plates of *Edrioaster*. Or we may suppose the canals and other organs to have remained as they were, the covering-plates to have closed permanently over them, merely leaving slits for the podia between them, and the flooring-plates to have disappeared. In either case we have to admit a closure of the integument over the ciliated groove (Fig. 12, D, *e*) just as in holothurians, since this is necessitated by

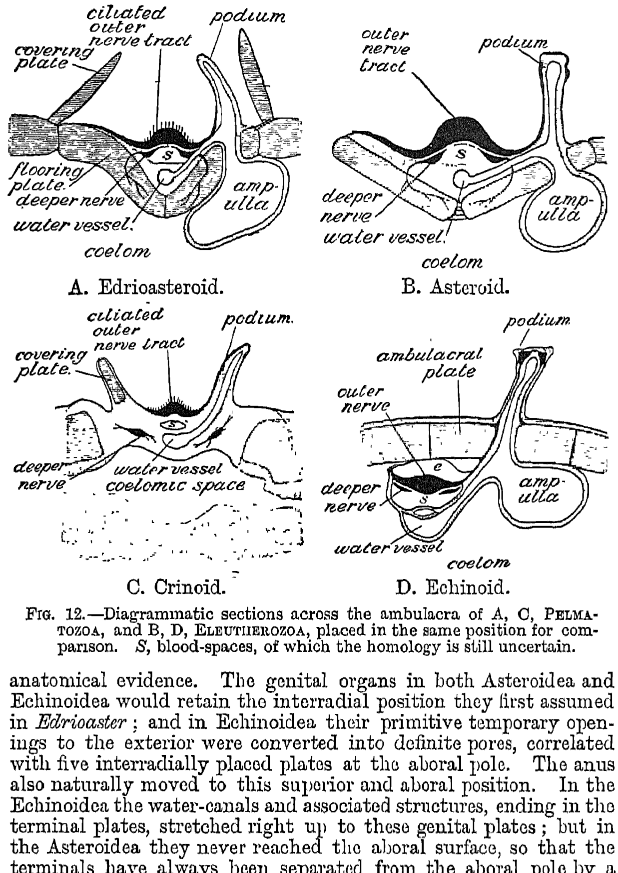


FIG. 12.—Diagrammatic sections across the ambulacra of A, C, PELMATOZOA, and B, D, ELEUTHEROZOA, placed in the same position for comparison. *S*, blood-spaces, of which the homology is still uncertain.

anatomical evidence. The genital organs in both Asteroidea and Echinoidea would retain the interradial position they first assumed in *Edrioaster*; and in Echinoidea their primitive temporary openings to the exterior were converted into definite pores, correlated with five interradially placed plates at the aboral pole. The anus also naturally moved to this superior and aboral position. In the Echinoidea the water-canals and associated structures, ending in the terminal plates, stretched right up to these genital plates; but in the Asteroidea they never reached the aboral surface, so that the terminals have always been separated from the aboral pole by a number of plates.

*Analysis of Echinoderm Characters.*—To follow the further evolution of the several classes would require a series of independent articles; reference must perforce be made to works (*vide infra*) in which this has recently been attempted. Regarding the Echinoderms as a whole in the light of the foregoing account, we may give the following analytic summary of the characters that distinguish them from other cœlomate animals:—

They live in salt or brackish water; a primitive bilateral symmetry is still manifest in the right and left divisions of the cœlom; the middle cœlomic cavities are primitively transformed into two hydrocœls communicating with the exterior indirectly through a duct or ducts of the anterior cœlom; stereom, composed of crystalline carbonate of lime is, with few exceptions, deposited by special amœbocytes in the meshes of a mesodermal stroma, chiefly in the integument; reproductive cells are derived from the endothelium, apparently of the anterior cœlom; total segmentation of the ovum produces a cœloblastula and gastrula by invagination; mesenchyme is formed in the segmentation cavity by migration of cells, chiefly from the hypoblast. Known Echinoderms show the following features, imagined to be due to an ancestral pelmatozoic stage:—Increase in the cœlomic cavities of the left side, and atrophy of those on the right; the dextral coil of the gut, recognizable in all classes, though often obscured; an incomplete secondary bilateralism about the plane including the main axis and the water-pore or its successor, the madreporite, often obscured by one or other of various tertiary bilateralisms; the development of the hydrocœl into a circumoral, arcuate or ring canal; development through a free-swimming, bilaterally symmetrical, ciliated larva, of which in

many cases only a portion is transformed into the adult Echinoderm (where care of the brood has secondarily arisen, this larva is not developed). All living, and most extinct, Echinoderms show the following features, almost certainly due to an ancestral Pelmatozoic stage:—An incomplete radial symmetry, of which five is usually the dominant number, is superimposed on the secondary bilateralism, owing to the outgrowth from the mouth region of one unpaired and two paired ciliated grooves; these have a floor of nervous epithelium, and are accompanied by subjacent radial canals from the water-ring, giving off lateral podia and thus forming ambulacra, and by a perihæmal system of canals apparently growing out from cœlomic cavities. All living Echinoderms have a lacunar, hæmal system of diverse origin; this, the ambulacral system, and the cœlomic cavities, contain a fluid holding albumen in solution and carrying numerous amœbocytes, which are developed in special lymph-glands and are capable of wandering through all tissues. The Echinoderms may be divided into seven classes, whose probable relations are thus indicated:—

PELMATOZOA { Cystidea, Blastoidea, Crinoidea }

Cystidea —— Edrioasteroidea

ELEUTHEROZOA { Holothurioidea, Asteroidea (and Ophiuroidea), Echinoidea }

AUTHORITIES.—In addition to the works referred to in the opening paragraph, the following deal with the general subject:—

BATHER, GREGORY, and GOODRICH. "Echinoderma," in LANKESTER'S *Treatise on Zoology*. London, 1900.—BELL. *Catalogue of the British Echinoderms in the British Museum*. London, 1892.—P. H. CARPENTER. "Notes on Echinoderm Morphology," *Quart. Journ. Micr. Sci.*, 1878–1887.—LANG. *Text-Book of Comparative Anatomy*, transl., part ii. London, 1896.—LUDWIG and HAMANN. "Echinodermen," in BRONN'S *Klassen und Ordnungen des Thierreichs*. Leipzig, 1889—in progress.—NEUMAYR. *Die Stämme des Thierreiches*. Wien, 1889.—P. B. and C. F. SARASIN. "Ueber die Anatomie der Echinothuriden und die Phylogenie der Echinodermen," *Ergebnisse naturw. Forsch. auf Ceylon*, Bd. i. Heft 3. Wiesbaden, 1888.—SEMON. "Die Homologien innerhalb des Echinodermenstammes," *Morph. Jahrb.*, 1889.—SLADEN. "Homologies of the Primary Larval Plates in the Test of Brachiate Echinoderms," *Quart. Journ. Micr. Sci.*, 1884.—ZITTEL. *Handbuch der . . . Palæozoologie*, i. pp. 308–560. München, 1879; also *Grundzüge*, translated and revised by EASTMAN as *Text-Book of Palæontology*. New York and London, 1899. A complete analytical index to the annual literature of the Echinoderma has for many years been published in the *Zoological Record*. London.

(F. A. B.)

**Echiuroidea.**—The Echiuroidea form a small group of marine animals which show in their larval life-history a certain degree of segmentation, and are therefore grouped by some authorities as Annelids. Formerly, together with the Sipunculoidea and Priapuloidea, they made up the class Gephyrea, but on the ground that they retain in the adult a large preoral lobe (the proboscis), that they have anal vesicles, that their anus is terminal, that setæ are found, and finally that they are segmented in the larval stage, they have been removed from the group, which by the proposed further separation of the Priapuloidea on account of their unique renal and reproductive organs, has practically ceased to exist.

Echiuroids are animals of moderate size, varying roughly from one to six or seven centimetres in length, exclusive of the proboscis. This organ is capable of very considerable extension, and may attain a length in *Bonellia viridis* of about a metre and a half (Fig. 1). It is grooved ventrally and ciliated. At its attachment to the body the groove sinks into the mouth. In *Bonellia* the proboscis is forked at its free end, but in the other genera it is short and unforked. The body is somewhat sausage-shaped, with the anus at the posterior extremity, surrounded in *Echiurus* by a single or double ring of setæ. The skin is usually wrinkled, and in *B. viridis*, *Thalassema lankesteri*, *Th. baronii*, *Hamingia arctica*, and in the larva of many species, is of a lively green colour. A pair of curved bristles, formed in true setal sacs as in Chætopoda, project from the body a short distance behind the mouth, and are moved by special muscles; they are of use in helping the animal to move

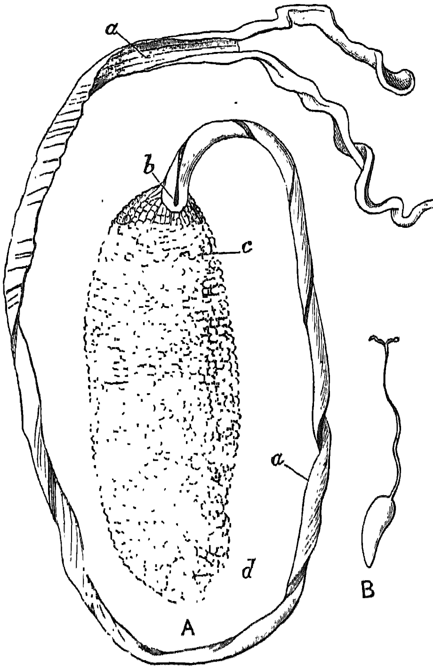


FIG. 1.—A, *Bonellia viridis*, Rol., ♀; B, *B. fuliginosa*. Both natural size. *a*, grooved proboscis; *b*, mouth; *c*, ventral hooks; *d*, anus.

slowly about, and they take a large share in the burrowing movements (C. B. Wilson, *Biol. Bull.*, 1900), for some species tunnel in the mud and sand and form more or less permanent burrows, the walls of which are strengthened by mucus secreted from the skin. The openings of the burrows become silted up, leaving, however, a small aperture through which the proboscis is extruded. This organ carefully searches the neighbourhood for particles of food. When these are found the grooved proboscis folds its walls inwards, and the cilia pass the particles down the tube thus formed to the mouth. Echiuroids also move by extending the proboscis, which takes hold of some fixed object, and then contracting, draws the body forwards. Recently it has been shown that *Echiurus* swims freely at night-time, using for locomotion both the proboscis and the contraction of the muscles of its body-wall. The motion is described as "gyratory," and the anterior end is always carried foremost. Those species which do not burrow usually conceal themselves in crevices of the rocks or under stones, or at times in empty Mollusc or Echinid shells. They are occasionally used by fishermen as bait.

*Anatomy* (Fig. 2).—A thin cuticle covers the epidermis, which contains mucus-secreting glands. Beneath the epidermis is a layer of circular muscles, then a layer of longitudinal, and finally in some cases a layer of oblique muscle-fibres. The inner face of this muscular skin is lined by a layer of epithelium. The cœlomic body-cavity is spacious. It does not extend into the proboscis, which is a solid organ traversed by the nervous and vascular rings, but otherwise largely built up of muscle-fibres and connective-tissue. Many sense-cells lie in the epidermis. The ciliated ventral groove of the proboscis leads at its base into the simple mouth, which gives access to the thin-walled alimentary canal. This is longer than the body, and to tuck it away it is looped from side to side. The loops are supported by strands of connective-tissue, which in some species are united so as to form a dorsal mesentery, whilst traces of a ventral mesentery are met with anteriorly and posteriorly

(H. L. Jameson, *Zool. Jahrb. Anat.*, 1899). The alimentary canal is divisible into fore-gut, mid-gut, and hind-gut, and the first named can be further divided into pharynx, œsophagus, gizzard, and crop, mainly on histological grounds. The mid-gut is characterized by the presence of a ciliated groove, from which arises the collateral intestine or siphon, a second tube which rejoins the alimentary canal lower down. Similar collateral intestines are familiar in the Echinids and certain Polychæts (Capitellidæ). The rectum receives the openings of a pair of very characteristic organs, the anal vesicles. Each consists of a branching tube, the tips of whose twigs terminate in minute ciliated funnels. The anal vesicles are thought to be excretory; whether this be so or not, they undoubtedly have some

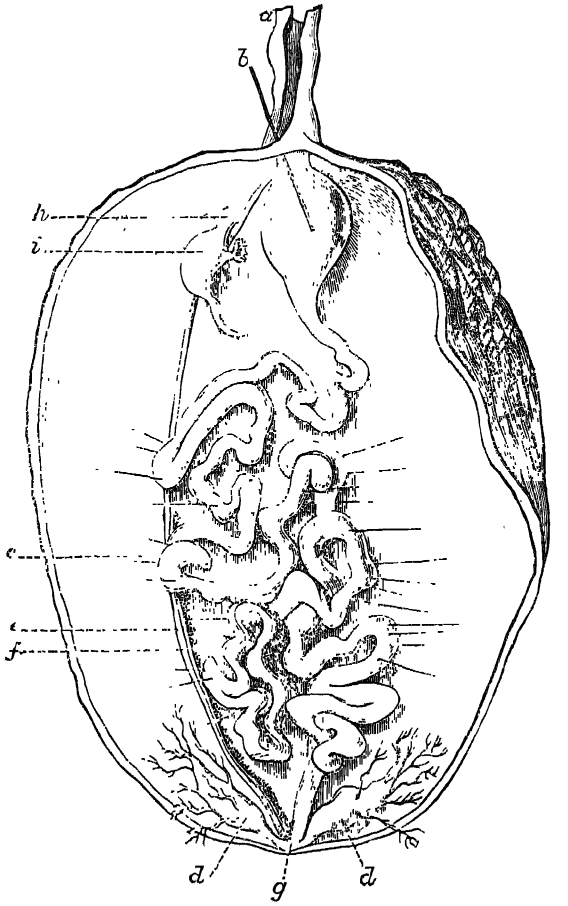


FIG. 2.—Female *Bonellia viridis*, Rol. Opened along the left side. × 2. *a*, proboscis cut short; *b*, bristle passing through the mouth into the pharynx; *c*, coiled intestine; *d*, anal tufts or vesicles; *e*, ventral nerve cord; *f*, ovary borne on ventral vessel running parallel with *e*; *g*, position of anus; *h*, position of external opening of nephridium; *i*, nephridium—the line points towards, but does not reach, the internal opening.

influence on the amount of fluid found in the cœlom. The cœlomic fluid contains as a rule both amœboid and rounded corpuscles, and, when ripe, the products of the gonads. A closed system of vessels, usually called the vascular system, is present. There are, however, no capillaries connected with this, and it is confined to certain portions of the body. It can possess few of the functions usually associated with a vascular system, and its main use is probably to assist in the expansion of the proboscis. The system consists of the following parts:—A dorsal vessel applied to the alimentary canal is continued anteriorly into a median vessel, which traverses the proboscis to its tip. Here the vessel splits, and each half returns along the lateral edge of the proboscis; they reunite around the œsophagus and form a single ventral vessel, which lies above the ventral nerve-cord. The ventral vessel, which ends solidly behind, sends off a branch which forms a ring around the intestine and opens into the posterior extremity of the dorsal vessel. In *Echiurus* and *Thalassema* the same vessel forms a ring round a stout muscle, which connects the bases of the two ventral setæ before passing to surround the intestine. Amœboid corpuscles float in the fluid contents. The nephridia vary in number from a single one in *Bonellia* to three pairs in many species of *Thalassema*. Their external openings are ventral, and on the same level as the ciliated funnel-shaped nephrostomes. The posterior wall of the organ is produced into a long blind sac, which is lined by secretory cells. The nervous system is a single ventral cord, which starts from a circum-œsophageal ring. This ring is involved in the growth of the proboscis, and is drawn out with it. Thus there is a lateral nerve near each edge of the proboscis which unites with its fellow dorsally above the œsophagus at the tip of the proboscis, and ventrally beneath the œsophagus, where they fuse to form the ventral nerve-cord. There are no specialized ganglia, but ganglion-cells are scattered uniformly along the nerve-cords. The ventral cord gives off rings, which run in the skin at regular intervals. The reproductive cells are modified cœlomic cells, which lie on the ventral vessel. They escape into the cœlomic fluid and there develop. When mature they leave the body through the nephridia. *Bonellia* and *Hamingia* are very interesting examples of sexual dimorphism. The female has the normal Echiuroid structure, but the male is reduced to a minute, flattened, planarian-like organism, which passes its life usually in the company of two or three others in a special recess of the nephridia of the female. Its structure may be gathered by a reference to Fig. 3.

*Larva.*—The larva is a typical trochosphere, which, although of a temporary character, shows a distinct segmentation of the mesoblast, of the nervous system, and of the ciliated and pigmented structures in the skin, resembling that of Chætopods. The preoral lobe persists as the proboscis. The sexes of the larvæ are not determinable in the early stages, but when a certain growth has been reached in *Bonellia* the males seek the proboscis of the adult females, and passing into the mouth undergo there the transformation into the planarian-like parasite which is the fully-formed male. This now creeps along the body of the female and takes up its home in her nephridia.

*Classification and Distribution.*—The Echiuroidea consists of the following genera:—(1) *Bonellia* (Rol.), with four species, widely distributed, but inhabiting the temperate and warmer waters of each hemisphere. (2) *Echiurus* (Guérin-Méneville), with four species. This genus reaches from the Arctic waters of both hemispheres into the cooler temperate regions. (3) *Hamingia* (Kor. and Dan.), with one species, which has been taken in the Arctic Sea and the Hardanger Fjord. (4) *Saccosoma* (Kor. and Dan.) was described from a single specimen dredged about half-way between Iceland and Norway. (5) *Thalassema* (Gaertner, Lamarck), with twenty-one species. This genus is in the main a denizen of the warmer waters of the globe. Sixteen species are found only in tropical or subtropical seas, three species are Mediterranean (*Mt. Stat. Neapel*, 1899), whilst three species are from the eastern Atlantic, where the temperature is modified by the Gulf Stream (Shipley; see Willey's *Zoological Results*, part iii., 1899; *Proc. Zool. Soc. Lond.*, 1898, 1899; and *Cambridge Natural History*, ii.). The following are found in the British area:—*E. pallasii* (Guérin-Méneville), *Th. neptuni* (Gaertner), and *Th. lankesteri* (Herdman, *Q.J.M.S.*, 1898).

*Affinities.*—The occurrence of trochosphere larva and the temporary segmentation of the body have led to the belief that the Echiuroids are more nearly allied to the Annelids than to any other phylum. This view is strengthened by certain anatomical and histological re-

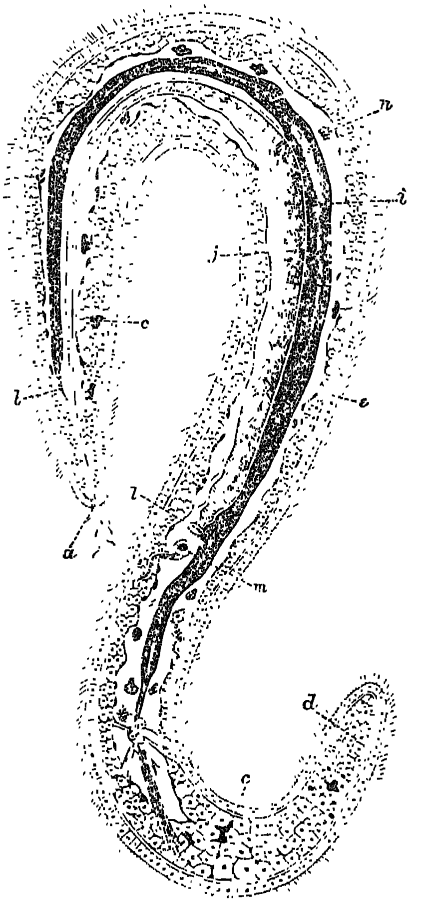

FIG. 3.—Adult male, *Bonellia viridis*, Rol. The original was 1·5 mm. long. The nervous system is not shown. (*After Selenka.*) *a*, generative pore with spermatozoa coming out; *b*, anterior blind end of intestine attached to the parenchymatous tissue by muscular strands; *c*, green wandering cells containing chlorophyll; *d*, parenchymatous connective-tissue; *e*, epidermis; *i*, intestine; *j*, vas deferens; *l*, internal opening of vas deferens; *m*, the left anal vesicle; *n*, spermatozoa in the body-cavity.

semblances to the genus *Sternaspis*, which in one species, *S. spinosa*, is said to carry a bifid proboscis resembling that of the Echiuroids. The relationship with the Sipunculoidea and the Priapuloidea are discussed in the article SIPUNCULOIDEA. (A. E. S.)

**Echuca,** a borough of Victoria, Australia, in the county of Rodney, on the river Murray, across which it is connected by bridge with Moama, which has railway connexion with Deniliquin, New South Wales. The town is the terminus of the Murray River Railway and the entrepôt of the overland intercolonial trade, and has large wool stores. The district, a rich agricultural one, is noted for its vineyards. Altitude, 314 feet. Mean temperature for the year, 58°·6 F.; for January, 71°·6; for July, 44°·7. Population (1881), 4789; (1901), 4083.

**Eckernförde,** a town of Prussia, province of Schleswig-Holstein, on a bay of the Baltic, 20 miles by rail north-west from Kiel. It has a good harbour, fishing, trade in agricultural products, and production of tobacco, salt, and iron goods. There are an architects' school and a teachers' seminary. The place suffered from a sea-flood in 1872. Population (1885), 5604; (1900), 6719.

**Eclipse.**—The general subject of eclipses, and the conditions under which they may occur, were fully treated in the article ASTRONOMY (*Ency. Brit.* vol. ii.). To that article nothing need be added on the subject of eclipses of the moon, and the present article is therefore confined to eclipses of the sun, especially those which are total.

***Elements of eclipses.***

The complete computation of the circumstances of an eclipse *ab initio* requires three distinct processes. The geocentric position of the sun and moon have first to be computed from the tables of the motions of those bodies. The second step is to compute certain elements of the eclipse from these geocentric positions. The third step is from these elements to compute the circumstances of the eclipse for the earth generally, or for any given place on its surface. The national Astronomical Ephemerides, or "Nautical Almanacs," give in full the geocentric positions of the sun and moon from at least the early part of the 19th century to an epoch three years in advance of the date of publication. It is therefore unnecessary to undertake the first part of the computation except for dates outside the limits of the published ephemerides, and for many years to come even this computation will be unnecessary, because tables giving the elements of eclipses from the earliest historic periods up to the 22nd century have been published by Oppolzer and Newcomb. We shall therefore confine ourselves to a statement of the eclipse problem and of the principles on which such tables rest.

Two systems of eclipse elements are now adopted in the ephemerides and tables; the one, that of Bessel, is used in the English, American, and French ephemerides, the other —Hansen's—in the German and in the eclipse tables of Oppolzer. The two have in common certain fundamental geometric constructions. A fundamental axis of reference in both systems is the line passing through the centres of the sun and moon; this is the common axis of the shadow cones, which envelop simultaneously the sun and moon (see Fig. 37, *Ency. Brit.* vol. ii. p. 803). The surface of one of these cones, that of the umbra, is tangent to both bodies externally. This cone comes to a point at a distance from the moon nearly equal to that of the earth. Within it the sun is wholly hidden by the moon. Outside the umbral cone is that of the penumbra, within which the sun is partially hidden by the moon. The condition that the two bodies shall appear in contact, or that the eclipse shall begin or end at a certain moment, is that the surface of one of these cones shall pass through the place of the observer at that moment. Let a plane, which we call the fundamental plane, pass through the centre of the earth perpendicular to the shadow axis. On this plane the centre of the earth is taken as an origin of rectangular coordinates. The axis of Z is perpendicular to the plane, and therefore parallel to the shadow axis; that of Y and Z lie in the plane. In these fundamental constructions the two methods coincide. They differ in the direction of the axis of Y and Z in the fundamental plane. In Bessel's method, which we shall first describe, the intersection of the plane of the earth's equator with the fundamental plane is taken as the axis of X. The axis of Y is perpendicular to it, the positive direction being towards the north. The Besselian elements of an eclipse are then:—$x$, $y$, the coordinates of the shadow axis on the fundamental plane; $d$, the declination of that point in which the shadow axis intersects the celestial sphere; $\mu$, the Greenwich hour angle of this point; $l$, the radius of the circle in which the penumbral or outer cone intersects the fundamental plane; and $l'$, the radius of the circle in which the inner or umbral cone intersects this plane, taken positively when the vertex of the cone does not reach the plane, so that the axis must be produced, and negatively when the vertex is beyond the

plane. It will be noticed that, in the first case, the eclipse appears annular to an observer at the point where the shadow axis intersects the fundamental plane, and in the second case total. But since an observer on the surface of the earth is nearer to the moon than the fundamental plane is, it may happen that an eclipse which is annular on the plane will be total to the observer on the earth's surface.

Hansen's method differs from that of Bessel in that the ecliptic is taken as the fundamental plane instead of the equator. The axis of X on the fundamental plane is parallel to the plane of the ecliptic; that of Y perpendicular to it. The other elements are nearly the same in the two theories. As to their relative advantages, it may be remarked that Hansen's co-ordinates follow most simply from the data of the tables, and are necessarily used in eclipse tables, but that the subsequent computation is simpler by Bessel's method. Its use, in case Hansen's form is used at first, requires merely the transformation of co-ordinates from the ecliptic to the equator. The eclipse tables of Oppolzer and Newcomb give the data for computing the ecliptic Y-co-ordinate at the moment T of true conjunction of the sun and moon in longitude. This co-ordinate is called B by Oppolzer and $y^\circ_2$ by Newcomb, and is expressed by Oppolzer in the form $B = p \sin P$. The tables also give, for the moment T, the value of $x^1_2$ or $\Delta L$, the hourly motion of the X-co-ordinate. Oppolzer gives separately data for $\Delta B$, the hourly motion of B, while Newcomb determines the motion of the shadow-axis from $x^1_2$ and the angle, assumed constant, which the path makes with the X-axis. An approximate value of the sun's longitude (L or ☉) and of the angle between the shadow-axis and the equator ($\delta$ [Delta] or $d$) is also found. Oppolzer uses these elements in the subsequent computation, while Newcomb transforms $x_2$ and $y_2$ into $x_1$ and $y_1$, the Besselian co-ordinates, which are to be used in the subsequent work.

Several problems are involved in the complete computation of an eclipse from the elements. First, from the values of the latter at a given moment to determine the point, if any, at which the shadow-axis intersects the surface of the earth, and the respective outlines of the umbra and penumbra on that surface. Within the umbral curve the eclipse is annular or total outside of it and within the penumbral curve the eclipse will be partial at the given moment. The penumbral line is marked from hour to hour on the maps given annually in the American Ephemeris. Second, a series of positions of the central point through the course of an eclipse gives us the path of the central point along the surface of the earth, and the envelopes of the penumbral and umbral curves just described are boundaries within which a total, annular, or partial eclipse will be visible. In particular, we have a certain definite point on the earth's surface on which the edge of the shadow first impinges; this impingement necessarily takes place at sunrise. Then passing from this point, we have a series of points on the surface at which the elements of the shadow-cone are in succession tangent to the earth's surface. At all these points the eclipse begins at sunrise until a certain limit is reached, after which, following the successive elements, it ends at sunrise. At the limiting point the rim of the moon merely grazes that of the sun at sunrise, so that we may say that the eclipse both begins and ends at that time. Of course the points we have described are also found at the ending of the eclipse. There is a certain moment at which the shadow-axis leaves the earth at a certain point, and a series of moments when, the elements of the penumbral cone being tangent to the earth's surface, the eclipse is ending at sunset. Three cases may arise in studying the passage of the outlines of the shadow over the earth. It may be that all the elements of the penumbral cone intersect the earth. In this case we shall have both a northern and southern limit of partial eclipse. In the second case there will be no limit on the one side except that of the eclipse beginning or ending at sunrise or sunset. Or it may happen, as the third case, that the shadow-axis does not intersect the earth at all; the eclipse will then not be annular or total at any point, but at most only partial.

The third problem is, from the same data, to find the circumstances of an eclipse at a given place—especially the times of beginning and ending, or the relative positions of the sun and moon at a given moment. Reference to the formulæ for all these problems will be given in the bibliography of the subject.

*Recurrence of eclipses.*

There are two well-marked periods in which eclipses recur at nearly the same distance from a node of the moon's orbit, one of 223 lunations, the other of 358. At the end of the latter period the eclipse recurs at the opposite node, and at the end of two periods, at the same node. The length of this period is 10,571·95 days, or 29 Julian years less 20·30 days. Hence 18 periods make 521 years, so that at the end of this time the eclipse recurs on the same day of the year. In the mean, the time of recurrence is so nearly at the same distance from the node that we find each central eclipse visible at our time to be one of an unbroken series extending from the earliest historic times to the present, at intervals equal to the length of the period. For example, starting from the eclipse of Nineveh, 763 B.C., June 15, recorded on the Assyrian tablets, we find eclipses on May 27, 734 B.C., May 7, 705 B.C., and so on in an unbroken series to 1843, 1872, and 1901, the last being the 93rd of the series. Those at the ends of 18 periods occurred on June 15, O.S., of each of the years 763, 242 B.C., A.D. 280, 801, 1322, and 1843. As the lunar perigee moves through 242°·4 in a period, the eclipses will vary from total to annular, but at the end of 3 periods the perigee is only 7°·1 in advance of its original position relative to the node. Hence in a series including every third eclipse the eclipses will be of the same character through a thousand years or more. Thus the eclipses of 1467, 1554, 1640, 1727, 1814, 1901, 1988, &c., are total.

The length of the other period, called the Saros, is 6585⅓ days, or 18 years and 11 or 12 days. The fact that eclipses recur at the end of this period has been known from ancient times. Owing to the fractional excess of ⅓ of a day in the period, each recurring eclipse takes place about 120° farther west in longitude than the preceding one of the series, and is therefore not generally visible in the same region. During the course of a Saros there are 223 lunations and 19 returns of the sun to each of the moon's nodes. The clearest idea of the law of recurrence thus arising may be gained by the conception of conjunction-points of the moon and sun in the following way:—

Imagine a circle, having the earth in its centre, to be situated in the mean plane of the moon's orbit, and to be fixed to the node of the orbit so as to make one revolution in its plane around its centre in the same period as the revolution of the node (about 18$^y$·6). Imagine also that, as the sun and moon revolve, we mark on this circle the points in the direction of which the mean conjunctions of the two bodies occur. These conjunction-points will fall at various points of the circle until the end of the Saros. Then after 223 conjunctions the 224th will fall very near the first. The deviation will be somewhat less than half a degree. To make it fall exactly upon the first we have only to give our circle, conceived as bearing the conjunction-points, a motion equal to this deviation, or, speaking more exactly, a uniform retrograde revolution through 0°·476 in one period. The amount of this motion was

slightly less in former centuries, and will increase a little in the future owing to the acceleration of the moon's motion. When this motion is assigned to the circle eclipses will always take place at one or the other of these 223 points, but will, of course, be confined to those which lie near the moon's node. The latter will now move over the system of points at the rate of $0^\circ{\cdot}476$ per period. This will carry the node from one conjunction-point to the next in about 61 years.

We may classify eclipses according to the conjunction-point at which they occur. As any one such point slowly approaches the node the successive eclipses, separated by an interval of one Saros, which occur at that point, will fall continually nearer the node until the conjunction-point passes it, near which time they will be central. After passing the node a certain distance the eclipse will cease to be central, and become partial until at length the distance of the point from the node will be such that the series will cease. The entire duration of each series is more than a thousand years. The introduction of the period in question would have no special significance but for one important circumstance. It happens that the lapse of one Saros brings together not only the sun and moon, but approximately the lunar perigee and the mean anomaly of the sun. The change in the former is less than three degrees, in the latter between ten and eleven degrees. The character of an eclipse, whether annular or total, and, if total, the duration of the total phase, depend on the position of the lunar and solar perigees relatively to the conjunction-point. It follows that each recurring eclipse will be of the same general character as that which preceded it. If the duration of totality of the latter is remarkably long, the same will be true of the recurring eclipse. This fact enables us, by the aid of suitable tables, to select almost at sight eclipses of long duration in the past or future.

**Notable eclipses.**

The following is a brief chronological enumeration of those total eclipses of the sun which are of interest, either from their historic celebrity or the nature of the conclusions derived from them. In numbering the years before the Christian era the astronomical nomenclature is used, in which the number of the year is one less than that used by the chronologists. The Chinese eclipses are passed over, owing to the generally doubtful character of the records pertaining to them.

762 B.C., June 14; a total eclipse recorded at Nineveh. Computation from the modern tables shows that the path of totality passed about 100 miles or more north of Nineveh.

584 B.C., May 28; the celebrated eclipse of Thales. An account of this eclipse will be found in the article THALES (*Ency. Brit.* vol. xxiii.).

556 B.C., May 19; the eclipse of Larissa. The modern tables show that the eclipse was not total at Larissa, and the connexion of the classical record with the eclipse is doubtful.

430 B.C., August 3; eclipse mentioned by Thucydides, but not total by the tables.

399 B.C., June 21; eclipse of Ennius. Totality occurred immediately after sunset at Rome. The identity of this eclipse is doubtful.

309 B.C., August 14; eclipse of Agathocles. This eclipse would be one of the most valuable for testing the tables of the moon, but for an uncertainty as to the location of Agathocles, who, at the time of the occurrence, was at sea on a voyage from Syracuse to Carthage.

Ginzel (*Spezieller Kanon der Finsternisse*) has collected a great number of passages from classical authors supposed to refer to eclipses of the sun or moon, but the difficulty of identifying the phenomenon is frequently such as to justify great doubt as to the conclusions. In a few cases no eclipse corresponding to the description can be found by our modern table to have occurred, and in others the latitude of interpretation and the uncertainty of the date are so wide that the eclipse cannot be identified.

Of mediæval eclipses we mention only the dates of those visible in England, referring for details to the works mentioned in the bibliography. The letter C following a date shows that the eclipse is mentioned in the Anglo-Saxon Chronicles. The dates in question are:—

A.D. 538, February 15, C. (partial).
540, June 12, C. (partial).
594, July 23.
A.D. 603, August 12.
639, September 3.
664, May 1, C.
A.D. 733, August 14 (annular).
764, June 4 (annular).
878, October 29, C.
885, June 15.
1023, January 24.
A.D. 1133, August 1, C.
1140, March 20, C.
1185, May 1, C.
1191, June 23, C. (annular).
1330, July 16.

Besides these, the tables show that the shadow of the moon passed over some part of the British Islands on 1424, June 26; 1433, June 17; 1598, March 6; 1652, April 8; 1715, May 2; 1724, May 22. The next dates are 1927, June 29, when a barely total eclipse will be seen soon after sunrise in the northern counties near the Scottish Border, and 1999, August 11, when the moon's shadow will graze England at Land's End.

**Eclipses of the 19th and 20th centuries.**

We give below, in tabular form, a list of the principal total eclipses between 1800 and 1970, omitting a few visible only in the extreme polar regions, and some others of which the duration is very short. The eclipses are classified in the table according to their position in the eighteen-years period, so that the table shows the successive eclipses occurring at this interval. In this way it is possible for the reader to continue the table, with a considerable degree of approximation, for several periods, while the law of recurrence and the gradual change in the character of the eclipse are made evident at sight. The first column gives the date of the point on the earth's surface at which the eclipse is central at noon. The next two columns give the position of this point to the nearest degree. As the date in the first column changes at 180° long. from Greenwich, the integer dates are not at equal intervals, and therefore the fourth column shows the Greenwich astronomical time of conjunction in longitude. The next column gives the duration of the total phase at the noon-point; this is sometimes $0^{m}{\cdot}1$ less than the greatest duration. The eclipses of each period occur near the same node of the moon, which is indicated at the head of the series. By the central date of the series is meant that date when an eclipse occurred, in the mean, nearest to the node. This is, of course, one of the dates of the series.

*Total Eclipses of the Sun, 1800 to 1970, classified by the 18-Years Period.*[1]

| Date at Noon-Point. | Central at Noon. Lat. | Central at Noon. Long. | Greenwich M.T. of Conj. in Long. | Dur. of Total Phase | Regions swept by Shadow. |
|---|---|---|---|---|---|
| SERIES I. *Ascending Node; Central date*, 1731, *Jan.* 8. | | | | | |
| | ° | ° | *d. h. m.* | *m.* | |
| 1803, Feb. 21 | 11 S | 136 W | 21 9 20 | 4·2 | Pacific Ocean, Mexico. |
| 1821, Mar. 4 | 8 S | 96 E | 3 17 50 | 4·3 | Indian and Pacific Oceans. |
| 1839, Mar. 15 | 6 S | 31 W | 15 2 14 | 4·4 | South America, Africa, Egypt. |
| 1857, Mar. 25 | 4 S | 155 W | 25 10 30 | 4·5 | Pacific Ocean, Mexico. |
| 1875, Apr. 6 | 2 S | 83 E | 5 18 36 | 4·7 | Indian Ocean, Siam, Pacific. |
| 1893, Apr. 16 | 1 S | 37 W | 16 2 35 | 4·8 | Venezuela to West Africa. |
| 1911, Apr. 28 | 1 S | 156 W | 28 10 26 | 5·0 | Australia, Polynesia. |
| 1929, May 9 | 1 S | 89 E | 8 18 8 | 5·1 | Sumatra, Malacca, Philippines. |
| 1947, May 20 | 2 S | 25 W | 20 1 44 | 5·2 | Argentina, Paraguay, Central Africa. |
| 1965, May 30 | 4 S | 137 W | 30 9 14 | 5·3 | Pacific Ocean. |
| SERIES II. *Descending Node; Central date*, 2183, *March* 23. | | | | | |
| 1804, Aug. 5 | 38 S | 66 W | 5 4 6 | 1·2 | Pacific Ocean, Chile, Argentina. |
| 1822, Aug. 16 | 36 S | 176 W | 16 11 22 | 1·4 | Australia, Pacific Ocean. |
| 1840, Aug. 27 | 34 S | 72 E | 26 18 45 | 1·6 | Africa, Indian Ocean. |
| 1858, Sept. 7 | 33 S | 41 W | 7 2 16 | 1·7 | Peru, Southern Brazil, Uruguay. |
| 1876, Sept. 17 | 33 S | 156 W | 17 9 54 | 1·8 | Pacific Ocean. |
| 1894, Sept. 29 | 34 S | 86 E | 28 17 34 | 1·8 | East Africa, Indian Ocean. |
| 1912, Oct. 10 | 35 S | 33 W | 10 1 41 | 1·8 | Colombia, Ecuador, Brazil. |
| 1930, Oct. 21 | 36 S | 155 W | 21 9 47 | 1·9 | Pacific Ocean, Patagonia. |
| 1948, Nov. 1 | 37 S | 82 E | 31 18 3 | 1·9 | Central Africa, Congo. |
| 1966, Nov. 12 | 38 S | 43 W | 12 2 27 | 1·9 | Bolivia, Argentina, Brazil. |
| SERIES III. *Descending Node; Central date*, 1626, *Feb.* 26. | | | | | |
| 1806, June 16 | 42 N | 66 W | 16 4 22 | 4·6 | New England, Atlantic, Spain. |
| 1824, June 26 | 47 N | 175 W | 26 11 43 | 4·4 | Pacific Ocean, Japan, China. |
| 1842, July 8 | 51 N | 77 E | 7 19 2 | 4·1 | Spain, France, Russia to China. |
| 1860, July 18 | 56 N | 31 W | 18 2 21 | 3·7 | British America, Spain, Egypt. |
| 1878, July 29 | 60 N | 139 W | 29 9 40 | 3·2 | United States. |
| 1896, Aug. 9 | 65 N | 112 E | 8 17 2 | 2·7 | North Europe, Siberia, Japan. |
| 1914, Aug. 21 | 71 N | 2 E | 21 0 27 | 2·1 | Scandinavia, Russia, Asia Minor. |
| 1932, Aug. 31 | 78 N | 105 W | 31 7 55 | 1·5 | Canada, East United States. |

[1] In addition to these, a series will commence 1938, May 29, and be continued 1956, June 8, 1974, June 20, &c., with a duration of 4 or 5 m., but will be visible only in the Southern Hemisphere.

*Total Eclipses*—(continued).

| Date at Noon-Point. | Central at Noon. Lat. | Central at Noon. Long. | Greenwich M.T. of Conj. in Long. | Dur. of Total Phase | Regions swept by Shadow. |
|---|---|---|---|---|---|
| SERIES IV. *Ascending Node; Central date*, 2096, *May* 22. | | | | | |
| | ° | ° | *d. h. m.* | *m.* | |
| 1807, Nov 29 | 11 N | 2 E | 28 23 48 | 1·4 | Central Africa, Anolia. |
| 1825, Dec. 9 | 9 N | 127 W | 9 8 27 | 1 5 | Pacific Ocean, Mexico. |
| 1843, Dec. 21 | 8 N | 102 E | 20 17 10 | 1·6 | Indian and North Pacific Oceans, India. |
| 1861, Dec. 31 | 9 N | 29 W | 31 1 55 | 1·8 | Caribbean Sea to North Africa. |
| 1880, Jan 11 | 10 N | 160 W | 11 10 40 | 2 1 | Pacific Ocean, California. |
| 1898, Jan. 22 | 13 N | 69 E | 21 19 24 | 2·3 | East Africa, India, China. |
| 1916, Feb. 3 | 16 N | 62 W | 3 4 6 | 2·5 | Pacific Ocean, Venezuela, West Indies. |
| 1934, Feb. 14 | 19 N | 168 E | 13 12 44 | 2·7 | Borneo, Celebes. |
| 1952, Feb. 25 | 22 N | 39 E | 24 21 17 | 3·0 | Nubia, Persia, Siberia. |
| 1970, Mar. 7 | 25 N | 88 W | 7 5 43 | 3·3 | Mexico, Georgia, South and North Carolina. |
| SERIES V. *Descending Node; Central date*, 1702, *Jan.* 28. | | | | | |
| 1810, Apr. 4 | 12 N | 154 E | 3 13 41 | Ann. | Pacific Ocean, Borneo. |
| 1828, Apr. 14 | 18 N | 30 E | 13 21 18 | 0·3 | Northern Africa, India. |
| 1846, Apr. 25 | 25 N | 75 W | 25 4 49 | 0·9 | Mexico, West Indies, Africa. |
| 1864, May 6 | 32 N | 173 E | 5 12 14 | 1·4 | Pacific Ocean. |
| 1882, May 17 | 39 N | 63 E | 16 19 34 | 1·8 | Egypt, Central Asia, China |
| 1900, May 28 | 45 N | 45 W | 28 2 50 | 2·1 | United States, Spain, North Africa. |
| 1918, June 8 | 51 N | 152 W | 8 10 3 | 2·4 | British Columbia, United States. |
| 1936, June 19 | 56 N | 101 E | 18 17 15 | 2·5 | Greece to Central Asia. |
| 1954, June 30 | 62 N | 5 W | 30 1 27 | 2·5 | Canada, Scandinavia, Russia, Persia. |
| SERIES VI. *Descending Node; Central date*, 2009, *July* 22. | | | | | |
| 1811, Mar. 24 | 39 S | 26 W | 24 2 19 | 3·4 | South Atlantic to South Africa. |
| 1829, Apr. 3 | 32 S | 149 W | 3 10 24 | 4·1 | South Pacific Ocean. |
| 1847, Apr. 15 | 24 S | 90 E | 14 18 22 | 4·7 | Indian Ocean, Java. |
| 1865, Apr. 25 | 16 S | 30 W | 25 2 13 | 5·3 | Brazil to Central Africa |
| 1883, May 6 | 9 S | 147 W | 6 9 58 | 6·0 | Pacific Ocean, Caroline Islands. |
| 1901, May 18 | 2 S | 97 E | 17 17 38 | 6·5 | Sumatra, Borneo. |
| 1919, May 29 | 4 N | 18 W | 29 1 12 | 6·9 | Peru, Brazil, Central Africa. |
| 1937, June 8 | 10 N | 131 W | 8 8 43 | 7·1 | Pacific Ocean, Peru. |
| 1955, June 20 | 15 N | 117 E | 19 16 12 | 7·2 | Ceylon, Siam, Philippines. |
| SERIES VII. *Ascending Node; Central date*, 1904, *Sept* 9. | | | | | |
| 1814, July 17 | 31 N | 84 E | 16 18 33 | 6·6 | Africa, Central Asia, China. |
| 1832, July 27 | 24 N | 28 W | 27 2 2 | 6·8 | West Indies to Central Africa. |
| 1850, Aug. 7 | 18 N | 142 W | 7 9 34 | 6·8 | Pacific Ocean. |
| 1868, Aug. 18 | 10 N | 103 E | 17 17 12 | 6·8 | India to Pacific Ocean. |
| 1886, Aug. 29 | 3 N | 14 W | 29 0 54 | 6·6 | West Indies, Central Africa. |
| 1904, Sept. 9 | 5 S | 133 W | 9 8 43 | 6·4 | Pacific Ocean. |
| 1922, Sept. 21 | 12 S | 106 E | 20 16 38 | 6·1 | East Africa, Australia. |
| 1940, Oct. 1 | 19 S | 16 W | 1 0 42 | 5·7 | Colombia, Brazil, South Africa. |
| 1958, Oct. 12 | 26 S | 139 W | 12 8 52 | 5·2 | Chile, Argentina. |
| SERIES VIII. *Ascending Node; Central date*, 2212, *March* 3. | | | | | |
| 1815, July 6 | 88 N | 175 W | 6 11 52 | 3·2 | Polar Regions, Western Siberia. |
| 1833, July 17 | 78 N | 76 E | 16 19 16 | 3·5 | North-Eastern Asia. |
| 1851, July 28 | 70 N | 34 W | 28 2 41 | 3·7 | Scandinavia, South-East Europe. |
| 1869, Aug. 7 | 61 N | 145 W | 7 10 8 | 3·8 | United States. |
| 1887, Aug. 19 | 53 N | 102 E | 18 17 39 | 3·8 | North Europe, Siberia, Japan. |
| 1905, Aug. 30 | 45 N | 12 W | 30 1 13 | 3·8 | Canada, Spain, North Africa. |
| 1923, Sept. 10 | 38 N | 128 W | 10 8 53 | 3·6 | California, Mexico, Central America. |
| 1941, Sept. 21 | 30 N | 114 E | 20 16 39 | 3·3 | Central Asia, China, Pacific Ocean. |
| 1959, Oct. 2 | 23 N | 6 W | 2 0 32 | 3·0 | Canaries, Central Africa. |
| SERIES IX. *Descending Node; Central date*, 1510, *May* 8. | | | | | |
| 1816, Nov. 19 | 43 N | 30 E | 18 22 9 | 1·8 | Eastern Europe, Central Asia. |
| 1834, Nov. 30 | 40 N | 101 W | 30 0 48 | 1·9 | Southern and Western United States. |
| 1852, Dec. 11 | 37 N | 127 E | 10 15 32 | 2·0 | China, Pacific Ocean. |
| 1870, Dec. 22 | 36 N | 5 W | 22 0 19 | 2·1 | Gibraltar, Northern Africa, Sicily. |
| 1889, Jan. 1 | 37 N | 138 W | 1 9 8 | 2·2 | California, Oregon, British America. |
| 1907, Jan. 14 | 39 N | 89 E | 13 17 57 | 2·3 | Russia, Central Asia. |
| 1925, Jan. 24 | 42 N | 44 W | 24 2 46 | 2·4 | United States. |
| 1943, Feb. 4 | 47 N | 176 W | 4 11 31 | 2 5 | Siberia, Alaska. |
| 1961, Feb. 15 | 53 N | 53 E | 14 20 11 | 2·6 | France, Italy, Austria, Siberia. |
| SERIES X. *Descending Node; Central date*, 1817, *Nov.* 9. | | | | | |
| 1817, Nov. 9 | 7 S | 149 E | 8 13 53 | 4·7 | Burma, Pacific Ocean. |
| 1835, Nov. 20 | 10 S | 29 E | 19 22 31 | 4·6 | Central Africa, Madagascar. |
| 1853, Nov. 30 | 11 S | 111 W | 30 7 14 | 4·4 | Pacific Ocean and Brazil. |
| 1871, Dec. 12 | 12 S | 118 E | 11 16 2 | 4·4 | Southern India, Northern Australia. |
| 1889, Dec. 22 | 12 S | 13 W | 22 0 52 | 4·2 | Western Africa. |
| 1908, Jan. 3 | 12 S | 145 W | 3 9 44 | 4·2 | Pacific Ocean. |
| 1926, Jan. 14 | 10 S | 82 E | 13 18 35 | 4·2 | East Africa, Sumatra, Philippines. |
| 1944, Jan. 25 | 7 S | 49 W | 25 3 25 | 4·2 | Peru, Brazil, West Africa. |
| 1962, Feb. 5 | 4 S | 179 E | 4 12 11 | 4·1 | New Guinea. |
| SERIES XI. *Ascending Node; Central date*, 2270, *Jan.* 22. | | | | | |
| 1927, June 29 | 78 N | 84 E | 28 18 32 | 0·7 | England, Scotland, Scandinavia. |
| 1945, July 9 | 70 N | 20 W | 9 1 36 | 1·1 | United States, British America, Scandinavia, Russia. |
| 1963, July 20 | 62 N | 126 W | 20 8 43 | 1·5 | Alaska, Hudson's Bay Territory. |
| 1981, July 31 | 54 N | 127 E | 30 15 53 | 1·8 | Central Asia, Siberia. |
| 1999, Aug. 11 | 46 N | 18 E | 10 23 8 | 2·2 | Cornwall, Southern Europe, and Asia. |

It will be noticed that two of these series, VI. and VII., will be, or have been, notable for the long duration of totality. Those of 1937 and 1955 fall not more than $20^s$ below the absolute maximum of $7^m\ 30^s$. But series IV. will increase to a yet greater duration, reaching in 2150, June 25, a duration of about $7^m\ 16^s$, and on 2168, July 5, a duration of $7^m\ 28^s$, the longest in human history. The first of these will pass over the Pacific Ocean; the second over the southern part of India, near Madras.

*Physical Phenomena of Recent Total Eclipses.*

As the moon advances on the solar disc, the sharp and rugged edge of the lunar disc is in strong contrast to the soft and uniform outline of the sun's limb. Some little time before the commencement of the total phase the entire outline of the moon may be distinguished, that part off the sun being seen by its cutting off the faint light of the corona. A few seconds before the commencement of the total phase the red light of the chromosphere becomes visible, and will be seen most distinctly as continuations of the solar crescent at its two ends. Owing to the inequalities of the lunar surface, the diminution of the solar crescent does not go on with perfect uniformity, but, just before the last moment, what remains of it is generally broken up into separate portions of light, which, magnified and diffused by the irradiation of the telescope, present the phenomenon long celebrated under the name of "Baily's beads." These were so called because minutely and vividly described by Baily as he observed them during the annular eclipse of May 15, 1836, when he compared them to a string of bright beads, irregular in size and distance from each other. The disappearance of the last bead is commonly taken as the beginning of totality. An arc of the chromosphere will then be visible at the point of disappearance, the length and duration of which will depend on the apparent diameter of the moon as compared with that of the sun, being greater in length and longer seen as the excess of diameter of the moon is less. The red prominences may now generally be seen here and there around the whole disc of the moon, while the effulgence of soft light called the corona surrounds it on all sides. Before the invention of the spectroscope, observers of total eclipses could do little more than describe in detail the varying phenomena presented by the prominences and the corona. Drawings of the latter showed it to have the appearance of rays surrounding the dark disc of the moon, quite similar to the glory depicted by the old painters around the head of a saint. The discrepancies between the outlines as thus pictured, not only at different times, but by different observers at the same time and place, are such as to show that little reliance can be placed on the details represented by hand drawings.

During the eclipse of July 8, 1842, the shadow of the moon passed from Perpignan, France, through Milan and Vienna, over Russia and Central Asia, to the Pacific Ocean. Very detailed physical observations were made, but none which need be specially mentioned in the present connexion. The eclipse of July 28, 1851, was total in Scandinavia and Russia. It was observed in the former region by many astronomers, among them Airy and Dawes. It was especially noteworthy for the first attempt to photograph such a phenomenon. A daguerreotype clearly showing the protuberances was taken by Berkawski at the Observatory of Königsberg. An attempt by Majocchi to daguerreotype the corona was a failure. Photographs of the eclipse of July 18, 1860, were taken by Padre Secchi and Mr Warren De La Rue, which showed the prominences well, and proved that they were progressively obscured by the edge of the advancing moon. It was thus shown that they were solar appendages, and did not belong to the moon, as had sometimes been supposed. The corona was

barely visible on De La Rue's plates, but those of Secchi showed it, with its rifts and the bases of the tall coronal wings, to about 15′ from the sun's limb. The sketches taken at this eclipse proved that the corona extended in some regions 1° from the sun's limb. As the sensitiveness of photographic plates has increased, they have gradually been wholly relied upon for information respecting the corona, so that at the present time naked-eye descriptions are regarded as of little or no scientific value. Owing to the great contrast between the brilliancy of the coronal light at its base and its increasing faintness as it extends farther from the sun, no one photograph will bring out all the corona. An exposure of one or two seconds is ample to show the details of the inner corona to the best advantage, while longer exposures give greater extent of the brighter portions. The most extended streamers are very little brighter than the sky, and must be photographed with short exposures.

The first application of the spectroscope to the phenomenon was made during the total solar eclipse of August 18, 1868, by Janssen and other observers in India. By them was made the capital discovery that the red solar prominences give a spectrum of bright lines, and are therefore immense masses of incandescent gases, chiefly hydrogen and the vapours of calcium and helium. Janssen also found that this bright-line spectrum could be followed after the eclipse was over, and, in fact, could be observed at any time when the air was sufficiently transparent. By one of those remarkable coincidences which frequently occur in the history of science, this last discovery was made independently by Lockyer in England before the news of Janssen's success had reached him. It was afterwards found that, by giving great dispersing power to the spectroscope, the prominences could be observed in a wide slit, in their true form. At this eclipse the spectrum of the corona was also observed, and was supposed to be continuous, while polariscopic observation by Lieutenant Campbell showed it polarized in planes passing through the sun's centre. The conclusion from these two observations was that the light was composed, at least in great part, of reflected sunlight. At the total eclipse of August 7, 1869, it was independently found by Professors Young of Princeton and Harkness of Washington that the continuous spectrum of the corona was crossed by a bright line in the green, which was long supposed to be coincident with 1474 of Kirchhoff's scale. This coincidence is, however, now found not to be real, and the line cannot be identified with that of any terrestrial substance. The name "coronium" has therefore been given to the supposed gas which forms it. It is now known that 1474 is a double line, one component of which is produced by iron, while the other is of unknown origin. The wave-length of the principal component is 5317, while that of the coronal line was found at the eclipses of 1896 and 1898 to be 5303.

The eclipse of December 28, 1870, passed over the south-western corner of Spain, Gibraltar, Oran, and Sicily. It is memorable for the discovery by Young of the "reversing layer" of the solar atmosphere. This term is now applied to a shallow stratum immediately above the photosphere, the absorption of which produces the principal dark lines of the solar spectrum, but which, being incandescent, gives a spectrum of bright lines by its own light when the light of the sun is cut off. This layer is much thinner than the chromosphere, and may be considered to form the base of the latter. Owing to its thinness, the phenomenon of the reversed bright lines is almost instantaneous in its nature, and can only be observed for a considerable period near the edge of the shadow-path where the moon advances but little beyond the solar limb. Elsewhere it is a mere flash. Young also at this eclipse saw bright hydrogen lines when his spectroscope was directed to the centre of the dark disc of the moon. This can only be attributed to the reflection of the light of the prominences and chromosphere from the atmosphere between us and the moon. The coronal light as observed in the spectroscope may thus be regarded as a mixture of true coronal light with chromospheric light reflected from the air, and it is therefore probable that the H and K (calcium) lines of the coronal spectrum are not true coronal lines, but chromospheric.

At the eclipse of December 12, 1871, visible in India and Australia, Janssen observed, as he supposed, some of the dark lines of the solar spectrum in the continuous spectrum of the corona, especially D, *b*, and G. This would show that an important part of the coronal light is due to reflected sunshine. This feature of the spectrum, however, is doubtful in the most recent photographs under the best conditions. At this eclipse the remarkable observation was also made by Herschel and Tennant that the characteristic line of the coronal spectrum is as bright in the dark rifts of the corona as elsewhere. This would show that the gas coronium does not form the streamers of the corona, but is spherical in form and distributed uniformly about the sun. Photographs were also taken on wet plates by a party in Java and by the parties of Lord Lindsay (at Baikul, India) and of Colonel Tennant (at Dodabetta). The Baikul and Dodabetta photographs were of small size (moon's diameter = $\frac{3}{10}$ inch), but of excellent definition. A searching study was made of them by Messrs Ranyard and Wesley (see *Memoirs R.A.S.* vol. xli. 1879), and for the first time a satisfactory representation of the corona was obtained. The drawings in the volume quoted show its polar rays, wings, interlacing filaments, and rifts as they are now known to be, as well as the forms and details of the prominences.

The eclipse of April 16, 1874, was observed in South Africa by Mr E. J. Stone, Astronomer-Royal at the Cape, who traced the coronal line about 30′ (430,000 miles) from the sun's limb. The visual corona was seen to extend in places some 90′ from the limb.

The eclipse of April 6, 1875, was observed in Siam by Sir J. Norman Lockyer and Professor Schuster. Their photographs showed the calcium and hydrogen lines in the prominence spectrum.

The eclipse of July 29, 1878, was thoroughly observed by many astronomers in the United States along a line extending from Wyoming to Texas. A number of the stations were at high altitudes (up to 14,000 feet), and the sky was generally very pure. The visible corona extended on both sides of the sun along the ecliptic for immense distances—at least twelve lunar diameters, about eleven million miles. Photographs taken by the parties of Professors Hall and Harkness gave the details of the inner corona and of the polar rays, showing the filamentous character of the corona, especially at its base in the polar regions. A photograph taken by the party of Professor Holden showed the outer corona to a distance of 50′ from the moon's limb. The bright-line spectrum of the corona was excessively faint and, as the solar activity (measured by sun-spot frequency) was near a minimum, it was concluded that the brilliancy of the coronium line varied in the sun-spot period, a conclusion which subsequent eclipse observations seem to have verified. It is not yet certain that the other coronal spectrum lines vary in the same way.

The eclipse of May 17, 1882, was observed in Egypt. On the photographs of the corona the image of a bright comet was found, the first instance of the sort. (A faint comet was found on the plates of the Lick Observatory eclipse expedition to Chile in 1893.) The slitless spectro-

scope showed the green line (coronium) and $D_3$ (helium) in the coronal spectrum.

The eclipse of May 6, 1883, was observed from a small coral atoll in the South Pacific Ocean by parties from America, England, France, Austria, and Italy. A thorough search was made by Holden (with a six-inch telescope) for an intra-Mercurial planet, without success, during an unusually long totality (5 m. 23 s.). Palisa also searched for such a planet. Janssen again reported the presence of dark lines in the coronal spectrum. "White" prominences were seen by Tacchini.

The eclipse of August 29, 1886, was observed in the West Indies. The English photographs of the corona, taken with a slitless spectroscope, show the hydrogen lines as well as K and *f*. Tacchini devoted his attention to the spectra of the prominences, and showed that their upper portions contained no hydrogen lines, but only the H and K lines of calcium. He also observed a very extensive "white" prominence. It was shown on the photographs of the corona, but could not be seen in the H$\alpha$ line with the spectroscope. It has been suggested by Professor G. E. Hale that the colour of a "white" prominence may be due to the fact that the H and K lines (calcium) are of their normal intensity, while the less refrangible prominence lines are, from some unknown cause, comparatively faint. It is known that the intensity of such lines does, in fact, vary, though it is not yet certain that the "white" prominences are produced in this way. The subject is one demanding further observation. High prominences are generally "white" at their summits, "red" at their bases. The Harvard College Observatory photographs show the corona out to 90′ from the moon's limb, though no detail is visible beyond 60′. Mr W. H. Pickering made a series of photographic photometric measures of the corona, some of which are given below, together with results deduced by Holden from the eclipses of January and December 1889 :—

| | August 1886. | January 1889. | December 1889. |
|---|---|---|---|
| Intrinsic actinic brilliancy of the brightest parts of the corona . | 0·031 | 0·079 | 0·029 |
| Do. of the polar rays . . | ... | 0·053 | 0·016 |
| Do. of the sky near the sun | 0·0007 | 0·0050 | 0·0009 |
| Ratio of intrinsic brilliancy of the brightest parts of the corona to that of the sky (actinic) . . | 44 to 1 | 16 to 1 | 32 to 1 |
| Magnitude of the faintest star shown on the eclipse negatives . | ... | 2·3 | ... |

The results in the first and third columns are derived from plates taken in a very humid climate, and are not very different.

The eclipse of August 19, 1887, was total in Japan and Russia, but cloudy weather prevented successful observations except in Siberia and Eastern Russia.

The eclipse of January 1, 1889, was observed in California and Nevada by many American astronomers. The photographs of the corona, especially those by Charoppin and Barnard, show a wealth of detail. Those of Barnard, of the Lick Observatory party, were studied by Holden, and exhibited the fact that rays, like the "polar-rays," extended all round the sun, instead of being confined to the polar regions only. The outer corona was registered out to 100′ from the moon's limb on Charoppin's negatives, to 130′ on those of Lowden and Ireland. On other plates the outline of the moon is visible projected on the corona before totality began. The spectrum of the corona showed few bright lines besides those of coronium and hydrogen.

The eclipse of December 22, 1889, was observed in Cayenne, S.A., by a party from the Lick Observatory under rather unfavourable conditions. Expeditions sent to Africa were baffled by cloudy weather. Father Perry observed at Salute Islands, French Guiana, and obtained some photographs of value. The effort cost him his life, for he died of malarial fever five days after the eclipse.

The eclipse of April 16, 1893, was observed by British and French parties in Africa and Brazil, and by Professor Schalberle of the Lick Observatory in Chile. The Chile photographs of the corona were taken with a lens of 40 feet focus, and are extremely fine. They show a faint comet near the sun. No great extensions to the corona were shown on any of the negatives, or seen visually, though they were specially looked for by British parties. The neighbourhood of the sun was carefully examined by Bigourdan without finding any planet. The spectrum of the corona was the usual one. The following lines were photographed in slitless spectroscopes, and undoubtedly belong to the corona :—W. L. 3987; 4086; 4217; 4231; 4240; 4280; 4486; 5303 (the last number is the wave-length of the green coronium line). All of these have been seen in slit spectroscopes also. It is possible that two lines observed by Young in 1869, namely, W. L. (Ångstrom) 5450 and 5570, should be added to the list of undoubted coronal lines. It is not likely that helium or hydrogen or calcium vapour forms part of the corona. The wave-lengths of some 700 lines belonging to the chromosphere and prominences were determined by the British parties.

The eclipse of August 9, 1896, was total in Norway and Nova Zembla. The day was very unfavourable, but good photographs of the corona were obtained by Russian parties in Siberia and Lapland. Mr Shackelton, in Nova Zembla, with a prismatic camera obtained a photograph of the reversing-layer at the beginning of totality. This photograph completely confirms Young's discovery, and shows the prominent Fraunhofer lines bright, the bright lines of the chromosphere spectrum being especially conspicuous.

At the solar eclipse of January 22, 1898, the shadow of the moon traversed India from the western coast to the Himalaya. The duration of totality was about 2 m. The eclipse was very fully observed, more than 100 negatives of the corona being secured. The equatorial extension of the visible corona was short and faint, and the invisible (spectroscopic) corona was also very faint. The spectrum of the reversing-layer was successfully photographed; one set of negatives shows the polarization of one of the longest streamers of the corona, and proves the presence of dust particles reflecting solar light. The bright-line spectrum of hydrogen in the chromosphere was followed to the thirtieth point of the series, and the wave-lengths were shown to agree closely with Balmer's formula (see SPECTROSCOPE). The wave-length of coronium was found to be 5303 (not 5317 as previously supposed), and the brightness of the corona was measured. Maunder made the curious observation of coronal matter enveloping a prominence in the form of a hood.

Observations of the eclipse of May 28, 1900, were favoured in a remarkable degree by the absence of clouds. The photographs of the corona obtained by Campbell extended four diameters of the sun on the west side. The sun's edge was photographed with an objective-prism spectrograph composed of two 60° prisms in front of a telescope of 2 in. aperture and 60 in. focus. A fine photograph, 6 inches long, of the bright- and dark-line spectra of the sun's edge at the end of totality was thus obtained. It shows 600 bright lines sharply in focus besides the dark-line spectrum, to which the bright lines gave way as the sun reappeared. The coronal material radiating the green light was found to be markedly heaped up in the sun-spot regions. No dark lines were found in the spectrum of the

inner corona. Hale and Frost also photographed the combined bright- and dark-line spectra of the solar cusps at the instants before and after totality. On one photograph showing no dark lines 70 bright lines could be measured between 4070 and 4340. On another were 70 bright lines between H*b* and Hs. On a third were 266 bright lines between 4026 and 4381, and some dark lines. These lines show a marked dissimilarity from the solar spectrum.

At this eclipse the "shadow-bands" received special attention. These consist of seeming vague and rapidly moving alternations of light and shade flitting over any white surface illuminated by the sun's rays just before and after the total phase; they are probably due to a flickering of the light from the thin crescent produced by the air, in the same way that the twinkling of the stars is produced.

*References.*—The richest mine of information respecting eclipses of the sun and moon is Oppolzer's "Kanon der Finsternisse," published by the Vienna Academy of Sciences in the 52nd volume of its *Denkschriften*, Vienna, 1887. It contains elements of all eclipses both of the sun and moon, from 1207 B.C. to A.D. 2161, a period of more than thirty centuries. Appended to the tables is a series of charts showing the paths of all central eclipses visible in the northern hemisphere during the period covered by the table. The points of the path at which the eclipse occurs, at sunrise, noon, and sunset, are laid down with precision, but the intermediate points are frequently in error by several hundred miles, as they were not calculated, but projected simply by drawing a circle through the three points just mentioned. For this reason we cannot infer from them that an eclipse was total at any given place. The correct path can, however, be readily computed from the tables given in the work. Dr Eduard Mahler's memoir, "Die Centralen Sonnenfinsternisse des XX. Jahrhunderts" (*Denkschriften*, Vienna Academy, vol. xlix.), gives more exact paths of the central eclipses of the 20th century, but no maps. General tables for computing eclipses are Oppolzer's "Syzygien-tafeln für den Mond" (*Publication der Astronomischen Gesellschaft*, xvi.), and Newcomb's, in *Publications of the American Ephemeris*, vol. i. part i. Of these, Oppolzer's are constructed with greater numerical accuracy and detail, while Newcomb's are founded on more recent astronomical data, and are preferable for computing ancient eclipses. Ginzel's *Spezieller Kanon der Sonnen- und Mondfinsternisse* (Berlin, 1899) contains, besides the historical researches already mentioned, maps of the paths of central eclipses visible in the lands of classical antiquity from 900 B.C. to A.D. 500, but computed with imperfect astronomical data. Maguire, "Monthly Notices," *R.A.S.*, xlv. and xlvi., has mapped the total solar eclipses visible in the British Islands from 878 to 1724. General papers of interest on the same subject have been published by Rev. S. J. Johnson. A résumé of all the observations on the physical phenomena of total solar eclipses up to 1878, by A. C. Ranyard, is to be found in *Memoirs of the Royal Astronomical Society*, vol. xli. A very copious development of the computation of eclipses by Bessel's method is found in Chauvenet's *Spherical and Practical Astronomy*, vol. i. Hansen's method is developed in the *Abhandlungen* of the Leipzig Academy of Sciences, vol. vi. (Math.-Phys. Classe, vol. iv.). The formulæ of computation by this method are found in the introductions to Oppolzer's two works cited above. (S. N.)

**Economic Entomology** is the study of insects based on their relation to man, his domestic animals and his crops, and, in the case of those that are injurious, of the practical methods by which they can be prevented from doing harm, or be destroyed when present. In Great Britain little attention is paid to this important branch of agricultural science, but in America and the British Colonies the case is different. Nearly every State in America has its official Economic Entomologists, and nearly every one of the British Crown Colonies is provided with one or more able men who help the agricultural community to battle against the insect pests. Most, if not all, of the important knowledge of remedies comes from America, where this subject reaches the highest perfection; even the life-histories of some of the British pests have been traced out in the United States and British Colonies more completely than at home, from the creatures that have been introduced from Europe.

Some idea of the importance of this subject may be gained from the following figures. The estimated loss by the Vine Phylloxera in the Gironde alone was £32,000,000; for all the French wine districts £100,000,000 would not cover the damage. It has been stated on good evidence that a loss of £7,000,000 per annum was caused by the attack of the Ox Warble Fly on cattle in England alone. In a single season Aberdeenshire suffered nearly £90,000 worth of damage owing to the ravages of the Diamond Back Moth on the root crops; in New York State the Codling Moth caused a loss of $3,000,000 to apple growers. Yet these figures are nothing compared to the losses due to Scale Insects, Locusts, and other pests.

The most able exponent of this subject in Great Britain was John Curtis, whose treatise on *Farm Insects*, published in 1860, is still the standard British work dealing with the insect foes of corn, roots, grass, and stored corn. The most important works dealing with fruit and other pests come from the pens of Saunders, Lintner, Riley, Slingerland, and others in America and Canada, from Taschenberg, Lampa, Reuter, and Kollar in Europe, and from French, Froggatt, and Tryon in Australia. It was not until the last quarter of the 19th century that any real advance was made in the study of economic entomology. Among the early writings, besides the book of Curtis, there may also be mentioned a still useful little publication by Pohl and Kollar, entitled *Insects Injurious to Gardeners, Foresters, and Farmers*, published in 1837, and Taschenberg's *Praktische Inseektenkunde*. American literature began as far back as 1788, when a report on the Hessian Fly was issued by Sir Joseph Banks; in 1817 Say began his writings; while in 1856 Asa Fitch started his report on the "Noxious Insects of New York." Since that date the literature has largely increased. Among the most important reports, &c., may be mentioned those of Riley, published by the U.S. Department of Agriculture, extending from 1878 to his death, in which is embodied an enormous amount of valuable matter. At his death the work fell to Professor Howard, who constantly issues brochures of equal value in the form of Bulletins of the State Department of Agriculture. The chief writings of Lintner extend from 1882 to 1898, in yearly parts, under the title of *Reports on the Injurious Insects of the State of New York*. Another author whose writings rank high on this subject is Slingerland, whose investigations are published by Cornell University. Among other Americans who have largely increased the literature and knowledge must be mentioned Webster and Felt. In 1883 appeared a work on fruit pests by William Saunders, which mainly applies to the American continent; and another small book on the same subject was published in 1898 by Miss Ormerod, dealing with the British pests. In Australia Tryon published a work on the *Insect and Fungus Enemies of Queensland* in 1889. Many other papers and reports are being issued from Australia, notably by Froggatt in N.S. Wales. At the Cape excellent works and papers are prepared and issued by the Government Entomologist, Dr Lounsbury, under the auspices of the Agricultural Department; while from India we have Cotes's *Notes on Economic Entomology*, published by the Indian Museum in 1888, and other works, especially on tea pests.

Injurious insects occur among the following orders:—*Coleoptera*, *Hymenoptera*, *Lepidoptera*, *Diptera*, *Hemiptera* (both *heteroptera* and *homoptera*), *Orthoptera*, *Neuroptera*, and *Thysanoptera*. The order *Aptera* also contains a few injurious species.

Among the *Coleoptera* or Beetles there is a group of world-wide pests, the *Elateridæ* or Click Beetles, the adults of the various "Wireworms." These insects in the larval or wireworm stage attack the roots of plants, eating them away below the ground. The eggs deposited by the beetle in the ground develop into yellowish brown wire-like grubs with six legs on the first three segments and a ventral prominence on the anal segment. The life of these subterranean pests differs in the various species; some undoubtedly (*Agriotes lineatum*) live for three or four years, during the greater part of which time they gnaw away at the roots of plants, carrying wholesale destruction before them. When mature they pass deep into the ground and pupate, appearing after a few months as the click beetles (Fig. 1). Most crops are attacked by them, but they are particularly destructive to wheat and other cereals. With such subterranean pests little can be done beyond

rolling the land to keep it firm, and thus preventing them from moving rapidly from plant to plant. A few crops, such as mustard, seem deleterious to them. By growing mustard and ploughing it in green the ground is made obnoxious to the wireworms, and may even be cleared of them. For root feeders, bisulphide of carbon injected

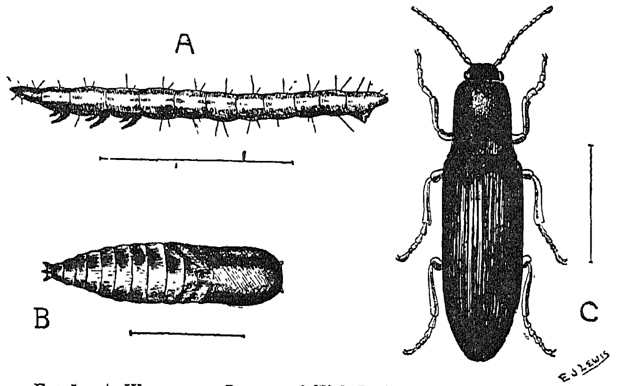


FIG. 1.—A, Wireworm; B, pupa of Click Beetle; C, adult Click Beetle (*Agriotes lineatum*).

into the soil is of particular value. One ounce injected about two feet from an apple tree on two sides has been found to destroy all the ground form of the Woolly Aphis. In garden cultivation it is most useful for wireworm, used at the rate of 1 ounce to every 4 square yards. It kills all root pests.

In Great Britain the Flea Beetles (*Halticidæ*) are one of the most serious enemies; one of these, the Turnip Flea (*Phyllotreta nemorum*), has in some years, notably 1881, caused more than £500,000 loss in England and Scotland alone by eating the young seedling turnips, cabbage, and other *Cruciferæ*. In some years three or four sowings have to be made before a "plant" is produced enormous loss in labour and cost of seed alone being thus involved. These beetles, characterized by their skipping movements and enlarged hind femora, also attack the hop (*H. concinna*), the vine in America (*Graptodera chalybea*, Illig.), and numerous other species of plants, being specially harmful to seedlings and young growth. Soaking the seed in strong-smelling substances, such as paraffin and turpentine, has been found efficacious, and in some districts paraffin sprayed over the seedlings has been practised with decided success. This oil generally acts as an excellent preventive of this and other insect attacks.

In all climates fruit and forest trees suffer from Weevils or *Cuculionidæ*. The Plum Cuculio (*Conotrachelus nenuphar*, Herbst) in America causes endless harm in plum orchards; Cuculios in Australia ravage the vines and fruit trees (*Orthorrhinus Klugii*, Schon, and *Leptops Hopei*, Bohm, &c.). In Europe a number of "long-snouted" beetles, such as the Raspberry Weevils (*Otiorhynchus picipes*), the Apple Blossom Weevil (*Anthonomus pomorum*), attack fruit; others, as the "corn weevils" (*Calandra oryzæ* and *C. granaria*), attack stored rice and corn; while others produce swollen patches on roots (*Ceutorhynchus sulcicollis*), &c. All these Cuculionidæ are very timid creatures, falling to the ground at the least shock. This habit can be used as a means of killing them, by placing boards or sacks covered with tar below the trees, which are then gently shaken. As many of these beetles are nocturnal, this trapping should take place at night. Larval "weevils" mostly feed on the roots of plants, but some, such as the Nut Weevil (*Balaninus nucum*), live as larvæ inside fruit. Seeds of various plants are also attacked by weevils of the family *Bruchidæ*, especially beans and peas. These seed-feeders may be killed in the seeds by subjecting them to the fumes of bisulphide of carbon. The corn weevils (*Calandra granaria* and *C. oryzæ*) are now found all over the world, in many cases rendering whole cargoes of corn useless.

The most important Hymenopterous pests are the Saw-flies or *Tenthredinidæ*, which in their larval stage attack almost all vegetation. The larvæ of these are usually spoken of as "false caterpillars," on account of their resemblance to the larvæ of a moth. They are most ravenous feeders, stripping bushes and trees completely of their foliage, and even fruit. Sawfly larvæ can at once be recognized by the curious positions they assume, and by the number of pro-legs, which exceeds ten. The female lays her eggs in a slit made by means of her "saw-like" ovipositor in the leaf or fruit of a tree. The pupæ in most of these pests are found in an earthen cocoon beneath the ground, or in some cases above ground (*Lophyrus pini*). One species, the Slugworm (*Eriocampa limacina*), is common to Europe and America; the larva is a curious slug-like creature, found on the upper surface of the leaves of the pear and cherry, which secretes a slimy coating from its skin. Currant and gooseberry are also attacked by sawfly larvæ (*Nematus ribesii* and *N. ventricosus*) both in Europe and America. Other species attack the stalks of grasses and corn (*Cephus pygmæus*). Forest trees also suffer from their ravages, especially the Conifers (*Lophyrus pini*). Another group of Hymenoptera occasionally causes much harm in fir plantations, namely, the *Siricidæ* or Wood-Wasps, whose larvæ burrow into the trunks of the trees and thus kill them. For all exposed Sawfly larvæ hellebore washes are most fatal, but they must not be used over ripe or ripening fruit, as the hellebore is poisonous.

The order Diptera contains a host of serious pests. These two-winged insects attack all kinds of plants, and also animals in their larval stage. Many of the adults are bloodsuckers (*Tabanidæ*, *Culicidæ*, &c.); others are parasitic in their larval stage (*Œstridæ*, &c.). The best known dipterous pests are the Hessian Fly (*Cecidomyia destructor*), the Pear Midge (*Diplosis pyrivora*), the Fruit Flies (*Tephritis Tryoni* of Queensland and *Halterophora capitata* or the Mediterranean Fruit Fly), the Onion Fly (*Phorbia cepetorum*), and numerous corn pests, such as the Gout Fly (*Chloropstæniopus*) and the Frit Fly (*Oscinis frit*). Animals suffer from the ravages of Bot Flies (*Œstridæ*) and Gad Flies (*Tabanidæ*); while the Tsetse disease is due to the Tsetse Fly (*Glossina morsitans*), carrying the protozoa that cause the disease from one horse to another. Other flies act as disease-carriers, including the mosquitoes (*Anopheles*), which not only carry malarial germs, but also form a secondary host for these parasites. Hundreds of acres of wheat are lost annually in America by

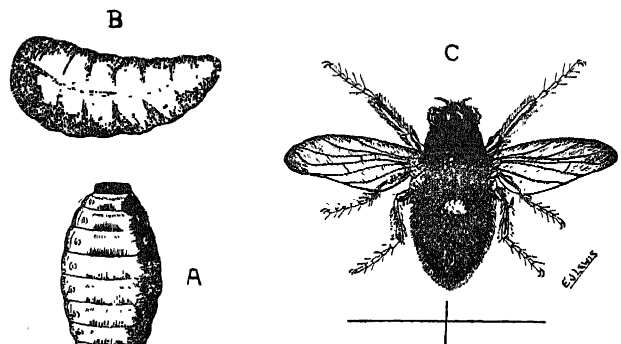


FIG. 2.—A, Ox Bot Maggot; B, puparium; C, Ox Warble Fly (*Hypoderma bovis*).

the ravages of the Hessian Fly; the Fruit Flies of Australia and South Africa cause much loss to orange

and citron growers, often making it necessary to cover the trees in muslin tents for protection. Of animal pests the Ox Warbles (*Hypoderma lineata* and *H. bovis*) are the most important (see Fig. 2). The "bots" or larvæ of these flies live under the skin of cattle, producing large swollen lumps—"warbles"—in which the "bots" mature (Fig. 2). These parasites damage the hide, set up inflammation, and cause immense loss to farmers, herdsmen, and butchers. The universal attack that has been made upon this pest has, however, largely decreased its numbers. In America cattle suffer much from the Horn Fly (*Hæmatobia serrata*). The dipterous garden pests, such as the Onion Fly, Carrot Fly, and Celery Fly, can best be kept in check by the use of paraffin emulsions and the treatment of the soil with gas-lime after the crop is lifted. Cereal pests can only be treated by general cleanliness and good farming, and of course they are largely kept down by the rotation of crops.

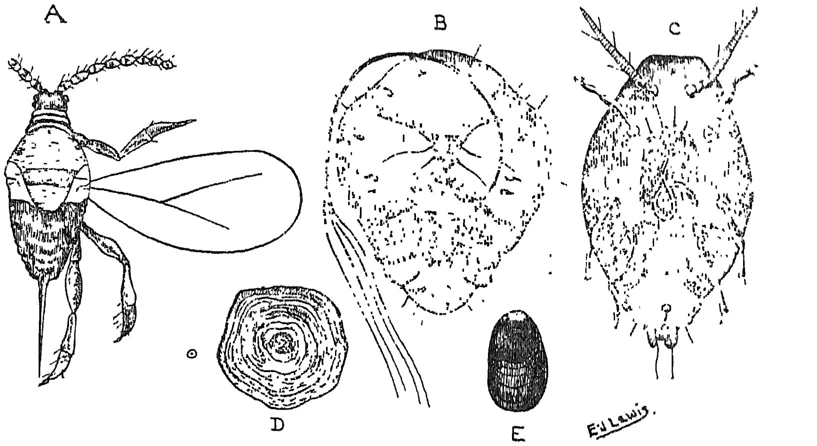


FIG. 4.—San José Scale ([illegible]). A, male scale insect; B, female; C, [illegible]; D, [illegible], E, male scale.

Lepidopterous enemies are numerous all over the world. Fruit suffers much from the larvæ of the *Geometridæ*, the so-called "Looper-larvæ" or "Canker-worms." Of these geometers the Winter Moth (*Cheimatobia brumata*) is one of the chief culprits in Europe (Fig. 3). The females in this moth and in others allied to it are wingless. These insects pass the pupal stage in the ground, and reach the boughs to lay their eggs by crawling up the trunks of the trees. To check them, "grease-banding" round the trees has been adopted; but as many other pests eat the leafage, it is best to kill all at once by spraying with arsenical poisons. Among other notable Lepidopterous pests are the "surface larvæ" or Cutworms (*Agrotis spp.*), the caterpillars of various Noctuæ; the Codling Moth (*Carpocapsa pomonella*), which causes the maggot in apples, has now become a universal pest, having spread from Europe to America and to most of the British Colonies. In many years quite half the apple crop is lost in England owing to the larvæ destroying the fruit. Sugar canes suffer from the Sugar-cane Borer (*Diatioca sacchari*) in the West Indies; tobacco from the larvæ of Hawk Moths (*Sphingidæ*) in America; corn and grass from various Lepidopterous pests all over the world. Nor are stored goods exempt, for much loss annually takes place in corn and flour from the presence of the larvæ of the Mediterranean Flour Moth (*Ephestia kuniella*); while furs and clothes are often ruined by the Clothes Moth (*Tinea trapezella*).

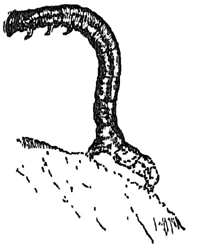

FIG. 3.—Looper-larva of Winter Moth (*Cheimatobia brumata*).

By far the most destructive insects in warm climates belong to the Hemiptera, especially to the *Coccidæ* or Scale Insects. All fruit and forest trees suffer from these curious insects, which in the female sex always remain apterous and apodal and live attached to the bark, leaf, and fruit, hidden beneath variously-formed scale-like coverings. The male scales differ in form from the female; the adult male is winged, and is rarely seen. The female lays her eggs beneath the scaly covering, from which hatch out little active six-legged larvæ, which wander about and soon begin to form a new scale. The *Coccidæ* can, and mainly do, breed asexually (parthenogenetically). One of the most important is the San José Scale (*Aspidiotus perniciosus*), which in warm climates attacks all fruit and many other trees, which, if unmolested, it will soon kill (Fig. 4). These scales breed very rapidly; Howard states one may give rise to a progeny of 3,216,080,400 in one year. Other scale insects of note are the cosmopolitan Mussel Scale (*Mytilaspis pomorum*) and the Australian *Icerya purchasi*. The former attacks apple and pear; the latter, which selects orange and citron, was introduced into America from Australia, and carried ruin before it in some orange districts until its natural enemy, the lady-bird beetle, *Adalia cardinalis*, was also imported.

After the *Coccidæ* the next most important insects economically are the Plant Lice or *Aphididæ*. These breed with great rapidity under favourable conditions: one by the end of the year will be accountable, according to Linnæus, for the enormous number of a quintillion of its species. Aphides are born, as a rule, alive, and the young soon commence to reproduce again. Their food consists mainly of the sap obtained from the leaves and blossom of plants, but some also live on the roots of plants (*Phylloxera vastatrix* and *Schizoneura lanigera*). Aphides often ruin whole crops of fruit, corn, hops, &c., by sucking out the sap, and not only check growth, but may even entail the death of the plant. Reproduction is mainly asexual,

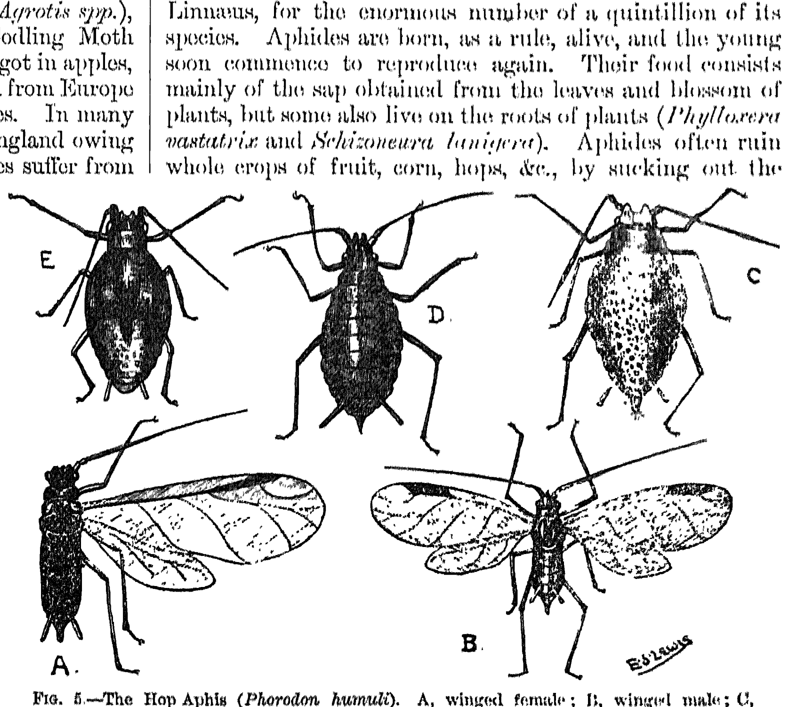


FIG. 5.—The Hop Aphis (*Phorodon humuli*). A, winged female; B, winged male; C, ovigerous wingless female; D, viviparous wingless female from plum; E, pupal stage.

the females producing living young without the agency of a male. Males in nearly all species appear once a year, when the last female generation, the ovigerous generation, is fertilized, and a few large ova are produced to carry on the continuity of the species over the winter. Some aphides live only on one species of plant, others on two or more plants. An example of the latter is seen in the Hop Aphis (*Phorodon humuli*), which passes the winter and lives on the sloe and damson in the egg stage until the middle of May or later, and then flies off to the hops, where it causes endless harm all the summer (Fig. 5); it flies back to the prunes to lay its eggs when the hops are ripe. Another Aphis of importance is the Woolly Aphis (*Schizoneura lanigera*) of the apple and pear: it secretes tufts of white flocculent wool often to be seen hanging in patches from old apple trees, where the insects live in the rough bark and form cankered growths both above and below ground. Aphides are provided with a mealy skin, which does not allow water to be attached to it, and thus insecticides for destroying them contain soft soap, which fixes the solution to the skin; paraffin is added to corrode the skin, and the soft soap blocks up the breathing pores and so produces asphyxiation.

Amongst *Orthoptera* we find many noxious insects, notably the Locusts, which travel in vast cloud-like armies, clearing the whole country before them of all vegetable life. The most destructive locust is the migratory locust (*Locusta migratoria*), which causes wholesale destruction in the East. Large pits are dug across the line of advance of these great insect armies to stop them when in the larval or wingless stage, and even huge bonfires are lighted to check their flight when adult. So dense are these "locust clouds" that they sometimes quite darken the air. The commonest and most widely distributed migratory locust is *Pachytylus cinerascens*. The mole cricket (*Gryllotalpa vulgaris*) and various cockroaches (*Blattidæ*) are also amongst the pests found in this order.

Of *Neuroptera* there are but few injurious species, and many, such as the lace wing flies (*Hemerobiidæ*), are beneficial.

*The Treatment of Insect Pests.*—One of the most important ways of keeping insect pests in check is by "spraying" or "washing." This method has made great advances in recent years. All the pioneer work has been done in America; in fact, until the South-Eastern Agricultural College undertook the elucidation of this subject, little was known of it in England except by a few growers. The results and history of this essential method of treatment are embodied in Professor Lodemann's work on the *Spraying of Plants*, 1896. In this treatment we have to bear in mind what the entomologist teaches us, that is, the nature, habits, and structure of the pest.

For insects provided with a biting mouth, which take nourishment from the whole leaf, shoot, or fruit, the poisonous washes used are chiefly arsenical. The two most useful arsenical sprays are Paris green and arsenate of lead. To make the former, mix 1 oz. of the Paris green with 15 gallons of soft water, and add 2 oz. of lime and a small quantity of agricultural treacle; the latter is prepared by dissolving 3 oz. of acetate of lead in a little water, then 1 oz. of arsenate of soda in water and mixing the two well together, and adding the whole to 16 gallons of soft water; to this is added a small quantity of coarse treacle. For piercing-mouthed pests like *Aphides* no wash is of use unless it contains a basis of soft soap. This soft-soap wash kills by contact, and may be prepared in the following way:—Dissolve 6 to 8 ℔ of the best soft soap in boiling soft water, and while still hot (but of course taken off the fire) add 1 gallon of paraffin oil and churn well together with a force-pump; the whole may then be mixed with 100 gallons of soft water. The oil readily separates from the water, and thus a perfect emulsion is not obtained; this difficulty has been solved by Mr Cousin's paraffin naphthalene wash, which is patented, but can be made for private use. It is prepared as follows:—Soft soap, 6 ℔ dissolved in 1 quart of water; naphthalene, 10 oz. mixed with 1½ pint of paraffin; the whole is mixed together. When required for use, 1 ℔ of the compound is dissolved in 5 to 10 gallons of warm water.

These two washes are essential to the well-being of every orchard in all climates. Not only can we now destroy larval and adult insects, but we can also attack them in the egg stage by the use of a caustic alkali wash during the winter; besides destroying the eggs of such pests as the *Psyllidæ*, Red Spider, and some Aphides, this also removes the vegetal encumbrances which shelter numerous other insect pests during the cold part of the year. Caustic alkali wash is prepared by dissolving 1 ℔ of crude potash and 1 ℔ of caustic soda in soft water, mixing the two solutions together, adding to them ¾ ℔ of soft soap, and diluting with 10 gallons of soft water when required for use. Another approved insecticide for Scale Insects is resin wash, which acts in two ways: first, corroding the soft scales, and second, fixing the harder scales to stop the egress of the hexapod larvæ. It is prepared as follows:—First crush 8 ℔ of resin in a sack, and then place the resin in warm water and boil in a cauldron until thoroughly dissolved; then melt 10 ℔ of caustic soda in enough warm water to keep it liquid, and mix with the dissolved resin; keep stirring until the mixture assumes a clear coffee-colour, and for ten minutes afterwards; then add enough warm water to bring the whole up to 25 gallons, and well stir. Bottle this off, and when required for use dilute with three times its bulk of warm soft water, and spray over the trees in the early spring just before the buds burst. For mites (*Acari*) sulphur is the essential ingredient of a spray. Liver of sulphur has been found to be the best form, especially when mixed with a paraffin emulsion. Bud Mites (*Phytoptidæ*, Fig. 6) are of course not affected. Sulphur wash is

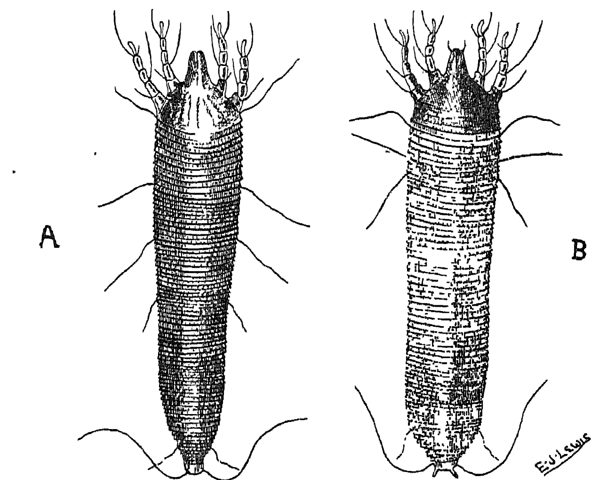


FIG. 6.—Bud Mites (*Phytoptidæ*). A, currant bud mite (*Phytoptus ribis*); B, nut bud mite (*P. avellanæ*).

made by adding to every 10 gallons of warm paraffin emulsion or paraffin-naphthalene-emulsion 7 oz. of liver of sulphur, and stirring until the sulphur is well mixed. This is applied as an ordinary spray. Nursery stock should always be treated, to kill scale, aphis, and other pests which it may carry, by the gas treatment, particularly in the case of stock imported from a foreign climate. This treatment, both out of doors and under glass, is carried out as follows:—Cover the plants in bulk with a light gas-tight cloth, or put them in a special fumigating house, and then place 1 oz. of cyanide of potassium in lumps in a dish with water beneath the covering, and then pour 1 oz. of sulphuric acid over it (being careful not to inhale the poisonous fumes) for every 1000 cubic feet of space beneath the cover. The gas generated, hydrocyanic acid should be left to work for at least an hour before the stock is removed, when all forms of animal life will be destroyed.

For spraying, proper instruments must be used, by means of which the liquid is sent out over the plants in as fine a mist as possible. Numerous pumps and nozzles are now made by which this end is attained. Both horse and hand machines are employed, the former for hops and large orchards, the latter for bush fruit and gardens. In America, where trees in parks as well as orchards and gardens are treated, steam-power is sometimes used. Among the most important sprayers are the Strawson horse sprayers and the smaller Eclair and Notus knapsack pumps, carried on the back (Fig. 7). The nozzles for "mistifying" the wash most in use are known as the Vermorel and Riley's, which can be fitted to any length of tubing, so as to reach any height, and can be turned in any direction. The pumps in the machine keep the insecticide constantly mixed, and at the same time force the wash with great strength through the nozzle, and so to the exterior, as a fine mist; every part of the plant is thus affected.

*Beneficial Insects* have also to be considered in Economic Entomology. They are of two kinds—(1) those that help to keep down an excess of other insects by acting either

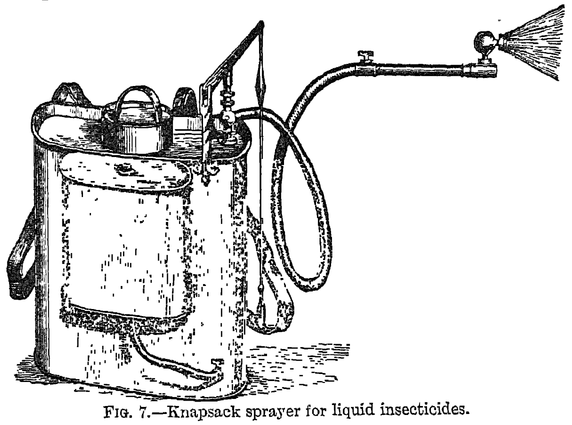

FIG. 7.—Knapsack sprayer for liquid insecticides.

as parasites or by being insectivorous in habit; and (2) insects of economic value, such as the bee and silkworm. Amongst the most important friends to the farmer and gardener are the Hymenopterous families of Ichneumon Flies (*Ichneumonidæ* and *Braconidæ*); the Dipterous families *Syrphidæ* and *Tachinidæ;* the Coleopterous families *Coccinellidæ* and *Carabidæ;* and the Neuropterous *Hemerobiidæ*, or Lace-Wing Flies. Ichneumon Flies lay their eggs either in the larvæ or ova of other insects, and the parasites destroy their host. In this way the Hessian Fly is doubtless kept in check in Europe, and the Aphides meet with serious hindrance to their increase. If a number of plant-lice are examined, a few will be found looking like little pearls; these are the dried skins of those that have been killed by *Ichneumonidæ*. The *Syrphidæ*, or Hover Flies, are almost exclusively aphis-feeders in their larval stage. *Tachina* flies attack lepidopterous larvæ. One of the most notable examples of the use of insect allies is the case of the Australian Lady Bird, *Adalia cardinalis*, which, in common with all lady birds, feeds off *Aphidæ* and *Coccidæ*. The Icerya Scale (*Icerya purchasi*) imported into America ruined the orange groves, but its enemy, the *Adalia*, was also imported from Australia, and counteracted its abnormal increase with such great results that the crippled orange groves are now once more profitable. (F. V. T.)

# ECONOMICS.

In a former article (see POLITICAL ECONOMY, *Ency. Brit.*, 9th edition, vol. xix. pp. 346–401), in which the growth of Economics from the earliest times was described, it was shown that, owing partly to the conditions affecting the industrial and commercial organization and the economic policy of different countries, partly to the influence on economics of the growth of other sciences, there were in Europe and America various schools of economists representing somewhat different views as to the aims, the subject-matter, and the method of the science. This state of things was no doubt a symptom of vitality and progress, but it was associated with much destructive criticism of principles hitherto considered well founded, and diminished for a time both the practical usefulness of the science and the estimation in which it was held by ordinary men. During the last few years there have been no new departures of fundamental importance, such as the application of the historical method to economic investigation; the methods characteristic of the different groups of economists have been seen to be not mutually exclusive, but complementary to each other; and much of the work done has been constructive, in the sense that economic writers have devoted themselves to the solution of particular problems rather than the discussion of the method by which the problems should be attacked. The time has therefore now arrived when we can review the situation and attempt to combine the positive results of a period of active criticism and inquiry. Many years must elapse before we can survey the whole field of economic investigation, if indeed the time ever arrives when we can undertake so great a task. Present tendencies scarcely point to the creation of a complete and well-rounded system of economics such as appealed to past generations. Like the world of business and commerce of which it is the reflex, economic thought resembles a great river. Its sources lie far back in the historic past. Its course has been determined by practical needs which are no longer felt, by ideals to which the present generation does not respond, and by systems of politics and philosophy whose day is over. The titles of an economic bibliography are a brief epitome of general history, and a complete survey of economic thought at the present time would involve a careful examination of many of the important questions which now occupy the public mind in, at least, Europe and America. It is the spirit and the method of economic science which we may hope will be permanent. The more numerous the points of contact between economic science and the real world of business, the less possible will it be, at any rate for many years, to construct a complete system. In the present state of economic knowledge, generality can only be obtained by abstraction. But it is possible to describe the character and and subject-matter of economics, to indicate its relation to other sciences, to explain the methods by which economists reach their conclusions, to show within what limits a science which we may call General Economics is possible, to apply our reasoning to particular groups of practical questions; and that is the task we shall attempt in the following pages.

***A review of recent work on economics.***

***Definition.***

Economics, as we understand it, is the science which investigates the manner in which nations or other larger or smaller communities, and their individual members, obtain food, clothing, shelter, and whatever else is considered desirable or necessary for the maintenance and improvement of the conditions of life. It is thus the study of the life of communities with special reference to one side of their activity. It necessarily involves the scientific examination of the structure and organization of the community or communities in question; their history, their customs, laws, and institutions; and the relations between their members, in so far as they affect or are affected by this department of their activity. At the root of all economic investigation lies the conception of the standard of life of the community. By this expression we do not mean an ideal mode of living, but the habits and requirements of life generally current in a community or grade of society at a given period. The standard of life of the ordinary well-to-do middle class in England, for example, includes not only food, clothing, and shelter of a kind different in many respects from that of a similar class in other countries and of other classes in England, but a highly complicated mechanism, both public and private, for ministering to these primary needs, habits of social intercourse, educational and sanitary organization, recreative arrangements, and many other

elements. Many influences operating for a long period of time on the character and the environment of a class go to determine its standard of life. In a modern industrial community it is possible to express this standard fairly accurately for the purposes of economic investigation in terms of money. But it is doubtful whether the most complete investigation would ever enable us to include all the elements of the standard of life in a money estimate. The character, tastes, and capacity for management of different individuals and groups differ so widely that equal incomes do not necessarily imply identity of standard. In the investigation of past times, the incommensurate elements of well-being are so numerous that merely money estimates are frequently misleading. The conception of the standard of life involves also some estimate of the efforts and sacrifices people are prepared to make to obtain it; of their ideals and character; of the relative strength of the different motives which usually determine their conduct. But no carefully devised calculus can take the place of insight, observation, and experience. The economist should be a man of wide sympathies and practical sagacity, in close touch with men of different grades, and, if possible, experienced in affairs.

**Character of subject-matter.**

It is evident that no permanent classification is possible of what is or is not of economic significance. No general rules, applicable to all times, can be laid down as to what phenomena must be examined or what may be neglected in economic inquiry. The different departments of human activity are organically connected, and all facts relating to the life of a community have a near or remote economic significance. For short historical periods, indeed, many phenomena are so remotely connected with the ordinary business of life that we may ignore them. But at any moment special causes may bring into the field of economic inquiry whole departments of life which have hitherto been legitimately ignored. In times past, biblical exegesis, religious ideals, and ecclesiastical organization, the purely political aims of statesmen, chance combinations of party politics and the intrigues of diplomatists, class prejudice, social conventions, apparently sudden changes of economic policy, capricious changes of fashion—all these causes and many others have exerted a direct and immediate influence on the economic life of the community. In our own day we have had many illustrations of the manner in which special circumstances may at once bring an almost unnoticed series of scientific investigations into direct and vital relation with the business world. The economist must, therefore, not only be prepared to take account of the physical features of the world, the general structure and organization of the industry and commerce of different states, the character of their administration, and other important causes of economic change. He must be in touch with the actual life of the community he is studying, and cultivate "that openness and alertness of the mind, that sensitiveness of the judgment, which can rapidly grasp the significance of at first sight unrelated discoveries or events."

Some people are of opinion that the factors to be taken account of in economic investigation are so numerous that progress on these lines is impossible. It would certainly be impossible if we had to begin *de novo* to construct the whole fabric of economic science. But, as we shall see, it is no more necessary to do this in the world of science than it is in the world of business or politics. There is in existence a vast store of accumulated knowledge, and few, if any, departments of economics have been left quite unilluminated by the researches of former generations. Progress is the result of adaptation rather than reconstruction. It must be remembered also that economic work in modern times is carried on by consciously or unconsciously associated effort, and although it must always require high qualities of judgment, capacity, and energy, many of the difficulties which at first sight appear so insuperable give way when they are attacked. In some ways also the study of highly developed organizations like the modern industrial state is simpler than that of earlier forms of society.

**Ancient and modern conditions in England.**

In the earliest times for which we have abundant material the economic life of England had already reached in certain directions a high degree of complexity. Even in the rural districts, manorial records reveal the existence of a great variety of classes and groups of persons engaged in the performance of economic functions. The lord of the manor with his officials and retainers, the peasantry bound to him by ties of personal dependence and mutual rights and obligations, constituted a little world, in which we can watch the play of motives and passions not so dissimilar as we are sometimes led to believe from those of the great modern world. In many a country district the gradations of social rank were more continuous, the opportunities of intercourse more frequent, and the capacity for organization greater than in modern times. The manorial accounts were kept with precision and detail, and we are told that a skilled official could estimate to the utmost farthing the value of the services due from the villein to his lord. The manor was indeed self-sufficient and independent in the sense that it could furnish everything required by the majority of the inhabitants, and that over the greater part of rural England production was not carried on with a view to a distant market. But in the earliest times the manor was subjected to external influences of great importance. Vast areas of the country were in fact under the single control of a territorial lord or an ecclesiastical foundation. Every manor composing these great fiefs was likely to be affected by the policy or the character of the administration of the feudal lord, and he, again, by the policy or the difficulties, the strength or the weakness, of the central government. Foreign trade and foreign intercourse were undeveloped, but their influence was in historical times never entirely absent, while the influence of Roman law and the Christian Church constantly tended to modify the manorial organization. In the towns the division of labour had proceeded much further than in the rural districts, and there were in existence organized bodies, such as the Gild Merchant and the crafts, whose functions were primarily economic. But one of the most striking characteristics of town life in the Middle Ages was the manner in which municipal and industrial privileges and responsibilities were interwoven. In modern times the artisan, however well trained, efficient, and painstaking he may be, does not, in virtue of these qualities, enjoy any municipal or political privileges. By means of his trade union, co-operative society, or club he may gain some experience in the management of men and business, and in so far as the want of a sufficient income does not constitute an insuperable difficulty, he may share in the public life of the country. But in his character as artisan he enjoys no municipal or political privileges. In the Middle Ages this differentiation of the industrial, municipal, and political life had not taken place, and in order to understand the working of at first sight purely economic regulations it is necessary to make a close study of the functions of local government. But this, after all, does not carry us very far. From the very nature of the records in which we study the town life of the Middle Ages, it follows that we obtain from them only a one-sided view. No one knows what proportion of the industrial population was included in the organized guilds,

or how complete was the control exercised by these bodies over their members. Elaborate regulations were in force, but no one knows how elastic they were in practice. Mediæval Englishmen were particularly apt to put their aspirations into a legal form, and then rest satisfied with their achievement. The number of regulations is scarcely to be regarded as a test of their administrative success. Further, as the country became more consolidated and the central government extended its authority over economic affairs, new regulations came into force, new organs of government appeared, which were sometimes in conflict, sometimes in harmony, with the existing system, and it becomes for a time far more difficult to obtain a clear view of the actual working of economic institutions. Thus the study of the economic life of the Middle Ages is one of the most complicated subjects which can engage the attention of man. It is impossible to carry the process of isolation very far. The different threads of social activity are so closely interwoven that we cannot follow any one for very long without forming wrong impressions, and it becomes necessary to turn back and study others which seemed at first sight unrelated to the subject of our investigations. Under an apparently uniform and stable system of social regulation there was much variation and movement, the significance of which it is impossible to estimate. Materials for forming such an estimate no doubt exist, but before doing so we have to study in infinite detail a vast number of separate manors, municipalities, or other separate economic areas. This involves great industry on the part of many scientific workers. Meanwhile we can *illustrate* the economic life of the Middle Ages, describe its main features, indicate the more important measures of public policy, and draw attention to some of the main lines of development.

***Conditions of economic science.***

It is only as we approach more modern times that the conditions of economic study are realized and economic science, as we understand it, becomes possible. Those conditions are: (i.) the life of the state or other community or communities we are studying must be so differentiated that we can isolate those functions which are wholly or predominantly economic. The "separation of employments" is not only a condition of economic efficiency; it was necessary before we could have an economic science. (ii.) We must be in a position so far to understand and estimate the character and motives of different classes and groups in these communities that we can rightly interpret their action. This condition cannot be realized without great difficulty, for "economic motives" are very different in different periods, nations, and classes, and even for short periods of time in the same country are modified by the influence of other motives of an entirely different order. In studying the economic history of the 18th century, for example, it is not enough to assume with Defoe that "gain is the design of merchandise." We have to be saturated, as it were, with 18th-century influences, so that we can realize the conditions in which industry and trade were carried on, before we can rightly explain the course of development. In our own day labour disputes, to take another example, can scarcely ever be resolved into a question of merely pecuniary gain or loss. The significance of the amount of money involved varies greatly for different trades, and can only be understood by reference to the character and habits of the people concerned. But questions of sentiment, shop-feeling, and trade customs invariably play an important part. (iii.) Economics can never lead to anything but hypothetical results unless we not only realize that we must "take account of" other than the purely economic factors, but also give due weight and significance to these factors. No explanation of the industrial situation in Germany, for example, would be intelligible or satisfactory even from the economic point of view which ignored the significance of the political conditions which Germans have to deal with. So, again, it is impossible to make a useful comparative estimate of the advantages and disadvantages of the transport systems of England, the United States, and Germany, unless we keep constantly in view the very different geographical, military, and political conditions which these systems have to satisfy. (iv.) Sufficient information must be available to enable us to test the validity of our hypotheses and conclusions. Whatever "method" of economic investigation we employ, we must at every stage see how far our reasoning is borne out by the actual experience of life. This obvious condition of scientific inquiry is very far from being completely realized even at the present time. It implies the existence of a well-trained class engaged in the work of collecting information, and much organization both by the state and private bodies. These four conditions can be reduced to two. The community we are studying must have reached such a stage of development that its economic functions and those immediately cognate to them form a well-defined group, and adequate means must be available so that we can, as it were, watch the performance of these functions and test our hypotheses and conclusions by observation and experience.

It is easy to understand, therefore, why we trace the beginnings of economics, so far as England is concerned, in the 16th century, and why the application of strict scientific tests in this subject of human study has become possible only in comparatively recent times. Mediæval economics was little more than a casuistical system of elaborate and somewhat artificial rules of conduct. From the close of the Middle Ages until the middle of the 18th century thousands of pamphlets and other works on economic questions were published, but, with the few notable exceptions mentioned in the former article, the vast majority of the writers have little or no scientific importance. Their works frequently contain information given nowhere else, and throw much light on the state of opinion in the age in which they wrote. It is also possible to find in them many anticipations of the views of the economists of later times; but such statements were as a rule generated merely by the heat of controversy on some measure or event of practical importance, and when the controversy died down were seldom regarded or incorporated in a scientific system. Trade bias, personal impressions, and guess-work took the place of scientific method. This was inevitable in the absence of trustworthy information on an adequate scale, and from the immediately practical aims of the writers. But from the end of the 17th century economics has been definitely recognized as a subject of scientific study.

***Necessity of economic science.***

In modern times the conditions which have made economic science possible have also made it necessary. While it is impossible to give a strictly economic interpretation of the earlier history of nations, economic interests so govern the life and determine the policy of modern states that other forces, like those of religion and politics, seem to play only a subsidiary part, modifying here and there the view which is taken of particular questions, but not changing in any important degree the general course of their development. This may be, in the historical sense, merely a passing phase of human progress, due to the rapid extension of the industrial revolution to all the civilized and many of the uncivilized nations of the world, bringing in its train the consolidation of large areas, a similarity of conditions within them, and amongst peoples and governments a great increase in the strength

of economic motives. When the world has settled down to the new conditions, if it ever does so, we may be confronted with problems similar to those which our forefathers had to solve. But, for the time, if we know the economic interests of nations, classes, and individuals, we can tell with more accuracy than ever before how in the long run they will act. Public policy therefore requires the closest possible study of the economic forces which are moulding the destinies of the great nations of the world. In most civilized countries except England this is recognized, and adequate provision is made for the study of economic science. But the subject is not only of immediate concern to the state in its corporate and public capacity. The neglect of it in the domain of private business can now only lead to disastrous results. To quote from a recently published work (see *National Education: a Symposium*, 1901), "the commercial supremacy of England was due to a variety of causes, of which superior intelligence, in the ordinary business sense, was not the most important. Her insular position, continuity of political development, and freedom from domestic broils played an important part in bringing about a steady and continuous growth of industry and manufactures for several generations before the modern era. The great wars of the 18th and the beginning of the 19th century, which arrested the growth of continental nations, gave England the control of the markets of the world. When peace was restored, England enjoyed something in the nature of a monopoly. The competition of France ceased for a time to be an important factor. What is now the German Empire was a mere congeries of small states, waging perpetual tariff wars upon each other. In the old Prussian provinces alone there were fifty-three different customs frontiers, and German manufactures could not develop until the growth of the Zollverein brought with it commercial consolidation, internal freedom, and greater homogeneity of economic conditions. The industries of the United States were in their infancy. Thus the productive power of England was unrivalled, and her manufactures and business men, under a régime rapidly approximating to complete freedom of trade, could reap the full advantages to be derived from the possession of great national resources and production by machinery. Commercial supremacy required not so much highly trained intelligence amongst manufacturers and merchants as keen business instinct and a certain rude energy. In the last generation all that has changed, and the change is of a permanent character. The struggle of the future must inevitably be between a number of great nations, more or less equally well equipped, carrying on production by the same general methods, each one trying to strengthen its industrial and commercial position by the adoption of the most highly developed machinery, and all the methods suggested by scientific research, policy, or experience. Under these conditions, it is no longer possible for the individual merchant, or for small groups of merchants, to acquaint themselves, by personal experience alone, with more than a fractional part of the causes which affect the business in which they are engaged. The spread of the modern industrial system has brought with it the modern state, with its millions of consumers, its vast area, its innumerable activities, its complicated code of industrial and commercial law. At the same time, the revolution in the means of transport and communication has destroyed, or is tending to destroy, local markets, and closely interwoven all the business of the world. Events in the most distant countries, industrial and commercial movements at first sight unrelated to the concerns of the individual merchant, now exert a direct and immediate influence upon his interests. The technical training of the factory or the office, the experience of business, the discharge of practical duties, necessary as they are, do not infallibly open the mind to the large issues of the modern business world, and can never confer the detailed acquaintance with facts and principles which lie outside the daily routine of the individual, but are none the less of vital importance." Economics, therefore, under modern conditions, is not only a subject which may usefully occupy the attention of a leisured class of scientific men. It should form part of the training of educated men of all classes, on grounds of public policy and administrative and business efficiency.

***Relations between economics and other sciences.***

The relations between economics and other sciences cannot be stated in a very general form. They vary for different periods, and are not the same for all branches of economics. There is no subject of human study which may not be at some time or other of economic significance, and anything which affects the character, the ideals, or the environment of man may make it necessary to modify our assumptions and our reasoning with regard to his conduct in economic affairs. But if the economist, while studying one side of man's activities, must also cultivate all other branches of human learning, it is obvious that no substantial progress can be made. The economist frankly assumes the reality of the existing world and takes men as they are, or as they have been if he is studying past times. His assumptions are based upon ordinary observation and experience, and are usually accurate in proportion to his practical shrewdness and sagacity, so that he is not interested in the speculative flights of philosophy, except in so far as they influence or have influenced conduct. In times past, and to a less extent in our own day, philosophical conceptions have formed the basis of great systems of politics and economics. The historical relations between philosophy and economics are of great importance in tracing the development of the latter, and have done much to determine its present form. But the modern conception of society or the state owes more to biology than philosophy, and actual research has destroyed more frequently than it has justified the assumptions of the older philosophical school. Experimental psychology may in course of time have an important bearing on economics, but the older science cannot be said to be of much significance except in its historical aspects. Ethics is in much the same position. That is, it is possible to conceive of an ethical science which would extend considerably our knowledge of economic affairs, but no important new principle or original discovery, relevant to economic investigation, has come from that quarter in recent years, and at present ethics has more to learn from economics than the latter has from ethics. It is in the adaptation of biological conceptions and methods, in the positive contributions of jurisprudence, law, and history, in the rigorous application, where possible, of quantitative tests, that the explanation of the present position of economics is to be found. Mathematics has influenced the form and the terminology of the science, and has sometimes been useful in analysis, but mathematical methods of reasoning, in their application to economics, while possessing a certain fascination, are of very doubtful utility.

There is no method of investigation which is peculiarly economic or of which economics has the monopoly. In every age economists have applied the methods ordinarily in use amongst scientific men. There would probably have been no controversy at all on this subject but for the fact that economics was elaborated into systematic form, and made the basis of practical measures of the greatest importance, long before the remarkable development in

the 19th century of historical research, experimental science, and biology. The application of the *à priori* method in economics was an accident, due to its association with other subjects and the general backwardness of other sciences rather than any exceptional and peculiar character in the subject-matter of the science itself. The methods applied to economics in the 18th and the early part of the 19th century were no more invented with a special view to that subject than the principles of early railway legislation, in the domain of practical policy, were devised with a special view to what was then a new means of transport. As a matter of fact, discussions of method and the criticism of hypotheses and assumptions are very rarely found in early economic works. It is only by reference to the prevailing ideas in philosophy and politics that we can discover what was in the minds of their authors. The growth of a science is much like the growth of a constitution. It proceeds by adaptation and precedent. The scientific and historical movement of the 19th century was revolutionary in character. When it began to affect economics, many people were afraid that the whole fabric of the science would be destroyed and the practical gains it had achieved jeopardized. These fears were justified, in so far as those who entertained them shut their eyes to everything new and assumed an attitude of no compromise. Where the newer methods were assimilated, the position of economics was strengthened and its practical utility increased. General discussion of method, however, is rarely profitable. In all branches of economics, even in what is called the pure theory, there is an implied reference to certain historical or existing conditions of a more or less definite character; to the established order of an organized state or other community, at a stage of development which in its main features can be recognized. In all economic investigation assumptions must be made, but we must see that they are legitimate in view of the actual life and character of the community or communities which are the subject of investigation. In common with other sciences, economics makes use of "abstractions"; but if for some problems we employ symbolic processes of reasoning, we must keep clearly in view the limits of their significance, and neither endow the symbols with attributes they can never possess, nor lose sight of the realities behind them. Every hypothesis must be tested by an appeal to the facts of life, and modified or abandoned if it will not bear examination, unless we are convinced on genuine evidence that it may for a time be employed as a useful approximation, without prejudice to the later stages of the investigation we are conducting.

***Method of economic investigation.***

We shall best illustrate the character and method of economic reasoning by examples, and for that purpose let us take first of all a purely historical problem, namely, the effect on the wage-earners of the wages clauses of the Statute of Apprenticeship (1563). It is at once obvious that we are dealing not with an abstract scheme of regulation in a hypothetical world, but with an Act of Parliament nominally in force for two hundred and fifty years, and applicable to a great variety of trades whose organization and history can be ascertained. The conclusions we reach may or may not modify any opinions we have formed as to the manner in which wages are determined under modern conditions. For the time being such opinions are irrelevant to the question we are investigating, and the less they are in our minds the better. There is no reason why we should apply to this particular Act a different method of inquiry from that we should apply to any other of the numerous Acts, of more or less economic importance, passed in the same session of Parliament. The first step is to see whether there is a *primâ facie* case for inquiry, for many Acts of Parliament have been passed which have never come into operation at all, or have been administered only for a short time on too limited a scale to have important or lasting results. The justices were authorized to fix wages at the Easter Quarter Sessions. Did they exercise their powers? To answer this question we must collect the wages assessments sanctioned by the magistrates. This is a perfectly simple and straightforward operation, involving nothing more than familiarity with records and industry in going through them. Without having recourse to any elaborate process of economic reasoning, by confining our attention to one simple question, namely, what happened, we can establish conclusions of the greatest interest to economic historians and, further, define the problem we have to investigate. We can show, for example: (1) that the Statute of Apprenticeship did not stand alone; it was one of a long series of similar measures, beginning more than two centuries before, which in their turn join on to the municipal and gild regulations of the Middle Ages; one of an important group of statutes, more or less closely interwoven throughout their history, administered by local authorities whose functions had grown largely in connexion with this legislation and the gradual differentiation of the trades and callings to which it related. (2) That wages were regulated with much greater frequency during the reigns of Elizabeth, James I., and Charles I. than at any later period. (3) That they were regulated in some counties and not in others. (4) That in the counties and towns where they were regulated the action of the magistrates was in general spasmodic, and rarely continuous for a long series of years. (5) That the magistrates used their powers sometimes to raise wages, sometimes to force them down. (6) That the local variations of wages and prices were what we should call excessive, so that the standard of comfort in one district was very different from that of others. (7) That the wages assessments group themselves round certain short periods, coincident in many instances with high prices, increase of poverty, and other causes of exceptional action. (8) That what we may call, with the above limitations, the effective period of the Act terminates with the outbreak of the Civil War. (9) That subsequent to that period organic changes in the industries affected, coupled with the incompetence of Parliament to adapt the old legislation to new conditions, and the growing acceptance of the doctrine of *laisser faire*, brought about a general disuse of the statute, though isolated attempts to enforce it were made and new Acts applicable to certain trades were passed in the 18th century. (10) For more than one hundred years before the repeal of the Act, trade unions and other forms of voluntary association amongst wage-earners, combinations amongst employers, collective agreements, customary regulations, were established in many of the important trades of the country. But these conclusions, after all, suggest more difficulties than they remove, for they show that our inquiry, instead of presenting certain well-marked features which can be readily dealt with, has to be split up into a number of highly specialized studies: the investigation of rates of wages, prices, and the standard of comfort in different localities, bye-industries, regularity of employment, the organization of particular trades, the economic functions of local authorities, apprenticeship, and a host of other subjects. Moreover, all these subjects hang together, so that it seems impossible to come to a decision about one of them without knowing all about the others.

***An illustration of economic method.***

It is a comparatively simple thing to state the questions to which we want an answer, but extremely difficult to define the exact nature of the evidence which will constitute a good answer; easy enough to say we must try

hypothesis after hypothesis, and test each one by an appeal to the facts, but a man may easily spend his life in this sort of thing and still leave to his descendants nothing more than a legacy of rejected hypotheses. Every volume of records we look through contains a mass of detailed information on the economic life of England in the period we are studying. How much of it is relevant to the subject of inquiry? What is to be the principle of selection? How shall we determine the relative weight and importance of different kinds of relevant evidence? As in modern problems, so in those of past times, a man requires for success qualities quite distinct from those conferred by merely academic training and the use of scientific methods. A correct sense of proportion and the faculty of seizing upon the dominant factors in an historical problem are the result partly of the possession of certain natural gifts in which many individuals and some nations are conspicuously wanting, partly of general knowledge of the working of the economic and political institutions of the period we are studying, partly of what takes the place of practical experience in relation to modern problems, namely, detailed acquaintance with different kinds of original sources and the historical imagination by which we can realize the life and the ideals of past generations. These qualities are required all the more because, in order to make any further progress with such an inquiry as we have suggested, we have deliberately to make use of abstraction as an instrument of investigation.

***The plan of a general theory.***

Let us see how this will work out. Suppose we have selected one of the numerous subsidiary problems suggested by the general inquiry, and obtained such full and complete information about one particular industry that we can tabulate the wages of the workers for a long series of years. We may do the same for other industries, some of them coming under the Statute of Apprenticeship, others not. If all the industries belong to one economic area over which, so far as we can tell from general statistics of wages and prices, and other information, fairly homogeneous conditions prevailed, we may be able to reach some useful conclusions as to the operation of the Act. But it would be absurd to suppose that we could reach those conclusions by simple reference to the trades themselves. We cannot assume that the fluctuations in wages were due to the action or inaction of magistrates without the most careful examination of the other influences affecting the trades. In economic affairs the argument *post hoc propter hoc* never leads to the whole truth, and is frequently quite misleading. We cannot suppose that the policy of the Merchant Adventurers' Company had nothing to do with the woollen industry; that the export trade in woollen cloth was quite independent of the foreign exchanges and international trade relations in those times; that the effect on wages of the state of the currency, the influx of new silver, the character of the harvests, and many other influences can be conveniently ignored. In studying, therefore, such an apparently simple question as the effect of an Act of Parliament on wages in a small group of trades we want a general theory which we can use as a kind of index of the factors we have to consider.

***Difficulties due to want of evidence.***

We shall return to this subject later (see p. 646). It is sufficient to say here that all that we require is amply provided by readily-accessible works on economics. Assuming that we have in our minds this safeguard against loose thinking and neglect of important factors, the investigation of the special problems arising out of the general inquiry resolves itself into a careful definition of each problem we wish to deal with, and the collection, tabulation, and interpretation of the evidence. In most cases the interpretation of the facts is far from obvious, and we have to try several hypotheses before we reach one which will bear the strain of a critical examination in the light of further evidence. But at this stage in historical investigation it is generally the want of evidence of a sufficiently complete and continuous character, rather than difficulties of method, which forces us to leave the problem unsolved. It is, for instance, practically impossible to obtain reliable evidence as to the regularity of employment in any industry in the 17th century, and the best approximations and devices we can invent are very poor substitutes for what we really want. For this reason guess-work must continue to play an important part in economic history. But every genuine attempt to overcome its difficulties brings us into closer touch with the period we are examining; and though we may not be able to throw our conclusions into the form of large generalizations, we shall get to know something of the operation of the forces which determined the economic future of England; understand more clearly than our forefathers did, for we have more information than they could command, and a fuller appreciation of the issues, the broad features of English development, and be in a position to judge fairly well of the measures they adopted in their time. By comparing England with other countries we may be able in the distant future to reach conclusions of some generality as to the laws of growth, maturity, and decay of industrial nations. But, like the early statisticians of the 17th century, economic historians are the "beginners of an art not yet polished, which time may bring to more perfection."

***The investigation of modern questions.***

When we come to exclusively modern questions, there is no reason or necessity for a fundamental change of method. We cannot suppose that there occurred, at or about the commencement of the 19th century, a breach of historical continuity of such a character that institutions, customs, laws, and social conventions were suddenly swept away, the bonds of society loosened, and the state and people of England dissolved into an aggregate of competing individuals. The adoption of machinery gradually revolutionized the methods of production; but in the first instance only certain industries were affected, and those not at the same time or in the same degree; old laws grown obsolete were repealed, but other laws affecting wage-earners and employers took their place, more complicated and elaborate than the Elizabethan code. Trade unions, so far from disappearing, were legalized, gathered strength from the changes in industrial organization, and nowhere became so powerful as in the most progressive industries; while other forms of combination appeared, incomparably stronger, for good or evil, than those of earlier times. But while we recognize these facts, we must not suppose that we have to study the action of men as though they were all enrolled in organized associations or covered by stringent laws which were always obeyed. There has never been in the history of English industry such licence as we find in certain directions in the earlier part of the 19th century.

It is not in the decay of combination and monopoly or in the growth of competition that we must look for the distinctive characteristics of modern problems. A 17th-century monopoly was a very weak and ineffective instrument compared with a modern syndicate; the Statute of Apprenticeship was certainly not so widely enforced as the "common rules" of trade unions; and many of the regulations of past times, which look so complicated to modern eyes, were conditions of free enterprise rather than restraints upon it. It is due to the influence of the *laisser faire* doctrine that we regard law and regulation as a restraint on liberty. As a maxim for guidance

in public affairs, *laisser faire* was genuinely relevant at the end of the 18th and the beginning of the 19th century, when the Statute Book was cumbered with vexatious and obsolete laws. As an explanation of what has taken place during the last sixty years, or of the actual economic life of the present day, it is ludicrously inadequate. Competition, in the sense in which the word is still used in many economic works, is merely a special case of the struggle for survival, and, from its limitation, does not go far towards explaining the actual working of modern institutions. To buy in the cheapest market and sell in the dearest; to secure cheapness by lowering the expenses of production; to adopt the less expensive rather than the more expensive method of obtaining a given result—these and other maxims are as old as human society. Competition, in the Darwinian sense, is characteristic not only of modern industrial states, but of all living organisms; and in the narrower sense of the "higgling of the market" is found on the Stock Exchange, in the markets of old country towns, in mediæval fairs and Oriental bazaars. In modern countries it takes myriads of forms, from the sweating of parasitic trades to the organization of scientific research. Economic motives, again, are as varied as the forms of competition, and their development is coeval with that of human society. They have to be interpreted in every age in relation to the state of society, the other motives or ideals with which they are associated, the kind of action they inspire, and the means through which they operate. Apparently the same economic motives have led in the same age and in the same nation to monopoly and individual enterprise, protection and free trade, law and anarchy. In our own time they have inspired both the formation of trade combinations and attempts to break them up, hostility to all forms of state interference and a belief in collectivism.

***The distinctive features of modern problems.***

The conditions which are peculiar to the modern world are the large numbers we have to deal with, the vast and fairly homogeneous areas in which justice is administered and property secured, and the enormously increased facilities for transport and communication. These conditions are of course not independent of each other, and they have brought in their train many consequences, some good and some bad. But they supply the bases for that general theory which, as we have seen, is indispensable in economic investigation. From the standpoint of general theory economic movements assume an impersonal character, and economic forces operate like the forces of nature. Although economic motives have become more complex, they have just as much and no more to do with general economic reasoning and analysis than the causes of death with the normal expectation of life, or domestic ideals with the birth-rate. So far as we have anything to do with psychology at all, it is the psychology of crowds and not of individuals which we have to consider. If we study the economy of a village, the idiosyncrasies of every individual in it are of importance. If the village is replaced by a large area, inhabited by millions, with modern facilities of communication, it is a matter of observation and experience that for the purposes of general reasoning the idiosyncrasies of individuals may be neglected. Whether such large numbers have the character of the "economic man" of the early economists matters very little. All the assumptions we require are furnished by observation of people in the mass and the larger generalizations of statistics. Thus we can construct a kind of envelope of theory, which, by careful testing as we proceed, can be made to indicate in a general manner the reactions of one part of the activities of the economic world upon the others, and the interdependence of the several parts. From its very nature this general theory can never correspond strictly to the actual life and movement of any given state. It is useful and necessary, and plays somewhat the same part in economic investigation as ton-mile statistics do in the administration of a railway. To express in any language or to illustrate by any images, from a purely objective standpoint, the infinitely complicated movements of the actual world, is a task far beyond human capacity.

With the aid of this general theory the methods we have sketched in relation to historical problems apply with greater force to the special problems of modern times, and are rewarded with results more accurate, more fruitful, more relevant to difficulties which all civilized nations have to face, than those of historical research. To many minds the interest and usefulness of economics depend entirely on the application of these methods, for it is the actual working of economic institutions about which the statesman, the publicist, the business man, and the artisan wish to know. Under the conditions we have described, many of the most interesting problems of our own time, when they are once defined, resolve themselves into statistical inquiries. But in most cases such an inquiry cannot be successfully carried out by a mere statistician. Definite economic problems can very rarely be dealt with by merely quantitative methods. In the tabulation and interpretation of statistical evidence, as in its collection, it is scarcely possible to overrate the importance of wide knowledge and experience. There is another very important instrument of investigation which can be used in our own time, but cannot be employed in historical research. Historical documents, however detailed, rarely show all the factors we have to deal with or fully explain a given situation. No sane person would suppose that the minutes of a modern legislative body explain the steps by which legislation has been passed, or the issues really involved. The ostensible cause of a modern labour dispute is frequently not the real or the most important cause. In modern problems we can watch the economic machine actually at work, cross-examine our witnesses, see that delicate interplay of passions and interests which cannot be set down or described in a document, and acquire a certain sense of touch in relation to the questions at issue which manuscripts and records cannot impart. We can therefore substitute sound diagnosis for guess-work more frequently in modern than in historical problems.

***Application to modern problems.***

What then, it may be asked, becomes of the "old Political Economy"? Of what possible use are the works of the so-called classical writers, except in relation to the history of economics and the practical influence of theory in past times? If we take the mere popular view of what is meant by the "old Political Economy," that is, that a generation or so ago economics was comprised in a neatly rounded set of general propositions, universally accepted, which could be set forth in a text-book and learnt like the multiplication table, it is not incumbent on the present generation to define its attitude at all. In this sense of the words, there was no faith delivered to our fathers which we are under any obligation to guard or even explain. If by the "old Political Economy" we mean the methods and conclusions of certain great writers, who stood head and shoulders above their contemporaries and determined the general character of economic science, we are still under no obligation to define the attitude of the present generation with regard to them. The fact that Adam Smith, with the meagre materials of the 18th century at his disposal, saw his way to important generalizations which later research has established on a firm basis, may enhance greatly the reputation of Adam Smith, but does not strengthen the

***The "old political economy."***

generalizations. They stand or fall by the strength of the evidence for or against them. In the history of economics or the biography of Ricardo it is of interest to show that he anticipated later writers, or that his analysis bears the test of modern criticism; but no economist is under any obligation to defend Ricardo's reputation, nor is the fact that a doctrine is included in his works to be taken as a demonstration of its truth. The appeal to authority cannot be permitted in economics any more than in chemistry, physics, or astronomy. But the cases stated above suggest more or less false issues. There has been no revolution in economic science, and is not likely to be any. The question we have really to determine is how we can make the best use of the accumulated knowledge of past generations, and to do that we must look more closely into the economic science of the 19th century.

Any one who has taken the trouble to trace the history of one of the modern schools of economists, or of any branch of economic science, knows how difficult it is to say when it began. "Anticipations" of method and doctrine can generally be found by the diligent investigator in the economic literature of his own or a foreign country. So that cross-sections of the stream of economic thought will reveal the existence, at different times, in varying proportions and at different stages of development, of most of the modern "schools." Again, the classification of an economic bibliography at once shows how varied has been the character of economic investigation, ranging from the most abstract speculation on the one hand to almost technical studies of particular trades on the other. Of the great army of writers who flourished in the first half of the 19th century some were closely identified with the utilitarian school, and the majority were influenced in a greater or less degree by the prevailing ideas of that school. Others, however, were hostile to it. In many works, such as those of a statistical or historical character, there are frequently to be found passages which could have been written in no other period, but are only of the nature of ejaculations and do not affect the argument. In stating the position of economics during this time we cannot ignore all writers, except those who belonged to one group, however eminent that group may have been, simply because they did not represent the dominant ideas of the period, and exercised no immediate and direct influence on the movement of economic thought. We must include the pioneers of the historical school, the economic historians, the socialists, the statisticians, and others whose contributions to economics are now appreciated, and without whose labours the science as we know it now would have been impossible. If we take this broadly historical view of the progress of economics, it is obvious that even in England there was no general agreement, during the 19th century, as to the methods most appropriate to economic investigation.

Suppose, now, we ignore the writers who were inaugurating new methods, investigating special problems or laboriously collecting facts, and concentrate attention on the dominant school, with its long series of writers from Adam Smith to John Stuart Mill. It is the work of these writers which people have in mind when they speak of the "old Political Economy." There are several quite distinct questions we can ask with regard to them. That they must be studied closely by every one who wishes to follow the history of economics goes without saying. That they must be studied by the economic historian is equally clear, owing to their practical influence and the fact that they furnished the theoretical bases of much of the economic policy of the 19th century. This is true whether their method is good or bad, whether their conclusions are true or false. It is not so easy to determine their relevance and usefulness in relation to distinctively modern problems, or to indicate within what limits their work is of permanent value, and we can only deal with these questions in their more general aspects.

It must be clear to every observer that the economists of the classical period, with the one exception of Adam Smith, will speedily share the fate of nearly all scientific writers. They will be forgotten, and their books will not be read. Adam Smith's *Wealth of Nations*, if it has ever been, has long ceased to be a scientific text-book. Whether a modern economist accepts his views or not is of no importance. There is probably not a single chapter in the *Wealth of Nations* which would be thoroughly endorsed by any living economist. But the reputation of the book and its author is quite independent of considerations of this kind. The *Wealth of Nations* is one of the great books of the world, many of the sayings of which are likely to be more frequently quoted in the future than they have been in the 19th century. Malthus is already an author whose name is probably more widely known than that of any other economist, but whose works are rarely read, and studied only by a small proportion of the few people who write books on the history of economic theory. Of economic students, many are unaware of the fact that he wrote any other book than the *Essay on the Principle of Population*, and what is of permanent importance in that work is contained in the generalization which it suggested to Darwin. Moreover, modern economists, while accepting in the main the general tenor of Malthus's theory of population, would not agree with his statement of it. Like Malthus, Ricardo owes his reputation very largely to the theory associated with his name, though it has long ceased to be stated precisely in the terms he employed. But there are very few people in the world who have made a careful study of his works; and although his theory of rent has a wide and increasing application in economics, it is not comparable in general scientific importance with Malthus's theory of population. It is already impossible to take J. S. Mill's *Principles of Political Economy* as a text-book. Important as it was for thirty or forty years, it will soon be as little read as M'Culloch's *Principles.* For the rest of the economists of this period, it is difficult to see how they can escape oblivion. When the generation whose economic training was based upon Mill has died out, the relevance of "the old Political Economy" is not likely to be a question of any interest to ordinary educated men and women, or even to the great mass of economic students.

The explanation of this decay of interest does not lie upon the surface. It is frequently supposed that the influence of the "old Political Economy" has been gradually undermined by the attacks of the historical school. But great as the achievements of this school have been, it has not developed any scientific machinery which can take the place of theory in economic investigation. If our view is correct that, broadly speaking, the two ways of regarding economic questions are complementary rather than mutually exclusive, there does not seem to be any reason why the growth of the historical school should have been destructive of the "old Political Economy" if it had been well founded. The use of the historical method has, in fact, raised more reputations than it has destroyed, because by keeping carefully in view the conditions in which economic works have been written, it has shown that many theories hastily condemned as unsound by *à priori* critics had much to be said for them at the time when they were propounded. This observation is true not only of old-world writers like the Mercantilists, but also of Ricardian economics. No one is concerned to prove that the Ricardian

economics applies to the manorial system, and it is generally supposed at any rate that the world has been approximating more and more nearly during the last century to the conditions assumed in most of the reasoning of that school. On the principles we have explained, therefore, the Ricardian economics should supply just that body of general theory which is required in the investigation of modern economic problems, and the reputation of at any rate the leading writers should be as great as ever. It would be of immense advantage from a scientific point of view if this could be taken for granted, if for a time the work of the classical economists could be considered final so far as it goes, and for the purposes of investigation regarded as the theoretical counterpart of the modern industrial system. This assumption, however, has been made quite impossible, not by the historical school, but by the criticism and analysis of economists in the direct line of the Ricardian succession.

Modern economic criticism and analysis has destroyed the authority of the "old Political Economy" as a scientific system. The assumptions, the definitions, the reasoning, the conclusions of the classical writers have been ruthlessly overhauled. Defects in their arguments have been exposed to view by those who are most concerned to defend their reputation. Writers with none of the prejudices of the historical school, but with the cold and remorseless regard for logic of the purely objective critic, have pointed out serious inconsistencies here, the omission of important factors there, until very little of the "old Political Economy" is left unscathed. In fact, there never was a scientific system at all. What was mistaken for it was fashioned in the heat of controversy by men whose interests were practical rather than scientific, who could not write correct English, and revealed in their reasoning the usual fallacies of the merely practical man. So the "old Political Economy" lies shattered. It is useless to suppose that this destructive criticism from within can be neutralized by generously sprinkling the pages of the classical writers with interpretation clauses. This may serve to show that the ideals of our youth were not without justification; but the younger generation, which does not care about our ideals, and looks to the future rather than the past, will not read annotated editions of old books, however eminent their authors. If the Ricardian school of economists had been merely philosophers, or even a group like the French physiocrats, this state of things might be regarded with equanimity. We might assume that criticism and analysis had separated the wheat from the chaff in their writings, that everything of permanent value had probably been preserved and incorporated in the works of later economists. But the character of much of their work makes this assumption impossible. It is, in fact, quite true that many of them were more interested in practical aims than in the advancement of economic science. We may talk of the assumptions implicitly involved in Ricardo's works. In reality we do not know what those assumptions were; we only know what assumptions we should make in order to reach the same conclusions, and they may be very different from "the mind of Ricardo." Ricardo's works, in fact, do not explain a theoretical system, but contain the matured reflexions, more or less closely reasoned, of a man of great mental power looking out on the world as it appeared to a business man experienced in affairs. The conclusions of such a work are of wider significance than the assumptions we attribute to the author would warrant. They are not expressed in terms which satisfy our canons of scientific accuracy. Dissected sentence by sentence, the book may be shown to be a mass of inconsistencies. If it has the misfortune to be systematized by an enthusiastic but dull and incompetent disciple, it may appear even absurd. But after all the misinterpretation of contemporaries and the destructive criticism of later times, the book as a whole leaves upon us an impression of peculiar strength and charm, and imparts a sense of the relations of things truer, because less mechanical, than the laboured reasoning of smaller men. Such is the character of much of the work of Ricardo and some of his contemporaries. We think that the decay of interest in these writers involves a real loss, and that students of modern problems may do worse than read Ricardo and his school. Some of the criticism of their works, necessary and useful as it has been, will probably be corrected later on by that breadth of view and sense of proportion which has enabled us to appreciate justly the achievements of lesser men in more remote times. But rehabilitation in accordance with the canons of historical justice will not restore the lost influence of the Ricardian school. Their achievements in the 19th century will be fully acknowledged, but the relevance of their work to the problems of the 20th century will be admitted less than at the present time.

*Ricardo's limitations.*

*Economics a conservative science.*

In a subject like economics it must always be very difficult to decide how far a departure from the traditional form and expression of its main doctrines is necessary or desirable. No one who is really experienced in economic investigation cares to emphasize the originality, still less the revolutionary character of his own work. It is much more likely than not that some principle which for the moment seems new, some distinction which we may flatter ourselves has not been observed before, has been pointed out over and over again by previous writers, although, owing to special circumstances, it may not have received the notice it deserved. Economics is therefore, on the whole, an intensely conservative science, in which new truths are cautiously admitted or incorporated merely as extensions or qualifications of those enunciated by previous writers. This procedure has its advantages, but it may easily become dangerous by destroying the influence of the science it is meant to preserve. It is not unlike the procedure of the canonists and casuists of the Middle Ages with regard to the doctrine of usury, by which the doctrine was to all appearances preserved intact while in reality it was stripped of all its original meaning by innumerable distinctions "over-curious and precise." In the same way the doctrines of the classical economists may be adapted by interpretation clauses and qualifications the exact force of which cannot be tested or explained, so that we do not know whether the original proposition is to be considered substantially correct or not. The result will be that while the doctrines are apparently being brought into closer correspondence with the facts of life, they will in reality be made quite useless for practical purposes or economic investigation. It is easier to point out the danger than to suggest how it should be met. The position we have described is no doubt partly due to the unsettlement of economic opinion and the hostile criticism of old-established doctrines which has characterized the last generation. Or it may be the result of economic agnosticism, combined with unwillingness to cut adrift from old moorings. Whatever the cause, the complete restatement of economic theory, which some heroic persons demand, is clearly impossible, except on conditions not likely to be realized in the immediate future. The span of life is limited; the work requires an extensive knowledge of the economic literature of several countries and the general features of all the important departments of modern economic activity. In general theory special studies by other men cannot play the same part as they do in historical and statistical work. In historical and statis-

tical investigation, or in special studies of particular subjects, it is possible, given the pecuniary means, to organize a whole army of skilled assistants, and with ordinary care to combine the results of their separate efforts. In general theory the inverse rule seems to prevail. There the unity of conception and aim, the firm grip of all the different lines of argument and their relation to each other, which are required, can only be given by a single brain. But no one individual can do original work over the whole field. He is lucky if he can throw new light on a few old propositions. For the rest, he can only, with the utmost caution, adopt the suggestions of other minds as qualifications of old doctrines, never feeling quite sure that he is right in doing so. A complete restatement could only be undertaken by a group of men, trained in much the same conditions, accustomed to think and work together, each one engaged on a special department, but all acting under the control of one master-mind. This is largely a question of the organization of economic studies, and it is of the greatest importance that, if possible, such an effort should be made to present in a connected form the best results of modern criticism and analysis.

*Some recent developments of economic theory.*

Economics is unlike many other sciences in the fact that its claim to recognition must be based upon its practical utility, on its relevance to the actual life of the economic world, on its ability to unravel the social and economic difficulties of each generation, and to contribute to the progress of nations. The very effectiveness of modern criticism and analysis, which has brought great gains in almost all branches of economic theory, has made the science more difficult as a subject of ordinary study. The extensions, the changes or the qualifications, of old doctrines, which at any rate in the works of responsible writers are rarely made without good if not always sufficient reason, have modified very considerably the whole science, and weakened the confidence of ordinary educated men in its conclusions. In the case of many subjects this would matter very little, but in that of economics, which touches the ordinary life of the community at so many points, it is of great importance, especially at a time like the present, when economic questions determine the policy of great nations. The "economic man" of the earlier writers, with his aversion from labour and his desire of the present enjoyment of costly indulgences, has been abandoned by their successors, with the result that in the opinion of many good people altruistic sentiment may be allowed to run wild over the whole domain of economics. The "economic man" has, on the other hand, been succeeded by another creation almost as monstrous, if his lineaments are to be supposed to be those of the ordinary individual—a man, that is, who regulates his life in accordance with Gossen's Law of Satiety, and whose main passion is to discover a money measure of his motives. It is extremely important to consider how far the economic conceptions based upon this view of the action of men in the ordinary business of life—such, for example, as the doctrine of marginal utility—depend for their truth and relevance on the fact that in economics we are dealing with large aggregates. The earlier writers generally assumed perfect mobility of labour and capital. No economist would deliberately make that assumption now unless he were dealing with some purely theoretical problem, for the solution of which it was legitimate at some stage in the reasoning. Many of the questions of the greatest practical importance at the present time, such as the competition between old and new methods of manufacturing commodities substantially the same in kind and equally useful to the great body of consumers, arise largely from the immobility of capital or labour, or both of them. But it is obvious that if the assumption of perfect mobility is invalid, there is scarcely any economic doctrine identified with the earlier writers which may not require modification, in what degree it is impossible to say without very careful investigation. Much suggestive work on this subject of a general character is incorporated in recent economic books, but there is room for a whole series of careful monographs on a question of such fundamental importance. The same may be said of another subject, too frequently neglected by earlier writers, to which due significance has been given in the best recent work, namely, time in relation to value. It would perhaps be too much to say that the full consideration of this point has revolutionized the theory of value, but it has certainly created what seems almost a new science in close contact with the actual life of the modern world.

Some doctrines of the earlier economists, such as the Wages Fund Theory, have practically been abandoned in recent times, though it may be said that they contained a certain amount of truth. Others, which were considered of fundamental importance, owe their position in modern economics and the form in which they are stated to the "tradition of the elders." If they could, by some happy chance, have been left for discovery by modern economists, they would without doubt have received different treatment, to the great advantage of economic science. Such a doctrine is the so-called Law of Diminishing Returns, which Mill considered "the most important proposition in Political Economy." "Unless this one matter," he says, "be thoroughly understood, it is to no purpose proceeding any further in our inquiry." "Were the law different, nearly all the phenomena of the production and distribution of wealth would be other than they are." On the other hand, Thorold Rogers, not to speak of earlier objectors, described the law as a "dismal and absurd theorem." The opinions of recent economists appear to fluctuate between these two extremes. The law may apparently be "a general rule" or "a tendency" which is liable to be "checked," or a particular case of the law of the conservation of energy. If we go to Mill to discover what it is, we find that "it is not pretended that the law of diminishing return was operative from the beginning of society; and though some political economists may have believed it to come into operation earlier than it does, it begins quite early enough to support the conclusions they founded on it." "It comes into operation at a certain and not very advanced stage in the progress of agriculture." But this very important stage in the history of a nation is not defined or clearly illustrated. We are told that we can see "the law at work underneath the more superficial agencies on which attention fixes itself"; it "undergoes temporary suspension," which may last indefinitely; and "there is another agency, in habitual antagonism" to it, namely, "the progress of civilization," which may include every kind of human improvement. Mill apparently is not content with the confusion between "law" and "agency" or "force," but opposes the one to the other. He is constantly speaking in terms which imply the conquering of one law by another, a habit from which his successors have not freed themselves; and the theory of natural processes which appears to have satisfied him, was that when two forces come into operation there is a partial or complete suspension of one by the other. In modern economics "fertility" has no very definite meaning. It may mean what is ordinarily understood by the word—climate, rainfall, railway rates, or anything else except "indestructible powers of the soil." To speak of "additional labour and capital" without reference to the kind and quality of the labour and capital, and the manner in

which they are employed, organized, and directed, throws very little light on agriculture. Every improvement involves, from a quantitative point of view, more or less of capital or of labour, so that it is the "antagonizing" influences, which are nearly all qualitative, which appear to be really important. It is therefore extraordinarily difficult at present to know what happens, or rather what would happen if it were not prevented, when a country reaches "the stage of diminishing returns"; what precisely it is which comes into operation, for obviously the diminishing returns are the results, not the cause; or how commodities "obey" a law which is always "suspended." Possibly the next few years of English industrial history will furnish many illustrations of the law of diminishing returns. We can only say that it requires investigation and restatement.

Closely related to the law of diminishing returns is the Theory of Rent. No economic doctrine so well illustrates the achievements and the defects of modern economic analysis. Ricardo's statement of the theory left upon the world an impression, not wholly just, of singular clearness. He employed the theory with wonderful success in unravelling the problems of his time. Its importance has not been seriously, or at any rate successfully, called in question. Treated at first as a doctrine peculiarly applicable to land, with a certain controverted relevance to other natural agents, it has been so extended that there is scarcely any subject of economic study in which we may not expect to find adaptations or analogies, so that Ricardo seemed to have discovered the key of economic knowledge. But it was discovered that there were no "indestructible powers of the soil"; that the fertility of land in a country like England is almost entirely the result of improvement at some time or other; that "advantage of situation" includes very much more than the words in their literal sense imply; that both "fertility" and "advantage of situation" include many kinds of differential advantage; that in some circumstances rent does not enter into the price of agricultural and other produce, and that in others it does. Moreover, the study of the theory of rent has had a very great influence on all branches of economics, by destroying the notion that it is possible to draw sharp lines of distinction or deal with economic conceptions as though they were entirely independent categories. That modern economic analysis is incomparably more accurate than that of earlier times there can be no question. But the net result of the development of the doctrine of rent is that all problems in which this factor appears, and they embrace the whole range of economic theory, must apparently be treated on their merits. In its modern form the doctrine is far too general to be serviceable without the closest scrutiny of all the facts relating to the particular case to which it is applied. To deal adequately with the numerous extensions or qualifications of these and other doctrines in the hands of modern economists would involve us in an attempt to do what we have already said is impossible except on conditions not at present realized. It is clear that in the interests of general economic theory we require a vast number of special studies before an adequate restatement can be undertaken.

It must be clearly recognized that the functions of economic science in the present requirements of the world cannot possibly be discharged by treatises on economic theory. The relations between general theory and special studies conducted on the lines we have indicated have completely changed in the last thirty years. General theory never has been, and in the nature of things never can be, the actual reflex of the life and movement of the economic world. It never has been, and never can be, more than an indication of the kind of thing which might be expected in a purely hypothetical world. When the aim of the man of affairs and the hypothesis of the economist was unrestricted competition, and measures were being adopted to realize it, general theory such as the classical economists provided was perhaps a sufficiently trustworthy guide for practical statesmen and men of business. If only people can be got to believe in them, a few abstract principles are quite enough to destroy an institution which it has taken centuries to create. But a new institution cannot be made on the same terms. The modern industrial system has brought with it an immense variety of practical problems which nations must solve on pain of industrial and commercial ruin. For these problems we want, not a few old-established general principles which no one seriously calls in question, but genuine constructive and organizing capacity, aided by scientific and detailed knowledge of particular institutions, industries, and classes. Just as the historical school grew up along with the greatest constructive achievement of the 19th century, namely, the consolidation of Germany, so the application to modern problems of the methods of that school has been called forth by the constructive needs of the present generation. We have already shown how these methods, in their turn, require the aid of general theory, but not of a general theory which tries to do their work. In fact, every attempt to make it do so must inevitably fail. How can such a huge mass of general propositions as are necessarily included in a system of economics ever be thoroughly tested by an appeal to facts? If they are not so tested, the general theory will remain a general theory, of no practical use in itself, until the end of time. If they are to be tested, an indefinitely large number of special studies must be made, for which the original materials must be collected and examined. That is, original investigation of special problems has to be carried out on a more gigantic scale than any economist of the historical school ever dreamt of or the world requires, with the certain knowledge that at the end of it all the general theory will not correspond with the facts of life. For there is all the difference in the world between using a body of general theory as an indication of the factors to be considered in the study of a special problem, and undertaking special studies with a view to testing the general theory. If the necessary limitations of general economic theory are recognized, most of the difficulties we have noticed disappear. Now that the "industrial revolution" has extended practically all over the world, so that we have several countries carrying on production by modern methods, it is easily possible to sketch the main features of industrial and commercial organization at the present time, to describe the banking and currency systems of the principal nations, their means of transport and communication, their systems of commercial law and finance, and their commercial policy. It is true that at present very little work of this kind has been done in England, but innumerable books, many of them about England, have been written by thoroughly competent economists, in French, German, and other languages. So that no great amount of original work is required for a reliable account of those general features of the modern system which should form the introduction to economics. The general theory which we require should be sketched in firm and clear outline, leaving the detailed qualifications of broad principles to special studies, where they can be dealt with if it is necessary or desirable, and examined by statistical and other tests. For such a general theory there is ample material in the economic literature of all civilized countries. It is of the utmost import-

***Relations between general economics and special studies.***

ance that the economic terms, which are also, though in many cases with an entirely different meaning, the terms of business and commerce, should as far as possible be used in their common and ordinary English sense: that they should correspond in meaning with the same words when used in description, in law, accountancy, and ordinary business. This is no doubt a difficult matter. But some change in this direction is necessary both in the interests of the science itself and of its practical utility. All the materials for investigation, all the facts and figures from which illustrations are drawn, all methods of keeping accounts in England, assume the ordinary English tongue. There are few if any conceptions in economics which cannot be expressed in it without depleting the ordinary vocabulary. At present the language of economics is for the ordinary Englishman like a foreign language of exceptional difficulty, because he is constantly meeting with words which suggest to his mind a whole world of associations quite different from those with which economic theory has clothed them. The refinements of economic analysis, as distinguished from its broader achievements, should be reserved for special studies, in which a technical scientific terminology, specially devised, can be used without danger of misconception. But in a subject like economics obscurity and an awkward terminology are not marks of scientific merit.

Economic studies should be as relevant to existing needs as those of engineering and other applied sciences. The scientific study of practical problems and difficulties is far more advanced in almost every civilized country than it is in England, where the limited scale upon which such work is carried on, the indifference of statesmen, officials, and business men, and the incapacity of the public to understand the close relation between scientific study and practical success, contrast very unfavourably with the state of affairs in Germany or the United States. The backwardness of economic science is an index of the danger which threatens the industrial and commercial supremacy of the United Kingdom. There are at the present time very few questions of public or commercial importance upon which the best and most recent investigations are to be found amongst English works. This would matter very little, perhaps, if Englishmen had a firm belief, established by actual experience, in the soundness of their policy, the present security of their position, and the sufficiency of their methods to strengthen or maintain it. But this is very far from being the case. If we take, for example, the corner-stone of the British commercial system, namely, the policy of free trade, the present generation does not read the economic works which supplied the theoretical basis of that policy, and if it did, would not be convinced by them. The generation which knew Cobden and Bright is rapidly dying out. The great men of their period are merely historical figures, not so real to the present generation as the younger Pitt was to their grandfathers. Long before his death, Bright's references in public speeches to the achievements of the Anti-Corn Law League were received with respectful impatience, and Peel's famous speech on the repeal of the Corn Laws would not convince the German Reichstag or a modern House of Commons. The result is that free trade has ceased to be an article of faith, or even in any real sense a doctrine of expediency. It is rather an old habit for which the ordinary English manufacturer could give no very reasonable explanation, which is not likely to be given up as long as the generation now over fifty years of age has the predominant influence in commerce and public affairs, but for which a younger generation will care no more than their grandfathers did for the mercantile system, unless it can win their adhesion as a policy well designed to realize the aims they will have in view. Hence free trade is in serious jeopardy unless it can be restated in terms which have a direct relevance to the present position of England and present conditions of international trade. If the Imperialist tendencies of the present time continue, as no doubt they will, this question will become one of burning interest. No great scheme of national or Imperial consolidation has ever been carried through without raising and solving questions of commercial policy; and although there is no reason why the consolidation of the British Empire should involve the destruction of the established commercial system of the United Kingdom, and every historical and scientific reason for safeguarding the inheritance of the past, we may see a revival of old fallacies in a new form. It should be the work of economic science ruthlessly to analyse the existing situation, explain the issues involved in the commercial policy of different countries, and point out the alternative methods of dealing with present difficulties, with their probable results.

***Economic problems in Great Britain.***

The commercial policy of a state is merely the reflex of its system of public finance. The absence of conviction in regard to British commercial policy has its counterpart in the attitude of many men to the financial system of the country. It is not often that the eulogies showered upon it in the past are repeated at the present time. The difficulty appears to be caused partly by the great increase in military and naval expenditure, which has been made necessary by the exceptional demands of a state of war and the great development of foreign Powers, partly by the great extension of the functions of the State during the latter part of the 19th century. The former causes are partly permanent, partly temporary; but those of a permanent character are likely to increase in force, and those of a temporary character will leave a deposit in the shape of an addition to the normal expenditure of the central Government. The extension of Government functions is much more likely to continue than to be checked. Normal expenditure is therefore almost certain to rise. It is almost inconceivable that it will fall. Meanwhile, in spite of the vast increase in national wealth, it is a matter of increasing difficulty to meet a comparatively slight strain without recourse to measures of a highly controversial character; and it is certain that no important new source of revenue can be suggested which will not raise, in an acute form, questions of commercial policy and the relations between the United Kingdom and the Colonies. Here there is room for a whole series of important monographs. There is no civilized country in which questions of public finance, in a concrete form, have received so little attention as in England.

***Commerce and finance.***

The development of the powers of the central Government has been less than that of the functions of local governing authorities. This, again, is a movement much more likely to extend than to be checked. Local governing authorities now discharge economic functions of enormous importance and complexity, involving sums of money larger than sufficed to run important states a generation ago. At present we do not know precisely what happens. The scientific study of the economics of local administration is in its infancy. It is of the utmost importance that it should be taken up in earnest by economists. These questions of commercial policy and local government are closely bound up with the scientific study of the transport system. On this important subject there is at present not a single treatise of first-rate importance by an English writer, and there is only one English railway company which records in a suitable form the

data necessary not only for scientific study but for efficient administration. So that, although the British Empire contains within itself every known species of railway enterprise, the study of railways and other means of transport, and their relation to the business, the commerce, and the social life of the country, is deplorably backward. It is obvious that no inquiry into commercial policy, or into such social questions as the housing of the poor, can be effective unless this deficiency is remedied.

The whole social and political fabric of the British Empire depends upon the efficiency of its industrial system. On this subject many monographs and larger works have been published in recent years, but dealing rather with such questions as trade unionism, co-operation, and factory legislation, than the structure and organization of particular industries, or the causes and the results of the formation of the great combinations, peculiarly characteristic of the United States, but not wanting in England, which are amongst the most striking economic phenomena of modern times.

These are some of the questions which might with advantage absorb the energies of the rising generation of economists. It would be possible to add to their number almost indefinitely, but these press for immediate attention. The claim of economics for recognition as a science and as a subject of study must be based on its relevance to the actual life of the economic world, on its ability to unravel the practical difficulties of each generation, and so contribute to the progress of nations.

It is impossible to give even a select bibliography which is at all adequate of the publications of recent years on *Economics*. The most important general work published in English is Marshall's *Principles of Economics*, vol. i., 1st edition, 1890; 4th edition, 1898. J. Shield Nicholson's *Principles of Political Economy*, 3 vols., which is now completed, not only gives a survey of economic principles since Mill's time, but contains much suggestive and original work. The writer of this article is much indebted to the works of Schmoller, particularly his *Grundriss der Allgemeinen Volkswirtschaftslehre* (1900), and Adolph Wagner, particularly his *Grundlegung der Politischen Oekonomie*. On the history of economic theory, Cannan's *History of the Theories of Production and Distribution* (1776–1848) is an admirable criticism, from a purely objective standpoint, of the works of the English classical writers. The most important English works published in recent years on general English economic history are Cunningham's *Growth of Industry and Commerce* and Ashley's *Economic History*, while Vinogradoff's *Villenage in England* and Maitland's *Domesday Studies* are of great importance to the student of early economic institutions. D'Avenel's *Histoire Économique de la Propriété*, &c. (1200–1800), is a monumental work on the history of prices in France. Some recent books dealing with special subjects are likely to take a very high place in economic literature. We may mention particularly Charles Booth's *Labour and Life of London* and Sidney and Beatrice Webb's *History of Trade Unionism* and *Industrial Democracy*. These books are generally regarded as typical of the best English work of recent years in economic investigation. We may also mention Schloss's *Methods of Industrial Remuneration*, a most important contribution to the study of the wages question; C. F. Bastable's works on *International Trade* and *Public Finance*; George Clare on the *Money Market* and the *Foreign Exchanges*; and A. T. Hadley's *Economics: An account of the relations between private property and public welfare* (1896). Studies of particular questions, both concrete and theoretical, in foreign languages are too numerous to specify, and much of the best modern work is to be found in economic periodicals.

(W. A. S. H.)

**Ecuador,** a country of South America extending between Colombia and Peru from 1° 56′ N. lat. to about 5° 30′ S. lat., and from the Pacific coast to a distance inland not yet determined. The boundary dispute between Colombia, Ecuador, and Peru was, by agreement of 15th December 1894, submitted to the arbitration of the Spanish Crown, but no award had been made up to the beginning of 1902, nor had any definite steps been taken to execute a survey of the frontier. The climate is on the whole healthy, especially in the inter-Cordilleran valley. Intermittent fevers, frequent in the coast region, are unknown in the highlands, where also pulmonary diseases are rare. The average rainfall at Quito is about 39 inches. The death-rate at Quito in 1892 was stated to be 36 per 1000.

*Population.*—The area has never been ascertained by survey, but is estimated at 118,630 square miles, an estimate which includes a vast territory still in dispute. No census has ever been taken, and the generally accepted estimate of the population is that of Cervallos, who for 1889 put the total number of inhabitants at 1,272,160. The following table shows the population of the fifteen provinces, the territory of Oriente, and the Galapagos Islands, which in 1885 were made dependent on the province of Guayas:—

| | Population, 1889. | | Population, 1889. |
|---|---|---|---|
| Carchi | 36,000 | Rios | 32,800 |
| Imbabura | 67,940 | Oro | 32,600 |
| Pinchincha | 205,000 | Guayas | 98,042 |
| Leon | 109,600 | Manabi | 64,123 |
| Tunguragua | 103,033 | Esmeraldas | 14,553 |
| Chimborazo | 122,300 | Oriente | 80,000 |
| Cañar | 64,014 | Galapagos Islands | 300 |
| Azuay | 132,400 | | |
| Loja | 66,456 | | |
| Bolivar | 43,000 | Total | 1,272,161 |

The population contains approximately 120,000 whites, 450,000 of mixed races, and 702,000 Indians. The isolated position of the inland towns has helped their white inhabitants to preserve the characteristics of the original Spanish settlers. The offspring of the intermixture of whites and Indians are called, in the language of the country, *mestizos*, and the offspring of mestizos and Indians, *cholos*. The crossing of white and negro, and of negro or mulatto and Indian, produces the classes named respectively *mulattos*, *zambos*, and *zambaigos*. The colour among these people confers superiority in rank, or at least in self-esteem. The half-breeds, whether those between Spaniards and Indians or Indians and negroes, are indolent and unintelligent. The Indians as a rule are sturdily built and have great power of endurance, travelling immense distances over mountainous country without undue fatigue. They are extremely docile, except when excited by drink. A few of the tribes near the seaboard in the province of Esmeraldas have a large admixture of negro blood from slaves formerly employed in that district. The foreigners resident in Ecuador number altogether about 6000, some 5000 being natives of South or Central America, 700 Europeans, and 300 Chinese. The population of Quito is estimated at 65,000; of Guayaquil at 45,000; of Cuenca at 25,000; of Riobamba, 12,000; and of Ambato, Loja, and Latacunga about 10,000 each. A fire destroyed half the city of Guayaquil in 1897.

*Constitution.*—The Constitution in force is that of 1884, with modifications introduced in 1887 and 1897. The legislative authority is vested in a Congress of two chambers, the Senate consisting of 30 members (2 for each province), and the Chamber of Deputies with 41 members (1 for every 35,000 inhabitants, and 1 more if there are still 15,000 unrepresented). Senators are elected for four years, and Deputies for two, directly by popular vote, every male citizen who can read and write being an elector. Congress meets every second year at Quito on 10th June for a session of 60 days. The executive authority resides in the

President of the Republic, elected for four years by direct vote of the people, and not re-eligible till the two following presidential terms have elapsed. The Vice-President is elected two years after the President, and is therefore a member of two distinct administrations. He succeeds for the remainder of the term in case of the decease or disability of the President, and is, moreover, President of the Council of State. The President is assisted by 4 Secretaries of State, heads of departments, appointed by himself, and by a Council of State consisting of the Vice-President of the Republic, the 4 Secretaries, the Fiscal Minister, 2 Senators, 1 Deputy, 3 private citizens, and an ecclesiastical functionary, the last 5 members being chosen by Congress. This Council must be consulted by the President on every important measure or appointment. The President has the power of veto over measures passed by Congress; but if these measures are again voted, he has no other alternative than to accept them. The President cannot dissolve Congress or shorten their sittings within the two months established by law, but he can call an extraordinary session for a specified purpose. By a decree issued in 1896 the Indian population is exempted from payment of tribute and admitted to rights of citizenship. The provinces are administered by governors, nominated by the supreme Government; the departments by *jefes politicos*, or political chiefs; and the municipalities by *tenientes politicos*, or political lieutenants. The Galapagos Islands are under a *jefe territorial*, or territorial chief.

The subdivisions of the provinces, the cantons, and the parishes are administered by subordinate officials, all of whom are appointed by the President.

*Justice.*—The judicial power rests with a Supreme Court, composed of six judges and a fiscal judge nominated by the executive; a *Tribunal de Cuentas* of four members; six superior courts; tribunals of the second and third instance for commercial cases; and courts of consular judges at Quito, Riobamba, Cuenca, Guayaquil, and Monte Cristi; magistrates are appointed in each provincial capital; municipal *alcaldes* at the headquarters of each department; civil magistrates in all parishes. *Tribunales de Jurados* exist in Ibarra, Quito, Loja, Latacunga, Ambato, Riobamba, Cuenca, and Guayaquil for the trial of such criminal cases as the law brings within their jurisdiction. The judges of the Supreme Court, the six superior courts, and the members of the *Tribunal de Cuentas* are elected by Congress for a term of six years. The laws of Ecuador are founded on Spanish law, and are all written and codified. There is a civil code, a code of civil procedure, a commercial code, a penal code, and a code of procedure in criminal cases. Constant complaints are heard of the inefficiency and dilatory method of procedure in the courts of Ecuador, and apparently with much justification.

*Religion.*—According to the Constitution, "the religion of the Republic is the Roman Catholic Apostolic, and all others are excluded," but as a matter of fact official toleration exists for all forms of religion. In 1889 the tithes from which Church revenues had been collected were abolished, and instead a tax of 3 per 1000 on real estate was imposed.

*Education.*—Primary education is free and nominally compulsory. No great effort is, however, made by the authorities to compel the attendance of children. Under President Flores, from 1888 to 1892, much attention was paid to the question of public instruction, and many new establishments were opened. The number of primary schools is 1088, and in these 1498 teachers are employed. The number of pupils on the rolls in 1898 was 68,380. The National Government supports 778 schools, 452 for boys and 326 for girls, the remainder being maintained by the municipalities or from private sources. There are 35 schools for secondary and 9 national colleges for higher education. Colleges for the higher education of women are established at Quito, Guayaquil, Cuenca, Loja, and Latacunga, under the supervision of religious orders. In Quito is a central university with 32 professors and attended by 216 students in 1897. There are also university corporations at Guayaquil and Cuenca. The faculties include philosophy and literature, jurisprudence, medicine and pharmacy, and science. Theology is taught in seminaries for the education of the priesthood, three of these institutions being situated at Quito, and one in each diocese of the Republic. Commercial and technical schools have also been established at Guayaquil and Quito. There is a national library at Quito, containing 13,000 volumes, amongst them many old and rare books and manuscripts. The National Government devotes about 600,000 *sucrés* annually to educational purposes.

*Defence.*—The army consists of 221 officers and 3120 non-commissioned officers and men. The National Guard nominally contains a total strength of 95,329 men. The navy consists of 1 transport, 1 small gunboat, and 1 torpedo launch, these vessels mounting in the aggregate 9 guns. The ships are manned by 114 sailors.

*Finance.*—Of the revenue, about 70 per cent. is derived from import duties, 8 per cent. from export duties, 15 per cent. from taxes on cocoa, real estate, rum, and tobacco, 6 per cent. from the salt and gunpowder monopolies, and the remainder from excise, state property, and the post office. The chief spending departments are those of Public Works, Finance, War, and Education. From 19th June 1895 to 31st July 1896 the ordinary revenue (the *sucré* being taken at 24d.) amounted to £512,860, and the extraordinary receipts (mostly loans from banks) to £373,070; while the total expenditure amounted to £877,950. For 1897 the revenue was stated to amount to £676,055, and the expenditure to £569,020. For 1900 the revenue was estimated at £826,810 and the expenditure at £896,780. The external debt originally consisted of liabilities taken over by the Republic on its secession from Colombia. In 1855 the debt was fixed at £1,824,000, and arrangements were made for the payment of interest. In 1868 default was made. In 1892 the debt was converted into a New Consolidated Debt of £750,000, but in 1894 payment of interest was suspended. In 1895 a new arrangement was made which was suspended in 1896. In 1897–1900 various contracts were signed whereby the Guayaquil and Quito Railway Company was to purchase the bonds of the existing debt, the Government guaranteeing the sum of £2,520,000 mortgage bonds of the company, and recognizing the external debt at 35 per cent. of its face value. The internal debt is stated to be about 10,000,000 *sucrés*; its service is attended to irregularly.

*Industry.*—Industrial development has not made any marked progress, owing largely to the absence of transport facilities throughout the interior. Cocoa is the most important product, and is cultivated on the lower lands, especially in the neighbourhood of the Guayaquil river. In 1895 the receipts of this article at Guayaquil amounted to 16,122 tons; in 1896 to 15,327 tons; in 1897 to 14,800 tons; in 1898 to 19,000 tons; and in 1899 to 23,200. Though the cultivation of coffee has been considerably extended, low prices have greatly discouraged the planters. In 1897 the amount exported was 1201 tons, and in 1898, 1692 tons. Sugar is grown and manufactured principally for local consumption. The total export of sugar in 1898 was less than 2500 tons. The collection of india-rubber from the forests of the interior has increased, the amount shipped abroad in 1898 being 429 tons, as compared with 271 tons in 1897. In the province of Tungurague some 200 acres are under vines, from which a small quantity of wine is made, but the bulk of the grapes are sold fresh. Tobacco is also produced on a small scale for home use, the centre of this industry being in the province of Esmeraldas. Pastoral industry is confined to breeding cattle to meet the home demand for meat. The export of hides was valued at £27,060 in 1898. Ivory nuts were shipped to the value of £23,080 in 1898. Mining industry is practically confined to the work of gold quartz crushing at Zaruma, in the province of Loja, and to extraction in Esmeraldas from gravel beds by hydraulic process by American companies. Gold washing in the beds of rivers and streams is practised by the Indians. Petroleum exists in different localities, but no serious attempt has been made to work this natural product, nor has any development in mining for copper, iron, lead, or coal taken place, although large deposits of these minerals are stated to be found. Silver is found in considerable quantities in the province of Cuenca, and quicksilver in that of Loja. Manufacturing industry is represented by factories for soap, chocolate, biscuits, and vermicelli and macaroni; 4 sawmills; some small woollen and cotton mills; and a brewery and ice factory at Guayaquil. The making of straw hats, known as "Panama," is a national industry, the value exported in 1898 being £8900.

*Commerce.*—The foreign trade passes almost exclusively through the port of Guayaquil. The value of the imports and exports for 1890, and for the years from 1894 to 1900, is returned as follows:—

| Years. | Imports. | Exports. | Years. | Imports. | Exports. |
|---|---|---|---|---|---|
| | £ | £ | | £ | £ |
| 1890 | 1,001,635 | 976,164 | 1897 | 930,000 | 1,217,630 |
| 1894 | 1,200,000 | 1,393,375 | 1898 | 910,000 | 1,257,930 |
| 1895 | 852,000 | 1,156,274 | 1899 [1] | —— | 2,142,025 |
| 1896 | 870,000 | 1,088,920 | 1900 | 1,341,688 | 1,541,922 |

[1] The statistics of imports for 1899 were in great part destroyed by the fire at Guayaquil on 27th November 1899.

The imports consist mainly of cotton and woollen fabrics, provisions, flour, hardware, wines and spirits, and other articles of consumption or common use. The staple article of export is cocoa, of which there were shipped abroad in 1895, 32,516,000 lb; in 1896, 33,909,000 lb; in 1897, 33,123,000 lb; in 1898, 35,036,000 lb; in 1899, 47,704,550 lb. Of the shipments in 1899, 22,186,190 lb went to France; 5,535,310 lb to Spain; 9,781,720 lb to Germany; 5,493,100 lb to Great Britain; 3,473,220 lb to the United States; 1,235,010 lb to other countries. The exports will probably increase, since millions of new plants are planted every year. Other articles of export have been already mentioned. Of the imports, about 33 per cent. in value are from Great Britain, 15 per cent. from Germany, 15 per cent. from the United States, and 14 per cent. from France. The imports from Ecuador into the United Kingdom in 1899 (according to British statistics) amounted to £175,500, of which £154,960 was for cocoa; while the exports to Ecuador from the United Kingdom amounted to £403,425, of which £253,640 was for cotton goods. According to American statistics, the Ecuadorian imports into the United States in the year 1899–1900 amounted to the value of $1,524,375 (£304,875), and the United States exports to Ecuador to the value of $1,216,005 (£243,201).

*Shipping.*—Guayaquil, the principal port, is in regular communication not only with other Pacific ports, but with New York, Liverpool, and Hamburg. The coasting trade is carried on by small vessels under the Ecuadorian flag. Of vessels in the foreign trade in 1898, 206 of an aggregate tonnage of 298,805 entered and 200 of 290,855 tons cleared at the port of Guayaquil. Of those that entered, 110 of 162,280 tons were British. At the same port there entered also 3600 vessels of 34,989 tons engaged in the coasting trade.

*Communications.*—Roads are nothing better than mule tracks, over which wheeled vehicles cannot pass. The highway of 115 miles between Guayaquil and Quito is constantly in need of repair, bridges and culverts being frequently washed away. The navigation of the rivers Guayas, Daule, and Vinces is carried on by a fleet of 17 steamers, and by small craft and canoes. The only railway is that—with a gauge of 36 inches—from Duran, near Guayaquil, to Chimbo, a distance of 58 miles. A concession has been granted to an American syndicate to take over the line and prolong it to Quito. The total length of telegraph lines open to public service in 1898 was 1242 miles, with 60 offices. The principal cities are connected with Quito, and that city with Guayaquil. From Guayaquil there is cable connexion with the rest of the world. The telephone is in use in Guayaquil and the vicinity. The inland postal correspondence is stated to comprise about 850,000 letters annually, and the foreign correspondence about 1,809,000 letters and 6,347,000 newspapers and parcels.

*Money, Weights, and Measures.*—The monetary unit is the silver *sucré* of 100 cents, weighing 25 grammes, and ·900 fine. The *sucré* derives its name from President Sucré, a prominent figure in the War of Independence with Spain. Other silver coins are 50-, 20-, 10-, and 5-cent pieces. There are nickel coins of 5-, 1-, and ½-cent pieces, and bronze coins of 2 cents and 1 cent. By an agreement between the banks and the commercial community a rate of exchange equal to 10 *sucrés* to £1 was sustained during 1898, and still continues, with slight variations. Congress has recently provided for the coinage of gold pieces of the same weight and fineness as the British sovereign; these will be known as *condores*, each *condor* being equal in value to 10 *sucrés*. The British sovereign is also declared by this measure to be legal tender for the same value as the *condor*.

The principal banks within the republic are the Banco del Ecuador and the Banco Comercial y Agricola. The former has a capital of 2,000,000 *sucrés*, the latter one of 500,000 *sucrés*. Both issue notes, the banking law providing that one-third of the value of the issue must be held in coin, one-half of the reserve being in gold. On December 31, 1898, the note issue of the Banco del Ecuador was 2,138,170 *sucrés*, and that of the Banco Comercial y Agricola 3,522,242 *sucrés*. There are also two mortgage banks, the Banco Hipotecario and the Banco Territorial. The rate of interest charged is from 8 to 12 per cent. per annum. By the law of 6th December 1856 the metric system of weights and measures is the legal system of the republic, but the old Spanish weights and measures are almost invariably used.

*Recent Political History.*—After the assassination of President Moreno at Quito, in August 1875, Dr Borrero was elected to the presidency, but his tenure of power was short. A revolution headed by General Veintemilla, the Radical leader, then military commandant at Guayaquil, broke out in 1876, and on 14th December of that year the Government forces under General Aparicio were completely routed at Galte. Veintemilla was proclaimed president, and in 1877 was duly elected by the Cortes. He altered the constitution in a more Liberal direction, and struck various blows at the Clerical party, among other things abolishing the concordat with Rome. In 1878 Veintemilla caused himself to be declared elected as president for a term of four years. At the expiration of this period the president assumed dictatorial powers and remained in office as chief of the executive. This action on the part of General Veintemilla led to a union between the Clericals and Moderate Liberals, and resulted in a popular rising throughout the republic, ending in his defeat and overthrow. His power was first restricted to Guayaquil and Esmeraldas, and finally General Rinaldo Flores drove him from Guayaquil, and Veintemilla fled (July 1883) to Peru. Dr Placido Caamaño was then called upon to take charge temporarily, and on 17th February 1884 was definitely elected for the presidential period terminating in 1888. Several revolutionary outbreaks occurred during the Caamaño administration, but were successfully suppressed. In 1888 Dr Antonio Flores succeeded Caamaño, the four years following being passed in peaceful conditions. In 1892 Dr Luis Cordero was elected, his administration again plunging the country into an epoch of internal disturbance.

The cause of the troubles under President Cordero was the assistance lent by Ecuador to Chile in the matter of the sale of the cruiser *Esmeralda* to the Japanese Government in 1894, in the middle of the Japanese–Chinese War. The Government of Chile arranged the sale of the *Esmeralda*, but wished to be free from all danger of international complications in the affair. To this end the transfer of the vessel was made to Ecuador, and she proceeded to Ecuadorian waters. On arriving at the Galapagos Islands the flag of Ecuador was replaced by that of Japan and the vessel handed over to the representatives of that nation sent for the purpose. When the part played by President Cordero in this transaction became known, an outburst of popular indignation occurred. An insurrection, headed by General Eloy Alfaro, followed; and after desultory skirmishing extending over a period of nearly a year the Government forces were finally routed, President Cordero abandoning his office and escaping from the country.

General Alfaro then assumed dictatorial powers as supreme chief of the nation, continuing in this capacity until 6th February 1897, on which date he was declared to be elected president of the republic. A series of revolutionary movements against the administration of President Alfaro occurred in the course of the next few years. Many of these risings were due to the intrigues of the Church party, and in view of these circumstances President Alfaro curtailed the influence of the clergy in several directions. On 31st August 1901 General Alfaro peacefully handed over the presidency to his elected successor, General Plaza.

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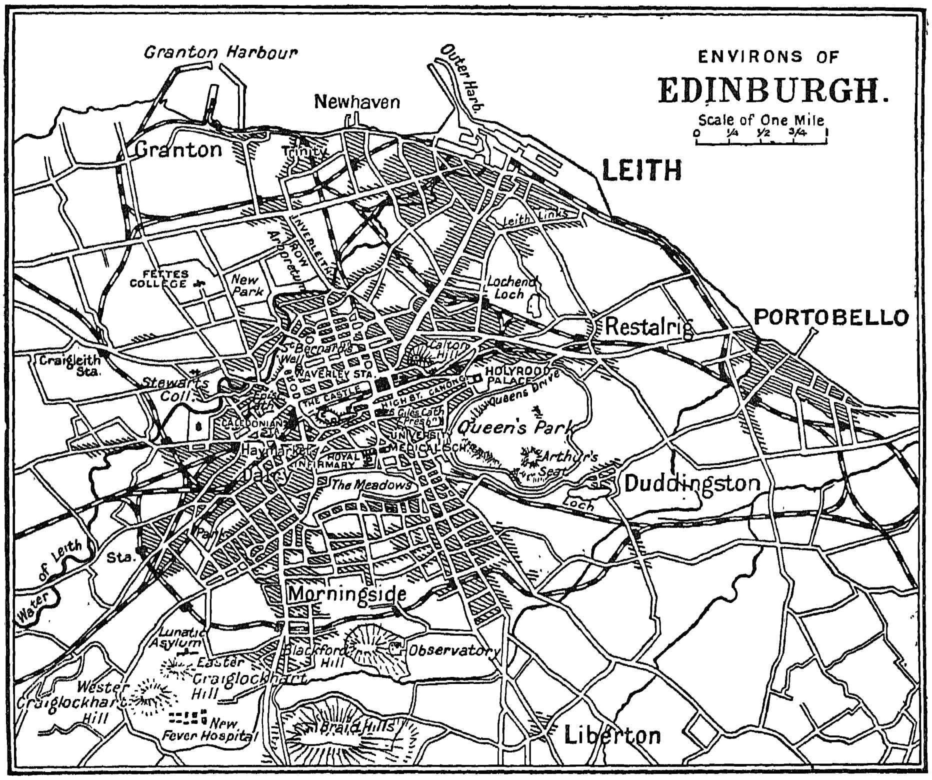
(W. W. R.; C. E. A.)

**Edessa,** now called Urfa, one of the most important towns of Northern Mesopotamia. It stands at a height of 1700 feet above sea-level, on the right bank of the Scirtus (Syrian, *Daiẓon*), a winter torrent which discharges into the Belikh, a tributary of the Euphrates. Urfa is the capital of a sanjak of the same name, in the Aleppo viláyet, seat of a governor and of an Armenian bishop, situated on the border of a fertile plain noted for its wheat and fine pasture, on the great caravan road from Aleppo to Mosul, about 46 miles east of Birejik. It stands partly on the plain and partly on two rocky hills, between which runs a small stream. There are remains of the old walls, with their rock-hewn ditch, and of the citadel. The streets are narrow and winding, with well-built stone houses. Beneath the citadel are two springs, which supply tanks—one the Birket Ibrahím, with sacred fish, now under the protection of Abraham, as they formerly were under that of Atergatis. About one mile from the town is a spring connected by tradition with the healing of Abgar's leprosy by Thaddeus. The climate is healthy, but not in summer: the "Aleppo button" is common. The principal manufactures are fine cotton stuffs and yellow leather. The population numbers 20,000 (Moslems 8500, Armenians 7500, Syrians, Greeks, Protestants, and Jews 4000). On the 28th and 29th December 1895 there was a barbarous massacre, between 3000 and 4000 Gregorian, Roman Catholic, and Protestant Armenians perishing.

Authorities. — Gutschmid. "Untersuchungen über die Geschichte des Königreich Osroene" in *Mémoires de l'Académie Impériale*. St Petersburg, 1887.—Fitzmaurice. *Report dated March 16th, 1896*, in Turkey No. 5, 1896. (C. W. W.)

**Edinburgh,** a city, county, and parliamentary burgh, and the capital of Scotland, situated on the south shore of the Firth of Forth, and surrounded by the county of Midlothian, 396 miles by rail north of London, with which it is connected by the Great Northern, Midland, and London and North-Western Railways. Its progress since 1880, if not so rapid as that of some other towns more dependent for their prosperity on trade and manufactures, has been steady and great.

*Area.*—Its area has been enlarged by successive extensions of its municipal boundaries, especially towards the west and south, the directions in which growth has been most marked. An important accession of territory was obtained in 1896, when portions of the parishes of Liberton and Duddingston and the police burgh of Portobello were incorporated in the city. The attempt then made to secure the amalgamation of the contiguous burgh of Leith to the Scottish capital did not prove successful. Under the Edinburgh Corporation Act, 1900, a further addition of nearly 1800 acres was made to the city area. This embraces portions of South Leith parish (landward) and of Duddingston parish, including the village of Restalrig and the ground lying on both sides of the main road from Edinburgh to Portobello; and also part of Cramond parish, in which is contained the village and harbour of Granton. The total area of the city is now 10,597½ acres.




*Population and Wealth.*—The number of inhabitants, set down at 212,729 in 1877, increased to 234,402 in 1881, to 261,225 in 1891, and to 316,479 in 1901. In 1900 the birth-rate was 26·90 per thousand of population, 7·8 per cent. of the births being illegitimate; the death-rate, 19·40 per thousand of population, and the marriage-rate 10 per thousand. Of the total number of deaths 29 per cent. were those of children under five years, compared with 39·8 per cent. in Glasgow. The increase in wealth may best be measured by the rise in the assessed valuation of the town. The city rental was £1,727,740 in 1880, £2,106,395 in 1890, and £2,807,122 in 1900–1901.

*Municipal Government and Finance.*—There have been corresponding growth and change in the municipal and political organization of Edinburgh. By the Redistribution Act of 1885 the number of the city's representatives was doubled, and it was divided, for electoral purposes, into East, West, Central, and South Edinburgh, each returning a single member; the parliamentary and municipal boundaries have been made almost coterminous. The parliamentary constituency in 1901 numbered 42,375 registered electors, of whom 11,025 were in the East, 8926 in the West, 7630 in the Central, and 14,794 in the South divisions. The municipal constituency is 59,339. The Town Council has been increased to fifty members, and consists of a Lord Provost, 7 bailies, a dean of guild, treasurer, and convener of trades, 7 judges of police, and 32 ordinary councillors. Among the important new public duties and functions undertaken by the Corporation and its dependent bodies may be mentioned the acquisition of the gas-works, and of the horse and cable tramways; the electric lighting of the streets; the bringing in of an additional water supply from the Moorfoots, to be supplemented by the Talla Water scheme; and the purchase of

several public parks, including the Braid Hills and Blackford Hill.

*Finance.*—The debt of the city at 15th May 1900, existing and in immediate prospect, amounted to £3,515,585, made up as follows:—To be met out of the rates, £1,623,440; tramways, £1,147,817; electric lighting, £652,078; municipal debt to be met out of Common Good revenue, £92,250. The estimated net expenditure of the city, under the Municipal and Police Acts, for the year ending 15th May 1901, was £331,365, of which £303,098 was chargeable on the burgh assessment. The rates imposed for 1900–1901 were at 9½d. per £ on owners and 1s. 8¼d. per £ on occupiers, together 2s. 5¾d. per £, being the same as the rates imposed in the preceding year. The estimated capital expenditure contemplated on schemes sanctioned by the Council includes the sums of £116,000 on the improvement of the City Chambers, £57,000 for the purchase of the new park at Saughton, £193,000 for the erection of the new City Hospital, and £153,000 for acquiring and demolishing old property and erecting new houses on "Dwelling-House Improvement" account.

*Industries.*—Many new branches of industry have been started; and the older industries, like printing and brewing, for which the town has long been celebrated, have received further development. But Edinburgh is still, as it was in 1875, and as it has been during its recorded history, a residential rather than a commercial or manufacturing city. City improvements, some of them still in progress, have swept away, as "slum property," numerous buildings of venerable age and historic associations. Along with this inevitable process of change there has gone, however, an effort not only to preserve ancient and characteristic features of the street architecture of the Old Town, but to rescue from degradation, and to restore something of their long-lost social dignity to, the closes and front "lands" of the Lawnmarket, the High Street, and the Canongate. If the city is no longer, in the same sense as early in the 19th century, the home and centre of literary society, it can still claim to be a place whose main industry is education, which, whether as regards its University and Medical School, its secondary, technical, and endowed institutions, or its public elementary schools, has undergone immense development since 1875.

*The Castle.*—The Castle, which from its rock has always dominated the site and history of Edinburgh, has received a number of improving and restoring touches. The most important of these was due to the late Mr William Nelson, publisher, who, by his restoration of the Argyll Tower and of the Old Parliament Hall, furnished but one of the many instances of local patriotism and private munificence exhibited during their lifetime by citizens on behalf of the amenities and institutions of the town. The Parliament and Banqueting Hall forms a lofty, spacious, and beautiful hall of arms, with a fine collection of Scottish armour and weapons and old regimental colours, and the heraldic bearings of royal and distinguished figures in national history emblazoned on the windows overlooking the Grassmarket. A new hospital, in the Scottish baronial style, has also replaced the former ugly structure.

*Holyrood.*—The neglected and dilapidated royal vault in the Chapel Royal has been repaired and put in order. Clockmill House and grounds have been added to the area of the parade ground, and there have been improvements in the Abbey precincts and in the accesses to the King's Park. The privileges of sanctuary came to an end with the abolition of imprisonment for debt in 1881.

*Old Town Improvements.*—Time and the city improvements have laid heavy hands on the Old Town buildings. Other agencies that have been active in producing change have been railway extension and the necessity for forming new or widening old streets. Much that was ancient and interesting has had to yield place to the requirements of sanitation, social progress, and public convenience. On the other hand, it has been found possible in many cases to increase the amenity of the main thoroughfares and the closes of "Auld Reekie," while preserving, and even enhancing, the picturesque features of its architecture. The Canongate quarter has suffered comparatively little alteration. New buildings have arisen, however, in the Watergate and Horse Wynd, and in the North and South Back of Canongate. The Old White Horse Close has been tastefully renovated; a public board school has taken the place of Milton House, traditionally associated with Cromwell's residence in Edinburgh; New Street, a town improvement of more than a century ago, and the home of eminent men in law and letters of a past generation, has disappeared in the course of railway alterations. Much change has taken place in the vicinity of the Netherbow, where formerly the bounds and authority of the city met those of the Canongate. St Mary Street, the former "Rag Fair" outside the town wall, has been almost rebuilt; it was the first-fruits of the labours of the Improvement Trust. Jeffrey Street has supplanted what was once Leith Wynd, and is continued westwards in Market Street, which fronts the railway line with many handsome buildings, including the new Trinity College Church. In the place of the historic Blackfriars Wynd there is a new and prosaic thoroughfare; and "Beaton's Palace," the old Cunzie House, and other ancient dwellings have been removed from the adjoining Cowgate. Much more significant and more important are the changes produced by the rebuilding of the North Bridge. The bridge has been widened and heightened, and at its northern end, opposite the General Post Office, the North British Railway Company have built a magnificent new hotel. To make way for the lofty and handsome block of buildings fronting the new North Bridge Street on the east side, many old houses have been pulled down, including Robert Fergusson's birthplace in the Cap and Feather Close, and Allan Ramsay's wigmaker's shop, "at the sign of the Mercury, opposite Niddry Wynd." As great a sweep of ancient landmarks has been made on the other side of the thoroughfare, where the new and stately *Scotsman* buildings occupy the site of the many famous drinking "howfs" of the Fleshmarket Close and Milne's Square. In the part of High Street between the Tron Church and Parliament Square an important city improvement has involved the demolition of a host of noteworthy sites and dwellings in Stevenlaw's, Burnet's, Covenant, and Assembly Closes, all these narrow and unwholesome alleys being now opened to the air and light. The extension of the Municipal Buildings in Writers' Court and Warriston Close has caused the destruction of Clerihugh's tavern, the scene of the "high jinks" described in *Guy Mannering;* and the earlier improvement of opening St Giles Street, beside which stands the new Bank of Scotland, caused another great breach in the ranks of the old High Street houses. Opposite, at the corner of High Street and George IV. Bridge, the County Buildings, erected in 1818, will be replaced by a more commodious structure. Among the improvements and additions made on the adjoining Parliament House may be mentioned the Library of the Solicitors before the Supreme Courts, which presents to the Cowgate a lofty elevation in red sandstone. The Sheriff Court Buildings and the new Free Library also rise out of the depths of that hidden thoroughfare, and face each other on the higher level of George IV. Bridge. The latter structure is the gift to the city of Mr Carnegie, and cost £50,000. The Lawnmarket, the West Bow, and the Castle Hill bear many traces, in frontages and recesses, of change tempered by taste. The congeries of alleys on the north side of the Lawnmarket, from Paterson's Close to James Court, have been cleansed and connected; and here Lord Rosebery has acquired and restored the 17th-century dwelling in which was located the legend of "My Aunt Margaret's Mirror." Another model restoration of a historic Edinburgh close is found across the way in Riddle's Court, converted into a "University Hall." Quaint examples of Lawnmarket and Bow Head tenements have disappeared, partly through the extension of the Free Church Assembly Hall; a board school has usurped the place of the old Gordon mansion on Castle Hill; while a new and noteworthy addition has been made to the architectural features and the social amenities of this part of the Old Town by the development of Allan Ramsay's former residence of Ramsay Lodge into the imposing group of Ramsay Gardens.

*The University, &c.*—The "youngest of the Scottish universities" has continuously maintained and enhanced its reputation as a seat of learning, and more particularly as a medical school; and it has increased in wealth, in equipment, and in the number of its students, which in 1899–1900 reached 2789, compared with 2065 in 1875–6. The constitution, administration, and curriculum of the university have undergone great development, the most recent changes taking place under the Act of 1889. In 1883 it celebrated its tercentenary; it was one of the first universities to admit women students to its classes and degrees; and its alumni have been brought into closer bonds of sympathy and action by the formation of a handsomely housed Students' Union. The university buildings have received extension and embellishment to meet the needs and tastes of the age. The plan of the structure, designed by Adam and Playfair, has been completed by a dome and cupola crowning the façade in South Bridge Street; the opening up of the spacious thoroughfare of Chambers Street, on the site of College Wynd and Brown and Argyll Squares, has cleared the precincts of the old university buildings of unsightly obstructions and unsavoury neighbours; the Museum of Science and Art, structurally united to it, has been completed and enriched with additional collections illustrative of industry, art, and natural history; and opposite have arisen other new structures, the Minto House Medical College and the Heriot-Watt College, which may be regarded as adjuncts of the university. Within, the library hall has received restoration and decoration, largely through the generosity of Sir William Priestley, formerly member for the university; while munificent additions to the academic funds and resources have been made by the late Earl of Moray, Sir William Fraser, Mr John Usher, and others. The University will benefit also, like the other Scottish Universities, from Mr

Carnegie's noble endowment fund. The most splendid evidence of its growth and of the liberal and enlightened spirit in which it is supported is provided by the new Medical School, built in Teviot Row, adjoining George Square and the Meadows. To this fine and spacious group of buildings the Faculty of Medicine has been removed; and its suite of class-rooms, operating theatres, and laboratories equip it thoroughly for its work of teaching and healing. The Medical School is in the Renaissance style, from the designs of Dr Rowand Anderson, and when completed by a campanile tower will have cost over £300,000. A magnificently decorated hall, for academic and other public functions, is the gift of Mr William M'Ewan, M.P., to the university and city, and with the grand organ has cost a sum of £115,000. Closely associated with the Medical School, and separated from it by the Middle Meadow Walk, is the Royal Infirmary, removed hither from Infirmary Street. Its wards, in which nearly 10,000 patients receive treatment annually, are lodged in a series of turreted pavilions, and cover a large space of ground on the margin of the Meadows, from which, to make room for it, George Watson's College—the most important of the Merchant Company schools—has had to shift to a site farther west, while the Sick Children's Hospital has moved to the farther side of the Meadows. The Old Infirmary buildings have served the purposes of a City Fever Hospital, which soon, however, will be accommodated more spaciously and suitably on a site lying on the burgh outskirts at Wester Craiglockhart Hill. Similarly, the Royal Edinburgh Asylum for the Insane has been crowded from its old ground at Morningside, and has occupied a noble structure set on a commanding position on the easter hill of Craiglockhart; and the Royal Blind Asylum has moved from its former quarters in Nicolson Street to a new home at Powburn. A Home for Incurables has been erected in Salisbury Place. Among the host of benevolent, charitable, and other public institutions mention may be made of the Central Public Baths in Infirmary Street, and branch establishments in other parts of the town, including the new suburb of Portobello, and the Workmen's Institutes planted in crowded districts of the city with funds provided by the late Mr Thomas Nelson.

*Endowed and Public Schools.*—Among buildings more strictly educational in their purposes, notice must be taken of the host of new public schools, for the most part large, handsome buildings, which bear witness to the zeal and activity of the School Board in providing for the elementary and advanced instruction of the young, and fulfilling their other duties under the Act of 1872. A large number of these schools have been erected within the city bounds, and the expenditure of the board on building, including sites, and exclusive of schools now being built, has been £496,000. The estimated expenditure on two new schools which are approaching completion, and for additions that are being made to other schools, is over £73,000; and plans have been prepared for a new school for the Craiglockhart district, in the south-west of the city, at a probable cost of £30,000. Two of the existing schools have been graded and fitted with apparatus to meet the requirements of the secondary education grant, and a day industrial school for truant children has been provided. The new Merchant Company colleges have more than fulfilled the expectations of those who devised the scheme by which the buildings and endowments founded on the old "hospital" system, were devoted to the purpose of establishing highly-equipped day schools, which should carry the pupils through all the stages of primary and secondary education. In this way George Watson's College, Stewart's College, and the Queen Street Ladies' College, George Square Ladies' College, and Gillespie School, possessing an aggregate income of £66,000, have taken a high place among the educational institutions of the city and country, and have become important feeders of the university. The Heriot Trust, also, has devoted its funds, now reaching over £30,000 annually, mainly to the encouragement of secondary, technical, and higher education; in addition to the support thus provided for the Heriot-Watt College already mentioned, the fine and venerable structure of Heriot's Hospital is occupied as a technical school, and a large part of the revenue is spent on a school and university bursary scheme. The Royal High School—the old and famous burgh school of Edinburgh—has also been reorganized and enlarged to meet modern requirements; and on the northern outskirts there has risen in Fettes College—an endowed institution on the model of the English public schools—an architectural ornament of the city.

*New Town Improvements.*—The New Town has spread westwards and northwards in handsome streets, terraces, and crescents, which in both directions have crossed over the valley of the Water of Leith. By the purification of the stream, carried out at the cost of the city, a great addition has been made to the amenity of its neighbourhood, which has been further increased by the restoration and embellishment of St Bernard's Well and its surroundings, an improvement of which the whole cost was borne by the late Mr William Nelson. Beyond the Water to the north, between Inverleith Row and the Fettes College grounds the Arboretum, joined on one side to the Royal Botanic Gardens, and adjacent on the other to the new Inverleith Park, has become a favourite public resort. To the south and west of Haymarket a populous working-class district has sprung up at Dalry. In Atholl Crescent is a possible site of a public hall for musical and other purposes, for which the late Mr Thomas Usher gave the sum of £100,000. Important changes have been made upon the architectural appearance of Princes Street, George Street, St Andrew Square, and the adjoining thoroughfares, through the erection of new hotels, banking and insurance offices, and clubs; and at the east end of Queen Street a stately structure, designed by Dr Rowand Anderson, to accommodate the National Portrait Gallery and the Antiquarian Museum, has been raised through the liberality of the late Mr J. R. Findlay of Aberlour, who bestowed a sum of nearly £70,000 for the purpose, the Government providing the site. In Castle Terrace the Synod Hall of the United Presbyterian Church (now joined to the Free Church, under the title of the "United Free Church of Scotland") is flanked on either side by the School Board and Parochial Board offices; while behind it, in Grindlay Street, is the Lyceum Theatre.

*Churches.*—The most important addition made in recent years to the churches of Edinburgh is St Mary's Cathedral, belonging to the Scottish Episcopal Church. It is built on ground and chiefly from funds bequeathed by the late Miss Walker of Coates, and the Cathedral Close contains the early 17th-century mansion of East Coates, now occupied by the organist, and a Song School. The church, designed in the Early Pointed style by Sir Gilbert Scott, is 278 feet in length, and is surmounted by a spire 275 feet in height. A chapter-house has been added by the late Mr Hugh Rollo, and when the two western towers are completed the whole cost of the edifice will be some £140,000. Many other churches, of different denominations, have been built or rebuilt in the city and suburbs, the most noticeable, from an architectural point of view, being perhaps the Catholic Apostolic church at the foot of Broughton Street, one of the features of which is a fine set of mural paintings executed by Mrs Traquair. In all there are now 192 places of worship in the city, of which 46 belong to the Church of Scotland, 75 to the United Free Church and 4 to the other Presbyterian churches, and 26 to the Episcopalian, 7 to the Roman Catholic, and 34 to other denominations.

*Railway Improvements.*—Among the most important of the city changes are those that have taken place in the hollow between the Old and New Towns. The increase in the traffic of the North British Railway has rendered necessary successive alterations and enlargements of the Waverley Station, which will become one of the most extensive, as regards platform area and other accommodation, in the country. Additional tunnels of access have been formed from Haymarket on the west and Abbeyhill on the east; and it has been found necessary to appropriate strips of the East and West Princes Street Gardens. The Caledonian Railway, also, has built a handsome and commodious new station, with hotel attached, at the west end of Princes Street; and among the additions to the railway mileage of the city and its vicinity are the Caledonian branch lines to Leith and Cramond Bridge, and the suburban and Corstorphine lines of the North British Railway.

*New Parks and Monuments.*—Edinburgh is well provided with "lungs," in the shape of public parks. In addition to the magnificent open spaces previously existing within the city bounds, in the King's Park, the Meadows, the Calton Hill, the Princes Street Gardens, &c., a large area of new ground has been set apart of late years for the health and recreation of the citizens. Mention may be made of the Blackford Hill, on the shoulder of which the new Royal Observatory has been built and the great Dunecht telescope fitted up. Beyond is another spacious and breezy playground, the Braid Hills, mainly devoted to the game of golf. These are on the south side of the city. On the north of the Water of Leith are the Arboretum and Inverleith Park. The Harrison Park provides recreation ground for the dwellers in the crowded district around Fountainbridge; and another and larger public park for the western district of the city has been purchased by the Town Council at Saughton Hall. The numerous monuments of Edinburgh have been reinforced by a statue of the late Duke of Buccleuch in High Street, of Dr Thomas Chalmers in George Street, of Dr Livingstone, Adam Black, and Sir James Young Simpson on the line of Princes Street, of John Knox in the quadrangle of the Free Church College, and Sir William Chambers in Chambers Street. (J. GE.)

**Edinburghshire,** or **Midlothian,** a county on the southern shore of the Firth of Forth, bounded on the W. by Linlithgow, on the E. by Haddington, and on the S.-W. and S. by Lanark, Peebles, Selkirk, Roxburgh, and Berwick shires. Geographically it embraces the city of Edinburgh (administratively a separate county) and the parliamentary burghs of Leith and Musselburgh.

*Area and Population.*—With regard to area, so many alterations have been, and are in process of being, made upon it by the extensions of Edinburgh city, and by alterations in the boundaries by the Boundary Commissioners under the Local Government Act of 1889, that it would be a matter of considerable difficulty to arrive at a correct statement of the present acreage. The geographical area is given as 362 square miles, or 231,724 acres. The county and parish changes of boundary in 1889 were chiefly in the parishes of Cramond and Fala, and involved small transferences of population and acreage from West Lothian and East Lothian to the county. The population of the registration county, including Edinburgh city, was 388,811 by the census of 1881, 433,552 in 1891, and 488,647 in 1901. Outside of the parliamentary burgh areas the figures were 75,120 in 1881, 81,033 in 1891, and 83,807 in 1901. The principal centres of population within the bounds of Midlothian are Edinburgh (municipal burgh, including Portobello), 316,479 inhabitants in 1901; Leith, 76,667; Musselburgh, 11,704; Dalkeith, 6753; Loanhead, 3011; Bonnyrigg, 2926; and Penicuik, 2803. According to the latest corrected figures, the percentage of births within the registration area was 2·91; of deaths, 1·67; and of marriages, 0·83. Illegitimate births formed 7·43 per cent. of the whole.

The following table gives particulars of births, deaths, and marriages in 1880, 1890, and 1899:—

| Year. | Deaths. | Marriages. | Births. | Per cent of Illegitimate Births. |
|---|---|---|---|---|
| 1880 | 8558 | 3016 | 13,255 | 7·3 |
| 1890 | 8909 | 3266 | 12,571 | 7·4 |
| 1899 | 8901 | 4290 | 13,485 | 6·3 |

The following table gives the birth-rate, death-rate, and marriage-rate per 1000 of population at different periods since 1880:—

| | 1880. | 1881–90. Average. | 1890. | 1899. |
|---|---|---|---|---|
| Birth-rate | 34·52 | 31·50 | 29·22 | 28·27 |
| Death-rate | 22·29 | 19·53 | 20·70 | 18·66 |
| Marriage-rate | 7·86 | 7·75 | 7·59 | 8·99 |

*Constitution and Government.*—The county, generally spoken of in this connexion as Midlothian, forms a single parliamentary constituency, exclusive of Edinburgh city and the Leith burghs. The parliamentary constituency in 1900–1 numbered 14,077; the valuation (including railways and water-works) was £674,842. Under the Local Government Act of 1889, the county is divided into 38 electoral districts, and these have been by the County Council arranged into 4 county districts for the purposes of the Roads and Bridges Act, 1878, and the Public Health Acts. The management of special districts formed for water supply, drainage, and other sanitary purposes is committed to sub-committees appointed by the respective district committees. The grant under the Local Taxation (Customs and Excise) Act is administered by the Technical Education Committee appointed by the Council; and on the same authority, a special committee, called the Secondary Education Committee, looks after the distribution of the grant under the Local Taxation (Scotland) Act.

*Education.*—There are in the county, exclusive of Edinburgh and the other burghs, 30 separate school boards, managing 96 schools, the average attendance in these being 16,394 in 1899–1900. The grant for higher education earned in 1899 amounted to £1588 16s. 4d.

*Agriculture.*—The depression in agriculture has not affected Midlothian so severely as some other counties; compensation for the fall in the price of grain and other agricultural products has been found in the growth of population and the local demand. There have been comparatively few changes in the size of agricultural holdings, either in the shape of cutting up large farms into small ones, or amalgamating small farms in larger. The neighbourhood of Edinburgh has given considerable stimulus to dairy-farming. The area under crops has increased rather than diminished, but the area under corn crops is nearly 6000 acres less than in 1880. Fallow land has practically disappeared.

| Year. | Area under Crops. | Corn Crops. | Green Crops. | Clover, &c. | Perennial Pasture. |
|---|---|---|---|---|---|
| 1880 | 134,344 | 38,628 | 21,365 | 29,390 | 44,703 |
| 1890 | 139,764 | 34,367 | 18,779 | 37,296 | 48,928 |
| 1899 | 132,833 | 33,033 | 19,354 | 32,813 | 47,279 |

Wheat, notwithstanding the fall in prices, may be said to hold its own among the grain crops; the area devoted to wheat, some 5000 acres, is rather larger than in 1880, and represents practically the whole acreage of arable land on which this crop can be profitably grown at present rates. Oats also maintain their ground on the whole; the great reduction has been in barley. The following are the figures for live-stock:—

| Year. | Total Horses. | Total Cattle. | Cows or Heifers in Milk or in Calf. | Sheep. | Pigs. |
|---|---|---|---|---|---|
| 1880 | 3979 | 18,907 | 10,765 | 170,562 | 5309 |
| 1885 | 4143 | 21,472 | 12,308 | 168,873 | 7141 |
| 1890 | 4415 | 22,404 | 12,623 | 179,565 | 6888 |
| 1895 | 4540 | 19,451 | 11,096 | 183,322 | 8133 |
| 1899 | 4478 | 21,450 | 12,537 | 191,403 | 8194 |

*Industries.*—There are few changes to note with regard to the staple industries of the county of Edinburgh. The paper-mills, situated chiefly in the valleys of the Esk and the Water of Leith, have increased their production while improving their processes. Near the outskirts of the city a number of new brewing, distilling, and other works have sprung up; on the other hand, some of the Midlothian granaries have been closed through exhaustion. The quantity of coal raised in 1900 was 1,329,495 tons; and 9160 men were employed at the collieries above and below ground. The production of oil shale was 637,810 tons. The county output of sandstone was 132,761 tons, and of limestone 177,696 tons. For the year 1900–1, the quantity of white fish landed in the Leith district was 207,218 cwts., valued at £133,895; there were 364,616 barrels of herrings, exported mostly to Germany.

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**Edison, Thomas Alva** (1847-——), American inventor, was born 11th February 1847, at Milan, Erie county, Ohio, but his parents moved to Port Huron, Michigan, when he was seven years old. At the age of twelve he became a train news-boy on the railway to Detroit, and managed to gratify his youthful interest in chemistry by performing experiments while travelling. At fifteen he became a telegraph operator, and was employed in many cities in the United States and Canada, but frequently neglected his duties in order to carry on studies and experiments in electrical science. Before he was twenty-one he had constructed an automatic repeater, by means of which a message could be transferred from one wire to another without the aid of an operator; and he had also directed his attention to the problem of duplex telegraphy, of which he later invented a successful system. In 1869 Edison came to New York City, and soon afterwards became connected with the Gold and Stock Company. He invented an improved printing telegraph for stock quotations, for which he received $40,000. He then established a laboratory and factory in Newark, N.J., for further experiments and for the manufacture of his inventions. In 1876 he removed to Menlo Park, and later to West Orange, N.J., where he continued his experiments. Since then his name has been prominently associated with all kinds of novelties in practical electricity. Among his principal inventions are his system of duplex telegraphy, which he later developed into quadruplex and sextuplex transmission; his carbon telephone transmitter; the microtasimeter, for the detection of small variations in temperature; the phonograph, which records and reproduces

all manner of sounds; and his method of preparing carbon filaments for the incandescent electric lamp. In 1878 Edison received the degree of Ph.D. from Union College, and in the same year was made a chevalier of the Legion of Honour by the French Government.

**Edmonton,** a suburb of London, England, in the Enfield parliamentary division of Middlesex, 9 miles north of the City by rail. There is an ancient church containing interesting brasses and tablets, town-hall, and a free library. Cowper and Keats lived here for a time, as did Charles Lamb, who died and was buried here. In 1881 Southgate was separated from Edmonton parish. Population of urban district (3890 acres), (1881), 15,174; (1891), 25,380; (1901), 46,899.

**Edmunds, George Franklin** (1828——), American lawyer and statesman, was born in Richmond, Vermont, on 1st February 1828. He began the practice of law in 1849. He served in each House of the Vermont legislature at different times between 1854 and 1862, and was elected to the United States Senate in 1866, where he remained until 1891, when he resigned in order to have more time for the practice of his profession. He took an active part in the attempt to impeach President Johnson. He was influential in providing for the electoral commission to decide the disputed Presidential election of 1876, and became one of the commissioners. In the Republican conventions of 1880 and 1884 he was a candidate for the Presidential nomination. From 1881 until 1885 he was president *pro tempore* of the Senate. As senator he was conspicuous on account of his legal attainments, industry, and liberal opinions. He was the author of the so-called Edmunds Act of 22nd March 1882 for the suppression of polygamy in Utah.

# EDUCATION.

FORMER articles on the subject of education have appeared successively in the various editions of the *Encyclopædia Britannica*, and have well illustrated the very different aspects under which the subject of education may be viewed. Mr James Mill's treatise in the Supplement of 1824 discussed with fulness and much acuteness various abstract questions—*e.g.*, the genesis of ideas; the qualities of mind which it should be the chief business of education to develop; the instruments of instruction; the circumstances, whether material or moral, which operate upon and control mental growth; and the right function of domestic, social, and political training respectively, as distinguished from formal didactic teaching by means of school lessons. Except for a descriptive reference to Jeremy Bentham's famous experiment of a "Chrestomathic" day-school, there is little in Mr Mill's article which deals practically with the provision or organization of schools, or with any proposals for legislative action. The whole of this valuable paper is speculative and philosophical, and is highly characteristic of its author and of the spirit in which the subject of popular instruction was at first approached by the leading thinkers of his day. Dr J. D. Morell, one of the most distinguished of the first group of inspectors, contributed to the edition of 1858 an account of German and Swiss education, and a description of the tentative efforts which at that date the Government of Great Britain was making in the department of public elementary instruction. He foreshadowed with much ability the probable future of a State system in England on the lines laid down by Sir James Kay Shuttleworth—a system then in an early and experimental stage, and only beginning to attract the serious attention of British statesmen. Mr O. Browning's article in the ninth edition is mainly concerned with the growth of educational ideas and theories. He followed the precedent set by Aristotle, who in book i. of the *Metaphysics* made a critical survey of the history of Greek philosophy from Thales to Plato, and an estimate of the merits of the chief metaphysical writers. As a descriptive history of the books and speculations which all through the Greek, Roman, and Renaissance periods have in different ways helped to shape opinion and policy on the subject of education, Mr Browning's article is invaluable to the student who desires to take a *vue d'ensemble* of the several parts of the educational problem, and to know what are the ideals which have from time to time prevailed on this subject, and how far it has been possible to give practical effect to those ideals. Other branches of the general subject will be found treated in detail in the articles UNIVERSITIES and TECHNICAL EDUCATION. In connexion with each of the countries of Europe and of the British colonies and dependencies there will be found facts relating to the educational provision made by their several Governments, and the way in which the law of public instruction is administered. The scope of the present article is thus definitely restricted. Its main purpose will be to trace the gradual growth of what may be called the English system, the forces which have controlled it, and the results it effected during the last quarter of the 19th century.

***Characteristics of English educational history.***

It should be observed *in limine* that England has a unique history so far as public provision for the education of the people is concerned. That provision is not the product of any theory or plan formulated beforehand by statesmen or philosophers. It has come into existence through a long course of experiments, compromises, traditions, successes, failures, and religious controversies. What has been done in this department of public policy is the resultant of many diverse forces, and of slow evolution and growth, rather than of clear purpose and well-defined national aims. It has been effected in different degrees by philanthropy, by private enterprise, by religious zeal, by ancient universities and endowed foundations, by municipal and local effort, and only to a small extent by legislation. The genius, or rather the characteristic mental habit, of the English people, is averse from philosophical system, and is disposed to regard education not as a science, but as a body of practical expedients to be discovered empirically and amended from time to time as occasion may require. The tendency to distrust theorists and to be afraid of legislation has in England been strongly reinforced, and indeed largely justified, by the fact that most of the legal enactments of the past were negative and restrictive only, and were neither calculated nor intended to encourage educational progress. Henry VIII.'s ordinances respecting grammar schools forbade the use of any other than the authorized primers and Latin books. Elizabeth's Act of Uniformity severely restricted the liberty of teaching; and the Act of Charles II. in 1662 obliged all schoolmasters, whether lay or clerical, to accept the declaration of Conformity, and to obtain a licence from the bishop or the ordinary. The Acts generally known as the Clarendon Code were even more stringent in their requirements, and the Occasional Conformity Act (1711) and the Schism Act (1713) put it out of the power of Dissenters to hold office or to keep any private or public school. Thus the

efforts of later reformers were during many years directed rather to the removal of disabilities and hindrances than to the actual encouragement of education by legal measures. It was not till the year 1779 that the Act was passed rendering it lawful for any person to act as schoolmaster without subscribing the Thirty-nine Articles. The Test and Corporation Acts survived to the year 1829; and subscription to the Articles was enforced as a condition of taking degrees at the Universities until 1871. It has thus happened that the habitual attitude of the English people was for a long period marked by watchful jealousy and dislike of all legislative action. In fact, the evil memories associated with the harsh and intolerant legislation of an older time caused many Englishmen in the beginning of the 19th century to suppose that no influence of the State in the spheres of charity, education, or religion could be otherwise than mischievous. Hence the popular faith in Voluntaryism. Hence, too, the resistance on the part of the Nonconformists during a part of the Victorian reign to the establishment of any system by which the Government proposed to aid and inspect primary schools. Nevertheless time has wrought a remarkable change in public opinion on this subject. Matthew Arnold, who devoted much time and thought to inquiries into the systems of foreign countries, tried in his reports to convince his countrymen that if once an enlightened democracy were animated by a progressive spirit and noble ideals, it would be the part of wisdom to invoke the collective power of the State to give effect to those ideals. Great Britain as a nation has not yet accepted this dictum in all its fulness. But it is not difficult to account for the slowness and hesitation with which English statesmen have approached this subject, and for the lack of symmetry and of scientific completeness in so much of the national system of education as already exists. What there is in that system, both of merit and of defect, will be better understood by a brief reference to three or four of the leading countries of Europe, in which the people, less hampered than in England by the traditions of the past, have felt free to recognize earlier their national obligations in this respect, and to make more systematic provision for the education of the people.

***France.***

In France, Turgot in 1775 drew the outlines of an elaborate system of national education. Talleyrand, even in the midst of the political and social storms of 1793, formulated proposals for the establishment, by authority, of a school for every 1500 inhabitants. The decrees of Napoleon made further provision for academic and higher instruction, for the establishment of a State University, and for the certification of qualified teachers. The whole of the legislation of the Consulate and the First Empire contemplated a system essentially laic, military, and highly organized, under the direct control of the Government. From that time, notwithstanding frequent aberration of opinion and political change, increasing and generous sacrifices have been made by the French people to complete their edifice of primary, secondary, and superior instruction. Ecclesiastical influence became more pronounced under the Restoration, and in 1816 public subventions were made for the maintenance of schools. Under the reign of Louis Philippe, Guizot, with the advice of Remusat and Cousin, made special efforts to secure the co-operation of the Churches in the business of national education. In a circular addressed to 300 elementary teachers in 1833, they are exhorted to bear in mind that "education has never really flourished when the religious sentiment has not been combined, in those who propagated it, with the taste for enlightenment and instruction." Accordingly, the law of 1833 expressly enacted that the wishes of the parent should always be consulted and followed in what concerned religious teaching. This was effected partly by multiplying schools of different confessions and types, forbidding proselytism, and exempting children in mixed schools from teaching which their parents disapproved. The Government said in effect to their Churches: "The State cannot make itself denominational, but we invite the denominations to make themselves more national." The response to this appeal was not very cordial; and when in 1860 Matthew Arnold made his report on *Popular Education in France*, he foresaw that the compromise was not likely to last. The efforts of Catholics were so far successful that in 1878 official statistics showed that more than a fourth of the primary public schools for boys and nearly two-thirds of those for girls were under "religious" masters and mistresses. But these efforts, in turn, to obtain increasing control over the State schools generated corresponding intolerance on the part of the extreme secularists, such as M. Paul Bert; and in 1877 a law was passed excluding the bishops from the Supreme Council of Education. Further measures in 1880 forbade the Jesuits to take any part in teaching, either in public or in private schools; and in 1886 it was enacted that none but lay teachers should be recognized in the public schools. The various stages by which the popular education of France has been gradually and completely secularized are clearly and fully described by Mr Lecky in chapter vi. of his *Democracy and Liberty*. Notwithstanding the liberal subsidies, both national and departmental, by which the common school system is now supported, it cannot be said that the system is coextensive with the needs of the nation, or that it satisfies the wishes of the people. In a parliamentary paper prepared by the writer of this article it was shown (*Memorandum on the Working of the Free School System in America, France, and Belgium*, 1891) that the complete secularization of the public school had aroused the hostility of the Roman Church, and had caused a large number of schools and scholars to be detached from the public school system and taught independently in voluntary or confessional schools. The statistics of that year showed that of the 5,545,000 scholars reported as enrolled in primary schools, 1,166,477, or more than one-fifth, were in private or denominational schools; of these, 370,772 were boys and 795,705 were girls. In Paris the disproportion was still greater, for while 111,112 scholars of the age from 6 to 13 were in the public schools, 71,850, or nearly two-fifths of the whole, were in schools outside the State system.

The returns for 1899 show how this tendency has continued, and that the number of the *écoles confessionelles* as compared with those aided and regulated by the State continues to increase. There were in that year in public primary schools 95,233 lay teachers and 9929 *congréganistes*, and in private schools 6994 lay teachers and 38,757 *congréganistes*. The total number of scholars in private or confessional schools had risen to 1,324,684. Besides these numbers in primary schools proper, the returns show that in *écoles primaires supérieures* or in *cours complémentaires* there were enrolled 56,051 scholars, and in the *écoles maternelles* or infant schools 532,077 younger children.

The most notable of recent changes in France concerns the higher academic education. At the time of the Revolution there were twenty-one universities governed by local academic bodies independent of each other, and for the most part feeble and inefficient. Napoleon created in their stead one Imperial institution, which was intended, under the name of the University of France, to co-ordinate and control the whole educational organization in the country, under the direction of the Minister of Public Instruction for the time being, who was to be *ex officio* Grand Master of the University of France and Rector of the Academy of Paris. The local academies had no power to confer University distinctions; but degrees in Letters and in Science were instituted by the State, and demanded by it as a guarantee for admission to certain professions and public offices. The University of France, thus constituted, continued all through the Restoration, the Government of July, the Second Empire, and part of the third Republic to dominate the education of the country, notwithstanding the efforts of Guizot and others to substitute for the separate faculties and schools a number of independent universities, and to make them centres of intellectual life. The general desire on the part of scholars and men of science for decentralization, and for restoring independence and some power of initiation to the local academies, found expression in the Act of 1896 and in the Decree of July 1897, which practically abolished the State University of France, and gave to sixteen institutions, at Paris, Bordeaux, Lille, Lyons, Montpellier, Nancy, Toulouse, Aix, Marseilles, Caen, Dijon, Grenoble, Poitiers, Rennes, Besançon, and Clermont, each comprising several faculties, larger liberty and autonomy—*e.g.*, the power to grant diplomas and certificates apart from the State degrees. The new law also handed over to these universities such fees for enrolment, and for the use of laboratories and other facilities for practical work, as were paid by the students of the faculties. The history and probable educational effect of this great reform are admirably summarized by M. Louis Liard in his article *Les Universités Françaises* in the fourth volume of Special Reports on Educational Subjects issued (1900) by the English Board of Education.

***Belgium.***

It is interesting to compare with these details the history of the neighbouring country of Belgium, which during the same period has gone through similar educational experiences, but has arrived at different practical conclusions. Though small, it is a highly prosperous country, full of industrial enterprise and activity, and it presents in a compact form illustrations of some of the more important problems concerning

education, especially those which affect the relation of the State to religion and the Church. Its history dates from 1831, when, on its separation from the kingdom of the Netherlands, it received its constitution under King Leopold. At that date its population was 2,800,773. In 1897 the numbers had reached 6,586,593. The rate of annual increase in the population is 14 per thousand, as compared with Germany, 11; Holland, 13; Austria, 9; Great Britain, 8; Switzerland, 7; Hungary and Sweden, 10; Italy and Spain, 4; and France, ·09. The density of its population is remarkable, there being 224 inhabitants *par kilomètre carré*, as compared with Great Britain, 126; Germany, 96; France, 71; Italy, 109; Spain, 36; Sweden, 11; and Norway, 6. (See article BELGIUM.)

One of the articles of the Constitution of 1831 asserts definitely the principle of the liberty of instruction. Private or individual enterprise and initiative are therefore not forbidden; but owing to the completeness of the State provision for primary, secondary, academic, and technical instruction, there is little room for such enterprise, and, except on the part of clerical authorities desirous to secure provision for religious instruction, hardly any private schools can be said to exist. But this exception is important. Its history has shown in Belgium since 1831 successive changes in popular opinion on the relations between Church and State which have from time to time profoundly modified the educational system. At first the law, as it was consolidated in 1842, required every commune to maintain a school or schools for primary instruction, that is to say, for children of ages from 6 to 14. The cost of building was to be defrayed by the commune, and the annual maintenance was to be provided partly by a subvention from the State, in addition to a nearly equal sum from the commune, partly and to a much smaller extent —about 3 per cent. of the total revenue—from the fees paid by parents. Practically primary education was gratuitous in all the large towns and in many rural districts; and provision was made that in all cases the children of indigent parents could claim, either from the local charity *bureau* or from the commune, the means of exemption from the payment of fees. "The law of 1842 made religious instruction obligatory, and placed it under the direction of the minister of the faith professed by the majority of the pupils in the school, children not belonging to the denomination of that majority being dispensed from attendance at the religious lessons. Supervision of this religious teaching, including inspection of its methods and results and the choice of text-books, was entrusted to the ecclesiastical authorities, who were represented (in a consultative capacity) in the Central Office, and were required to make an annual report to the Minister" (see "Recent Legislation in Belgium," vol. i. of *Special Reports on Educational Subjects*, 1897). This compromise lasted thirty-seven years; but meanwhile there was a steady growth of one section of public opinion hostile to any "association of the State with the action of a favoured Church," on the ground that it violated the spirit of the Belgian Constitution. The law of 1879 accordingly prescribed that religious education should be left wholly to the care of the families and to the clergy of different faiths. The system of religious inspection was abolished, religious instruction ceased to be included in the curriculum of the communal schools, and in its place instructors were enjoined "to give moral precepts and to inculcate sentiments of duty, of love for country, respect for national institutions, and attachment to constitutional liberty." This provision was not found to satisfy the educational requirements of a nation in which the Roman Catholic Church exercises an exceptionally powerful influence. The purely secular, or rather non-religious, character of the State schools was from the first distasteful to the authorities of that Church; parents were exhorted to withdraw their children from the communal schools, and private and denominational schools were established by the efforts of the congregations and the clergy. These schools received no subventions from the State, yet they attracted year by year a larger number of scholars. In 1883 there were in the public or communal schools 320,709, and in the private or Catholic schools 479,280 scholars. It was computed that in that year there were for every 100 inhabitants in the kingdom 14 children in elementary schools, of whom 8·47, or 59·9 per cent., were taught in *écoles confessionelles*, and only 5·67, or 40 per cent., in the schools provided by the State. A strong Catholic majority at the general election of 1884 led to the enactment of a new law, which, though not relieving the communes from the responsibility of providing schools, gave liberty to place religious and moral instruction at the head of the curriculum, and also to accept as *écoles adoptées*, and to assist by public funds and recognition, the confessional schools which had since 1879 been maintained by the private efforts of the Church. Provision was further made entitling any twenty parents of children of school age to demand either a school of the normal communal type, or one which gave separate religious instruction in the tenets of the Church. Subsequent legislation in 1895 took a further step in the same direction, gave additional subsidies to private or confessional schools, and made religious instruction obligatory in the first or last half-hour of each school attendance, children whose parents so desired being excused. It further required that the inspection of religious instruction shall be exercised by the ecclesiastical authorities. The effect of this change has been to cause a large diminution in the number of communal schools and a considerable increase in the influence of the clergy. There is no immediate prospect of any reversal of the policy which has thus made the Belgian system of public education essentially denominational, although the proportion of Catholics has somewhat declined. The general election of 1900 resulted in the return of 85 Catholics, 33 Liberals, and 34 Socialists to the Representative Chamber, and of 47 Catholics and 29 Liberals to the Senate or Upper House.

The returns for 1899 show that a total of 940,370 children, or nearly one-sixth of the population, are in attendance in primary schools. Of these, 475,487 (292,382 boys and 183,105 girls) are in communal schools, 168,397 (57,310 boys and 111,087 girls) in adopted schools, and 120,416 (46,513 boys and 73,903 girls) in private or confessional schools, besides 176,070 infants in *écoles gardiennes*. It will be observed that the proportion of girls under direct clerical influence is greater than that of boys. In the staff of teachers the effect of the new law has been very marked. There were in 1894 in the communal schools 9275 lay schoolmasters and 200 members of religious orders, and in the denominational schools now "adopted" 1252 lay schoolmasters and 411 *religieuses*. Out of the 7418 mistresses, 3419 (of whom 3225 are employed in adopted schools) are *religieuses*. There are in the whole country 19 training colleges for men and 34 for women, and the aggregate number of normal students is 3585, who furnish an annual supply of certificated teachers (*diplomés*) of 915. The total annual cost of primary education is 33,318,328 frs., of which the State contributes 13,868,045 frs.; the communes, 15,402,204 frs.; the fees of parents, 1,314,410; charitable endowments, 226,801; and the *bureaux de bienfaisance*, 334,372.

Some light is thrown on the degree of efficiency attained in primary education by the official returns of the examination of young men drawn annually for military service. These show that the number unable to read and write was in 1870, 29·23 per cent.; in 1880, 21·66 per cent.; in 1890, 15·92 per cent.; and in 1898, 12·83 per cent. In 2116 continuation schools, held for the most part in the evening and for adults, there were 91,269 scholars. The provision for secondary instruction may be regarded as ample. In the special normal schools for higher or intermediate teachers there were in 1898, 56 men and 92 women students. The High Schools or *Athénées Royales* were attended in 1897 by 5657 scholars, the State intermediate schools (*écoles moyennes*) by 13,923 boys and 5497 girls, and the communal secondary schools by 1518 boys and 1440 girls. Academic education (*enseignement supérieur*) in connexion with the four Universities of Brussels, Ghent, Liège, and Louvain is provided for a total number of 4951 students, or 75 for every 100,000 of the entire population. Of these, 536 are entered in the Faculty of Arts and Letters, 1028 in that of Science, 921 in Law, 1172 in Medicine, and 54 in Theology. For special instruction in the Fine Arts there are in the kingdom 87 academies and schools of design with 15,958 pupils, and 53 *conservatoires* or *écoles de musique* with 13,063 pupils. Thus the country may be said to possess, in proportion to its population, a very complete equipment of primary, secondary, technical, and academic or university education.

**Holland.**

A Dutch law of 1857 established throughout the Netherlands an excellent system of national education. Secular teaching alone was to be endowed with public funds. No schoolmaster in the national schools was allowed to give religious instruction, or "to say, do, or tolerate anything disrespectful to the religion of any class of pupils." Religious teaching was left wholly to the care of religious bodies, who were permitted to provide it in the schoolrooms, outside the regular school hours. This system was confirmed by the law of 1878. But it proved unsatisfying to the large and earnest minority of religious persons who had set up at their own expense schools for the denominational education of their children. In 1888 no fewer than 480 of these "Bible schools" were found to be maintained by voluntary gifts, with 11,000 teachers and 79,000 pupils (cf. Lecky, *Democracy and Liberty*, ii. p. 72). The law has since 1889 been so altered as to permit these schools, on fulfilling certain conditions of efficiency, to receive regular subsidies and inspection from the State. The result is in Holland a mixed system which, while leaving the public secular schools undisturbed, recognizes voluntary and religious schools, and offers to aid them with grants of public money.

The following statistics show the latest returns respecting primary education in Holland. Further details will be found in the important report of Mr. Balfour in the fourth volume of Special Reports issued by the English Board of Education.

In the school year 1898–99, 730,688 pupils were receiving primary education in Holland. This figure includes both girls and boys. The total population on 31st December 1898 was, according to the communal population returns, 5,074,632.

The 730,688 pupils were distributed among the various classes of schools as follows:—

| | | |
|---|---|---|
| *In Public Primary Schools—* | | |
| Boys . . . . . | 280,152 | |
| Girls . . . . . | 223,579 | |
| | | 503,731 |
| *In Subsidized Private Primary Schools—* | | |
| Boys . . . . . | 130 | |
| Girls . . . . . | 770 | |
| | | 900 |
| *In Private Primary Schools not receiving Government subsidies—* | | |
| Boys . . . . . | 99,340 | |
| Girls . . . . . | 126,717 | |
| | | 226,057 |
| Total, . . . | | 730,688 |

It is noticeable that whereas the figures for all primary schools amount for the year 1899 to 730,688, and for the year 1898 to 719,415, showing an increase for the attendance of all schools of 11,273, the increase has been mainly confined to the public schools and the unassisted private schools.

Possibly the explanation of these facts may be found in the conditions attaching to Government grants to private or denominational schools.

Such grants were first instituted by the law of 1889, which established the compromise by which the long-standing religious difficulty seems finally to have been settled. Yet after ten years of operation, the law of 1889 has enabled the Government to make grants to eighteen only out of 1448 private schools. And while the number of schools receiving Government grants has decreased, the unassisted private schools show a great increase, larger even than that of the public schools.

The following are some of the conditions that have to be fulfilled by a private school claiming a Government grant under the Act of 1889:—

1. It must be managed by an association or institution possessing the rights called "civil personality" (similar to the English "rights of a corporation").
2. Its headmaster must possess the rank of *instituteur-en-chef*, or "master-in-charge."
3. The instruction must comprise all the obligatory subjects of primary education.
4. Instruction must be given in obligatory subjects during at least eighteen hours per week.
5. The school must possess a body of rules and regulations which are binding upon it, and must annually receive the signature of the Inspector of the arrondissement, whose duty is to see that the rules are not contrary to school law.

It is, therefore, to the conditions which preclude private schools from applying for Government grants that we should look for an explanation of the figures already given. These negative conditions are as follows:—

No school can claim a Government grant
(1) in which there are not more than 25 pupils more than six years of age;
(2) in which the school fees exacted reach an average of 80 florins per pupil;
(3) which has been established or is managed for pecuniary profit.

It should further be noted that whereas Government grants are made to public schools, in aid of new buildings, repairs, &c., to the amount of 25 per cent., no such grants are made to any private school.

If the explanation of the small number of private schools receiving Government grants is not to be found in the conditions attached to them by the law of 1889,—and it will be generally agreed that those conditions are in no sense onerous,—then the only explanation is that the members of religious and charitable associations who direct the private schools of the country prefer partial freedom from Government control, and will not sacrifice this in order to gain Government assistance.

**Germany.**

In Matthew Arnold's report to the Schools Inquiry Commission in 1866, he said, "The school system of Germany, in its completeness and carefulness, is such as to excite the foreigner's admiration." There is, in fact, no country in Europe in which more skill, statesmanship, and public spirit have been brought to bear on national education. So early as 1649 the General Synod of Würtemberg (G. Perry, *German Elementary Schools*, p. 24) required that parents should send their children to school. Similar regulations were enforced in Saxony in 1764, in Prussia in 1736, and in Bavaria in 1802. The Prussian Constitution of 1850 declares "that adequate provision for the education of the young is made by means of public schools; and that parents and their representatives may not leave their children and foster-children without the instruction prescribed for the public elementary schools." The laws in the several German states differ slightly in some details, but generally enforce attendance from the age of six to fourteen, and an additional attendance at a *Fortbildungschule* is frequently required in the evenings or on Sundays, *e.g.*, in Saxony, Saxe-Weimar, Saxe-Coburg-Gotha, and Hesse, for either two or three years after attaining that age. In the kingdom of Saxony alone there were 1900 such institutions, with 77,808 boys. Long habit and tradition and the public opinion of the industrial classes have rendered the attendance laws easy of enforcement, and it is computed that the absences from school vary from 3·6 to 7 per cent., and seldom exceed 6. Moderate school fees are exacted in Prussia, Saxony, and Bavaria; but some municipalities—notably those of Berlin and Dusseldorf—have made the instruction in the communal schools gratuitous. (Arnold, *Report to Education Department*, 1886, p. 4.) On the average of the whole kingdom of Prussia, school fees meet 20 per cent. of the cost of teaching in the popular schools, endowments 12 per cent., the municipalities 55 per cent., and the State 12 per cent. In Bavaria the fee is fixed at a minimum of eightpence and a maximum of one shilling and fourpence per quarter. In Saxony the minimum fee is three shillings per annum, but a higher charge is made according to the means and social status of the parents. But in all the states provision is made for the gratuitous instruction of the very poor. The general rule in Germany is "a school fee where the scholar can afford to pay it, remitted where he cannot." As to the quality of the school instruction, Arnold, in the same report, describes a fuller programme for the elementary schools than in England: religion, German, English, history, geography, arithmetic and algebra, geometry, writing, drawing, singing, and gymnastics being all included. In the opinion of that acute observer, the methods of teaching in Germany were more gradual, more natural, and more rational than the English; and the religious teaching, chiefly in the form of Bible history and extracts and evangelical hymns, appeared to him to be specially interesting and intelligent. In 1896 Prussia had a population of 31,840,795 persons. It was then computed that 223 out of every thousand of the population were between the ages of five and fifteen, and that the number of scholars actually in attendance in the Volkschulen was 5,236,826.

The famous Prussian Minister of Instruction, Dr Falk, sought energetically in his anti-clerical campaign (the *Kultur-Kampf*) to make national education more completely secular in its character. The drastic "Falk Laws" of 1873 were chiefly directed against the Catholic Church and the influence of the priests in education. They gave to the State the right to inspect all educational institutions, both private and public, and resulted in the closing of many seminaries and establishments of religious orders. But after the death of Pius IX. in 1878, diplomatic relations between the Government and the Vatican were restored, and Prince Bismarck succeeded, after direct negotiations with Rome, in mitigating the severity of the Anti-Catholic Laws. Subsequent efforts of the Catholic party in the Reichstag to increase clerical influence over education have, however, failed. But from 1887 a more conciliatory policy towards the religious bodies has been adopted in Prussia, and provision has been made in the State schools for the separate religious instruction of Roman Catholics, Protestants, and Jews in accordance with the wishes of the parents. Dr Falk resigned office in 1879, and died in 1900.

It is evident that Germany owes as much as any other country to a strong sense of the national importance of education, and to the consistent and resolute efforts of her statesmen during many years to develop and to perfect it. Hence, as Mr Sadler has said (*Problems in Prussia, Special Reports*, vol. iii. p. 89), "Through the labour of generations the public higher schools for boys stand, from several points of view and in many important respects, as models to the world. They are unrivalled in their high level of many-sided attainments. Thought has been lavished on the planning and concentration of their studies. The quality, the range, and the method of their teaching are under the watchful care of State inspectors, themselves experienced in the work of secondary education. All the schools are thus scrupulously kept up to an exacting standard of excellence. Prussia, in particular, owes much to Stein, to Humboldt, to Wolf, and to Schleiermacher, and in the department of primary education to the ideas of Pestalozzi and to the inspiration of Fichte." So early as 1794 the *Allgemeines Landrecht* formally declared schools and universities to be State institutions. In 1808 there was established a special section of the Home Office for worship and public instruction, and from the year 1817 this section has been separated from the Home Office and has constituted an independent Education Department.

**Switzerland.**

Switzerland, with its small population of 2,993,334, has long been distinguished for its educational efforts and resources. It was the home of De Fellenberg and of Pestalozzi; and it is here that some of the most fruitful experiments in public instruction have been tried. An article in the Federal Constitution requires that throughout the country "primary instruction shall be obligatory, and in public schools gratuitous."

All the cantons comply with this general law of the Constitution; but each of them has its own school law, and the right to provide and to regulate their local schools is jealously guarded by the several cantons. Every proposal to extend the power of the Bund over primary education has been met with strenuous opposition.

The total expenditure from public funds on all the grades of education amounts to £1,617,201; that is to say, £948,788 on primary education, £223,118 on higher primary and continuation schools, £30,530 on training colleges, £167,089 on lycées and other secondary and intermediate schools, £97,250 on universities, and £150,426 on technical instruction. The contribution of the communes amounts to 51·7 per cent. of the total expenditure, that of the cantons to 42·2 per cent., and that of the Bund to 6·1 per cent., this last being mainly a recent grant for technical instruction only, and appropriated chiefly to the *Polytechnicum*, or Technical University at Zurich, which is a federal and not a cantonal institution. The entire revenue for general education may thus be said to be derived from local resources. There are differences of some importance in the proportion of revenue assigned in different cantons to primary and secondary instruction respectively; *e.g.*, in Bern and Lucerne secondary and higher schools are gratuitous and the public subvention is large; in Zurich and other cantons moderate fees are charged.

By a decree of April 1891 the Swiss Confederation proposed to grant subsidies for the encouragement of technical and commercial instruction, and also to furnish bursaries for scholars specially qualified by their capacity and industry, to enable them to attend the higher courses of a local commercial school. These must be boys of fifteen, who are to undergo three years' instruction, and at the end to receive a diploma. There are fourteen such schools in Switzerland. The chief subjects of instruction are: mathematics, arithmetic (including book-keeping, office work, and commercial law), political economy, some branch of technology, natural science, chemistry and industrial geography, one foreign language at least, type-writing, shorthand, gymnastics and military exercises, visiting factories under supervision, and writing descriptive accounts of the same. Fees are paid amounting to from 30 to 100 frs. for natives and 60 to 200 frs. for foreigners. In 1895, in the school subsidized by the Federal Government, the fees paid by students amounted to 47,891 frs., and the Federal subsidy to 63,250 frs. The total number of pupils was 542.

The provision for the training of teachers is ample. There are 24 State and 13 private normal colleges, with 2600 students. Most of these institutions are training colleges pure and simple, but ten of them form parts or appendages of higher primary schools.

There are no pupil teachers, but candidates for admission to a training college must have been in a higher primary school for two years. The curriculum extends over two or three years. Prominent importance is given to music, to pedagogy, theoretical and practical, and every student is required to study one language other than the mother-tongue, and some branch of experimental science. Arrangements are also made for an annual Alpine excursion of three or four days for botanical or geological research, or for visits to famous institutions. The annual cost is about £22 for each student, the State and the communes contributing three-fourths; the rest is partly derived from voluntary contributions and partly from the fees paid by parents; but by means of bursaries, graduated to suit the private circumstances of the students, these fees are so reduced that they seldom amount to £6 per annum. Certificates of competency are granted by the Council of Education for each canton, and not by the Federal Government. There is only one (in Canton St Gall) training college for higher primary or for secondary schools, but candidates who have had the full qualification of an elementary teacher, and have in addition served one year as assistant teacher and studied for two years at a university, may come up for the higher teacher's certificate (*Sekundärschullehrer*). The teacher is not, as in England, required very early to pursue his professional and his general education *pari passu;* he must up to 17 at least continue in a course of liberal training, and not attempt to take up pedagogic study or practice until after that age. The religious difficulty appears to have been for the present satisfactorily solved. Matthew Arnold (*Special Report to the Education Department*, 1886) cites the article of the Swiss Constitution: "The public schools shall be capable of being attended by adherents of all confessions without injury to their freedom of faith and conscience." He adds that no difficulty has arisen in giving effect to this principle. The Swiss communes have in every popular school religious instruction in the faith of the majority—Catholic instruction in cantons like Lucerne, and Protestant in Protestant cantons like Zürich. Where there are enough children of the confession of the minority, a separate school is established for them; where there are not enough, the children often attend the religious instruction of the majority, if the parents consent. In the great town school of Lucerne, 400 Protestant children were found attending in class with 2900 Catholics, the Catholic children receiving their religious instruction in the school, and the Protestant children out of school and out of hours.

**Scotland.** The foregoing details as to four of the most progressive countries of Europe will serve as a basis of comparison, and will render more intelligible the fact that in Great Britain the educational problem has from the first presented special difficulties, and has been less systematically and more tardily solved. In the northern part of the island the solution of that problem has proved less complex than in England and Wales. Some of the conditions in Scotland have been exceptionally favourable. So early as 1560 the Church Assembly, largely owing to the influence of John Knox, put forth its *Book of Discipline*, containing provisions, soon afterwards ratified by the Estates of the realm, requiring that every parish kirk in a town should have its Latin school, and that in the rural districts there should be elementary schools, and in large towns colleges for teaching logic, rhetoric, and the Greek and Roman languages. This legislation, confirmed by Acts of the Scottish Parliament in 1633 and 1696, and further enforced in 1803 by requiring each parish to provide a house and stipend for a schoolmaster, has resulted in the gradual production not only of a higher level of education in the country, but also of a universal recognition of the value of instruction on the part of the community, including peasants and persons of all ranks. The parochial schools, the burgh schools or academies, have for many generations been in close relation to the Universities. The religious difficulty so acutely felt in the southern portion of the island has been greatly reduced in Scotland owing to the practical unanimity of the people in the adoption of the Presbyterian form of faith. Hence the educational progress of Scotland has in many respects been more steady than in England, and has not been confined to the primary schools. The report of the Scottish Education Department for 1899 shows that with an estimated population of 4,290,619, the country possesses 3535 separate departments in primary schools, with an attendance of 681,334 scholars, and 1016 evening continuation schools, with 57,729 scholars. The return of teachers shows that 10,676 are fully certificated, 2371 are assistants, and 4111 are pupil teachers. The experience of the Scottish Education Department, like that of the English, has led by degrees to the gradual abandonment of the practice of individual examination of children in standards as the basis for the computation of the parliamentary grant, and to the substitution of a normal or block grant for one determined by the number of passes in separate subjects. Otherwise the features of the Scottish system which distinguish it from that of England are: (1) the provision that "the normal grant may, on the recommendation of the inspector, be reduced by not less then one-tenth nor more than one-half for faults of instruction and discipline," thus retaining the principle that public aid shall be proportioned to the efficiency of the school (Art. 32); (2) the award of a merit certificate after the age of twelve to all who pass a satisfactory examination in the ordinary subjects of an elementary school course, thus recognizing the importance of an individual examination of scholars at the end of their course; (3) the special encouragement given to advanced departments in elementary schools; (4) the larger proportion (more than two to one) of trained to untrained teachers, and of head teachers who have graduated at the Universities; (5) the increasing influence of the Scottish Education Department over secondary and technical schools, exercised by means of inspection, by direct subsidies under the Education and

Local Taxation Account Act (Scotland) of 1892, and by the award of leaving certificates and bursaries after the examination of pupils.

In Ireland the problem of national education has assumed a shape differing in many ways from that prevailing in other parts of the United Kingdom. Its present system owes less to local initiative—either private or municipal—and more to the direct action of the Government. The population is more sharply divided in religious profession, at least 75 per cent. being Roman Catholics, about 11 per cent. members of the Anglican Church, and 11 per cent. Presbyterians, chiefly in the province of Ulster; the minor dissenting communities, so numerous in England, being almost unknown. These conditions should be borne in mind in any attempt to estimate the historical development of the Irish system or to compare it with that of Great Britain. In 1831, two years after the enactment of Catholic emancipation, Lord Grey's Government established a Board of Education composed partly of Roman Catholic and partly of Protestant members. To this body was entrusted the control of all funds which might be annually voted by Parliament for the purpose of erecting schools, visiting and inspecting them, making gratuities to teachers, establishing a model school for the training of teachers, and supplying school-books and necessaries. Before this date grants had been made in aid of the Charter Schools, the Foundling Hospital, and the Kildare Place Society—a body which had been founded in 1811, and had sought to provide a system of schools wherein Catholics and Protestants might be instructed together, and the Bible might be read without note or comment. This society did not wholly succeed in obtaining the co-operation of the heads of either the Catholic or the Established Church. The Commissioners, however, in the earlier stages of their administration endeavoured to obtain such co-operation by means of a system of combined moral and literary instruction, and separate religious instruction for children of different faiths. At first the Board also prepared for general use books of Scripture extracts from the historical portions of the Bible and from the Psalms, the Gospel of St Luke and the Acts of the Apostles; and for a time the use of such books continued in the schools with the partial approval of the authorities of both Churches. But this compromise ultimately failed. The story of its failure, and of the gradual steps by which the Commissioners have abandoned the attempt to secure a mixed and comprehensive plan and have adopted a practically denominational system, is fully told by Mr Sadler (*Special Reports*, 1896–97, p. 211), and is further described in careful detail in a memorandum in the same volume by Mr C. T. Redington, late Resident Commissioner. It must suffice here to refer to the most recent changes, especially to those which have resulted from the Report of the Viceregal Commission of Inquiry into Manual and Practical Instruction, 1897. With regard to the administration of the public grant, there is a fundamental difference between the conditions under which the Irish Commission acts and those which have controlled the English Education Department. This Department does not appoint teachers nor dismiss them, promote them or pay them. It neither builds nor furnishes the schools, nor regulates the duties of the staff, the choice of books, or the course of instruction. It simply makes a grant in aid to local managers, who have full power to supply these things at their discretion. Hence there was no other way open to the central Department to secure the efficiency of a school than by withholding a grant, or graduating it in accordance with the result of examination. But in Ireland the Central Board generally erects the school buildings of the "vested schools," it has the power to fix the stipends of teachers, to augment those stipends for good service, and to make all needful provision for the equipment of the school and for determining the course of instruction. Thus the Board has ample means of securing a good educational equivalent for its outlay. Nevertheless, until recently a considerable portion of the grant paid to teachers was made to depend on the answers given by the scholars when examined individually in each separate subject of a very extensive programme. The Commissioners have lately recommended a considerable modification in the system of distributing the grant. New rules were sanctioned in 1900 providing that teachers should in future be paid (*a*) a fixed salary, called a *grade* salary, there being three grades of teachers; (*b*) an additional salary called *continued good service* salary, which may be increased triennially; and (*c*) a capitation grant on the average attendance of the scholars. The teacher's position in the school, his length of service, and the goodness of his teaching, as attested by the proficiency of the scholars and the reports of the inspectors, are all taken into account in determining the salary of the teachers and their promotion from one grade to a higher. In this way the administration of the funds is calculated to secure efficiency by other means than that of payment by the results of individual examination, a plan now definitely abandoned. Other provisions in the newest regulations of the Board, for increasing the responsibility of local managers, for the preparation of reports of progress, and for giving to parents a more direct interest in the educational welfare of their children, have been very carefully framed in the light of recent experience, and are full of promise for the future.

**Ireland.**

A new department has been created for the promotion of technical instruction, and an active society, for Irish Agricultural Organization, is already trying some valuable and most hopeful experiments in the establishment in the rural districts of creameries, fruit-growing, poultry-yards, and the economy and distribution of farm produce.

The estimated population of Ireland being 4,531,051, the returns show that the number of pupils on the rolls of the national schools was 796,163, or more than one-sixth of the population. The number in average daily attendance, however, was 513,852, or only 64·5 per cent. as compared with the number on the rolls. Of the scholars in (*a*) schools under Roman Catholic teachers exclusively, 192,278, or 94·7 per cent., are Catholics, and 11,103 are Protestants; in (*b*) schools under Protestant teachers exclusively, 7512, or 9·8 per cent., are Catholics, and 69,240, or 90·2 per cent., are Protestants; and in (*c*) schools under Catholic and Protestant teachers conjointly, 3818, or 58·8 per cent., are Catholics, and 2672, or 41·2 per cent., are Protestants. The proportion of schools which are specially denominational schools, and are solely attended by Roman Catholic or by Protestant scholars, has steadily though slowly increased, and the last returns show that it reaches 62·5 per cent. The total revenue of the schools is £1,215,816, of which £1,149,692 is derived from the State, including £83,818 from the Customs and Excise grant. From all local sources together, including subscriptions and endowments and the fees paid by parents, the amount available is only £66,124. It is computed that the sum needed per head for elementary education is £2, 7s. 11½d., of which £2, 5s. 3d. is contributed by the State and 2s. 7½d. from all other sources.

The Board of Education maintains one Training College (undenominational), in Marlborough Street, Dublin, under its own management, and subsidizes four other Training Colleges, of which two for men and one for women are under the care of the Catholic hierarchy, and one for men and women is managed by the Protestant Episcopal

Church of Ireland. These institutions provide training for 380 students in the two years' course, and for 217 in the course for one year. The total number of students who passed the final examination qualifying them for recognition as teachers was in 1899, 159 men and 159 women.

The Board does not provide or support secondary schools, but encouragement is furnished by the examinations and certificates, with result fees, under the Irish Intermediate Education Act of 1878. All schools, whether denominational or not, including those of the Christian Brothers, are admitted to participate in the distribution; and in 1890 the sum allocated under the Local Taxation Act made it possible to augment the result fees, and was placed at the disposal of the Intermediate Education Board for that purpose.

***England and Wales.***

In England the problem of national education has been rendered more difficult, partly by the complete absence until 1846 of any national recognition of the necessity of public education, partly from the great variety of Churches and of theological beliefs in the nation, and partly from the practical isolation of the Universities, the intermediate schools, and the public elementary schools from one another. Of these difficulties, one which has given most concern and trouble to English statesmen has doubtless been that of determining the religious basis of national education. As one studies the history of thought and controversy in other countries in regard to religious teaching, it is seen that there are possible three sharply-defined forms of opinion on this subject:—(1) There are those who contend that the State being a secular institution, having no religious creed of its own, and yet composed of persons of very different religious belief, ought to confine itself absolutely to secular instruction, and to leave the teaching of theology to the several Churches. This is the principle on which the school systems of France and of the States of the American Union are founded. (2) There are others who contend that education is wholly incomplete without religion, that the teaching of religion means the enforcement of a creed, that the proper exponents of a creed are the authorized ministers of religion, and hence that a system of national education should be essentially denominational, and that if the State helps or controls primary education at all, it should do so through the agency of the Churches and their ministers. Throughout all Europe the Roman Catholic Church has always insisted on this view, and has been unwilling to entertain any proposals for a compromise. In some sections of the English Church the same belief exists, although to a much smaller extent. (3) There is another and a large class of the friends of education who dread the exclusion of the Bible and religious teaching from the common schools, but who do not desire to make such schools the propaganda for any particular sect. They regard the reading of the Bible, with simple undogmatic explanation, as appropriate to the intellectual needs of childhood, and well suited for general adoption by Christian parents, so long as full liberty is given to the minority to withdraw their children from any religious instruction which they may disapprove. This is the principle which was adopted by the supporters of Joseph Lancaster, and by the British and Foreign School Society in 1811, and recognized in the Education Act of Mr Forster in 1870. Clause 14 of that Act, generally known as the Cowper-Temple Clause, enacts that "in any school provided by a School Board, no religious catechism, or religious formulary which is distinctive of any particular denomination, shall be taught." The School Boards are not bound to include religion in their course of instruction. But in 83 per cent. of the School Boards of England, including that of London, it is the custom to give careful scriptural teaching, to make the children familiar with Bible history, with the life and teaching of the Founder of Christianity, with the poetry and literature of the Old Testament, and with such devotional or ethical parts of the Bible as are suited to the comprehension of children, it being understood that controversial teaching on points on which the several Churches differ shall be wholly excluded. This comprehensive and scriptural but unsectarian ideal has proved very acceptable to English people, and especially to parents. At this moment it prevails over a considerable and increasing majority of the schools aided and inspected by the State.

There is, however, nothing inconsistent between the views of those who hold this third opinion and the recognition of the denominational principle within certain limits. Accordingly, the Act of 1870 leaves full liberty to the schools attached to the several Churches to give to their scholars the distinctive dogmatic teaching to which the managers attach special importance, provided that the secular instruction shall fill four-fifths of the day's exercises, and shall be thoroughly efficient. On these conditions, which are verified and certified after examination by H.M. Inspectors, the State recognizes voluntary schools and makes liberal grants for their maintenance. And in consequence there is not a single religious body in England or Scotland which does not, in so far as it is concerned with elementary education, comply with the regulations of the State and receive aid from it; nor is there a remote corner in either country where the inhabitants are not within reach of a public elementary school under Government inspection.

The particulars given in vol. vii. p. 679 of the *Encyclopædia Britannica* (ninth edition) bring up the story of administrative changes to the date of 1877, and show what was the constitution of the newly-formed School Boards and what were their powers. Mr Forster had hesitated to make school attendance compulsory by the Act of 1870, but in Clause 36 of that Act he plainly contemplated such an early change in public opinion as would justify local bodies in enforcing attendance. Hence a later Act in 1876 enforced the duty of every parent to send his child to school between the ages of 5 and 14, forbade employment under that age except to those who procured a labour certificate, and provided that indigent parents might claim from the guardians the payment of school fees. The same Act provided that the grant payable to a school should not exceed the limit either (*a*) of 17s. 6d. per scholar in average attendance, or (*b*) the total income derived from other sources than the grant. These limitations have since disappeared. In 1880 Mr Mundella's Act established direct and universal compulsion, and empowered the local school authorities to enforce it. In 1891 Sir W. Hart Dyke's Act practically abolished the payment of school fees, and thus threw upon the State the duty of compensating school managers for the loss of nearly two millions of annual revenue hitherto contributed by parents. A subsequent Act in 1896, introduced by the Vice-President, Sir John Gorst, provided a Special Aid Grant for the further relief of voluntary school managers. In the year 1890, before these great changes were made, the Government grants to elementary schools amounted to £3,326,177, the voluntary subscriptions to £758,670, the local rates levied by School Boards to £1,320,487, and the contributions of parents in the form of fees to £1,940,546. Later legislation during the administration of Lord Salisbury had the effect of altering materially the proportions in which the educational revenue is provided.

The whole of that revenue for the year 1899–1900

amounted to £12,336,986. This sum was made up as follows:—

| | |
|---|---|
| Endowment | £156,012 |
| School Board rates | 2,959,717 |
| Voluntary contributions | 812,104 |
| Fees and payment for books | 262,135 |
| County Council grants for technical instruction | 35,930 |
| Other local sources | 108,107 |
| Government grants, viz:— | |
| Annual grants | 4,993,115 |
| Fee grant under the Act of 1891 | 2,327,416 |
| Special aid grant to voluntary schools under Act of 1896 | 669,772 |
| Science and Art Department | 12,678 |
| | £12,336,986 |

Thus it is seen that the contributions from public sources, including the grants from the Treasury and from local taxation, amounted to £11,106,735, out of a total expenditure of £12,336,986. In the near future the contributions of parents and of voluntary subscribers may reasonably be expected to bear a yet smaller proportion to the total expenditure, and public control will in corresponding measure supersede private management.

These financial changes have not been without an important influence on the character of elementary education. It should be remembered that the Department does not appoint or dismiss the teachers, nor pay them, nor recognize them as civil servants. The curriculum of instruction is largely in the hands of the local managers, and from the first the main influence of the Education Department has been exercised through its methods of awarding grants to these bodies. In fact, during many years the prime function of the Department was not to direct education or to set up a national system, but to distribute a grant in aid of local effort, and to do this on a graduated system under such conditions as would stimulate improvement and ensure to the nation a good educational return for its expenditure. In this respect the English system has materially differed from more imperative forms of educational administration adopted in other countries. A Royal Commission of 1853, presided over by the Duke of Newcastle, recommended the adoption of the principle of payment by results in the crudest and most uncompromising form, and Mr Lowe's Code of 1860 was designed to give effect to that recommendation. He said in effect: "We do not insist on the adoption of any educational system, but we say if the Voluntary managers will show us certain results we will help them with a grant. Thus if our conditions are not fulfilled, the nation will find the plan economical. If the plan proves not to be economical, it will be very efficient, for the instruction will be worth paying for." Thus originated the system commonly known as payment by results. The grants were to be proportioned to the efficiency of the school, as determined by the individual examination of the scholars in reading, writing, and arithmetic alone. Later experience has by slow degrees materially modified the application of this principle, and has, indeed, partly discredited the principle itself. The plan of measuring the efficiency of the school solely by the number of scholars who were able to pass the examination led to the adoption by teachers, in many cases, of merely mechanical methods, designed rather to secure the maximum number of passes than to cultivate the intelligence of the scholars or to subserve the higher purposes of school discipline and training. Mr Forster, in 1870, was one of the first to see the inadequacy of the system, and in the Code of that year he added grants for history, grammar, science, and other humanizing subjects. Subsequently special grants were made for discipline and organization; and in 1881 Mr Mundella sought to enlarge the curriculum by permitting a wider option of additional scientific subjects and otherwise, by encouraging for the first time the Frobelian system of training and manual exercise in the infant classes; and by the introduction of a supplementary "Merit Grant," carefully graduated and designed to recognize and reward any form of excellence in discipline or organization or general intelligence which was not capable of measurement by the results of individual examination as tabulated in a schedule of "passes." A second Royal Commission of 1887, presided over by Lord Cross, was instituted to inquire into the operation of the Elementary Education Acts, and in its final report declared its opinion

> "That the distribution of the Parliamentary grant cannot be wholly freed from its present dependence on the results of examination without the risk of incurring graver evils than those which it is sought to cure. Nor can we believe that Parliament will continue to make so large an annual grant as that which now appears in the Education Estimates without in some way satisfying itself that the quality of the education given justifies the expenditure. Nevertheless we are unanimously of opinion that the present system of payment by results is carried too far and is too rigidly applied, and that it ought to be modified and relaxed in the interests equally of the scholars, of the teachers, and of education itself."

Accordingly, the Commissioners proceeded to recommend some modifications of the plan by which the amount of the grant payable to schools was at that time awarded; *e.g.*, that there should be a fixed grant of 10s. per scholar, and a variable grant of not less than the same amount, dependent partly on the results of individual examination and partly on various conditions hitherto recognizable for the purpose under the name of the "Merit Grant," the principle of which they sought to retain, though under a slightly altered form. These were moral training, order, obedience, general intelligence, and right classification. The Commission added, however, that in distributing the variable grant special stress should be laid upon proficiency in elementary subjects. These recommendations were substantially enforced by subsequent changes made during the Vice-Presidencies of Sir W. Hart Dyke and Mr Arthur Acland. Later experience, however, has led the Education Department to abandon altogether the attempt to graduate the grant according to the degrees of efficiency in the schools. In place of testing the proficiency of individual scholars, there is to be one summary estimate of the work of the school; in place of an annual examination, occasional inspection without notice; in place of a variable grant dependent on a report in detail on the several subjects of instruction and on particular educational merits and defects, one block grant payable to all schools alike. This grant is fixed at either 17s. or 16s. per head in infant schools or classes, and at either 22s. or 21s. for older children; the gain or loss of one shilling being the only difference recognized between the best schools and those which are not so bad as to justify the withholding of the grant altogether. It is hardly to be expected that this arrangement will be regarded as the final solution of the problem. It may possibly have the effect of reproducing the state of things which provoked the censure of the Duke of Newcastle's Commission of 1853, and which led to the novel and somewhat drastic expedient of determining the amount of the grant solely on the results of individual examination of scholars. Various expedients have been suggested for neutralizing the effect of so large a relaxation of the conditions by which it has been hitherto sought to secure accuracy and thoroughness in teaching. Among these, two have already been referred to as having been adopted in

the Scottish Code: a provision enabling an inspector to recommend deductions for specified faults in instruction, and a provision for the award of a merit certificate, to be given to a scholar as the result of an individual examination at the end of his or her school course; this latter plan of a leaving certificate having been in practical working, with very satisfactory results, in France for many years. Neither of these expedients has yet been adopted by the Board of Education for England and Wales, but by this or by some other means it will probably be found necessary to make greater provision than the newest Code furnishes for stimulating apathetic school managers and teachers to make efforts for improvement, and for assuring Parliament that its large annual grants are wisely, economically, and fruitfully expended.

The character of the instruction in the public elementary schools has in other ways been materially affected by the system on which the central Department has awarded money payments. Successive Codes and Acts of Parliament have recognized the age of fourteen as the limit of primary instruction; and after that age, and the completion of the curriculum known as the "seventh standard," the ordinary grant to elementary schools ceased to be payable in the case of any scholar. But increasing numbers of scholars have shown a readiness to remain and pursue an advanced course of instruction, without going on to schools of the higher or secondary rank. The Science and Art Department has been for many years administering special grants for drawing, design, and various branches of science; and these grants have been still available for scholars who had completed the elementary school course. Hence School Boards and Voluntary managers who have desired to retain scholars after the age of 14 have been led by financial considerations to give special prominence to those subjects for which grants were claimable from the Science and Art Department. But this has proved to be a partial and very inadequate provision, since the developed programme of what are called "higher grade schools" is often needed in the literary and general as well as in the specific and technical direction. A demand has arisen for schools or upper departments analogous to the *écoles primaires supérieures* which have proved so successful in France. This want is being recognized by the Government. By the Act of 1900 the Science and Art Department ceases to have a separate existence and to make separate payments for special branches of science. The new Board of Education, by which title the whilom Education Department is now known, is charged with the general supervision of primary and secondary, including technical and scientific, instruction, and will doubtless bring the various educational agencies into due relation to each other and make them take their places as parts of one coherent system. In such a system a place must certainly be found for "higher grade schools" such as have proved highly popular, especially in the great industrial cities of the North. They are not secondary schools, but merely places for continuing the instruction for an additional two or three years on the general lines followed in good elementary schools. The precise relations which are to subsist between these institutions and others, and indeed the true delimitation of the respective provinces of primary and secondary instruction, are matters which have been the subject of judicial decision and much debate. But they remain at present unsettled, and await the decision of Parliament and the new Board. One result of the existence of higher grade schools occupying, as they do, a kind of borderland between primary and secondary instruction, will probably be that the future local authorities will no longer be School Boards charged with the interests of elementary instruction only, nor new bodies concerning themselves with secondary instruction only, but single local authorities having cognizance of all the public educational resources of a district.

The statistical returns of public elementary education for the year ending 31st August 1900 show that while the population of England and Wales was 32,526,075, there were 31,313 separate departments under head teachers, of which 4060 were for boys, 3912 for girls, 15,300 for boys and girls (mixed), and 8041 for infants only. The total numbers on the register were: in Church of England schools, 2,300,150; in Wesleyan schools, 156,666; in Roman Catholic schools, 316,769; in British and other unsectarian schools, 269,421; and in schools under School Boards, 2,662,669. Thus the total of registered scholars is 5,705,675, of whom only 6823 were 15 years of age and over. Accommodation was provided for 6,544,092, or about 20·11 per cent. of the estimated population. But the total average attendance was 4,687,646. The staff of teachers was composed of 64,038 certificated masters or mistresses, 32,436 adult assistants, 29,393 pupil teachers, and 17,512 additional assistants.

There are at present no data from which similar statistics can be compiled respecting secondary schools.

**Secondary instruction.**

Experience has proved that the differentiation of primary and secondary and higher instruction cannot be determined by enumerating the subjects proper to be taught under each head. The true distinction is to be found by considering the probable age to which the period of instruction is to be extended. A course of educational discipline which is to end at the age of fourteen is a primary or elementary course. The school which seeks to retain its pupil to the age of sixteen or seventeen, and to prepare him to enter a skilled trade or one of the minor professions, is a secondary or intermediate school; and one which has a curriculum designed to suit the requirements of a youth till the nineteenth year, and to qualify him for entrance to a University or one of the learned professions, is an academic school of the highest educational rank. In various degrees, science, technology, manual instruction, classics, a modern language, history, geography, and mathematics may enter into the curriculum of all three; but the character of the teaching must in the main be dominated by the length of the school-life. Local circumstances and the probable destination of the majority of the scholars will rightly influence the choice and the co-ordination of subjects; but we may conclude, generally, that whatever may be taught honestly and without pretension within the limits of age may be regarded as a legitimate part of a primary, a secondary, or a high school course. Of Greek, for example, it may be safely said that, as a rule, it could not be wisely introduced as a subject either into a primary or an intermediate school, because in such a school there would be no chance of carrying the course of instruction to the fruit-bearing stage; but otherwise there is no good reason for excluding from a school of any one of the three grades the elements at least of some subject which will stimulate the appetite for self-improvement and serve as a good foundation for further acquisition after leaving school.

The existing provision for secondary instruction in England has been hitherto furnished chiefly (*a*) by endowed grammar schools, (*b*) by proprietary schools established by religious bodies or public companies, and (*c*) by private enterprise. An inquiry instituted by the Education Department in 1898 with a view to ascertain the number of pupils in public and private, secondary and other schools in England, not being public elementary or technical schools, resulted in a report to Parliament which was very significant of the varied and incoherent character of the

provision made for secondary instruction. The report says:—

"Some are boarding schools, some are only for day-scholars. Some are the property of private individuals or of partners in private enterprise; some are controlled by committees representing bodies of subscribers; some are the property of companies formed under articles of association with limited liability; some are controlled by local public authorities; some are regulated by Royal Charter, by Act of Parliament, by scheme under the Charitable Trusts Act or under the Endowed Schools Acts, or by some other legal instrument. Some are for boys only, some for girls only, some for both boys and girls. But as there is no general system of inspection applying to all the schools alike, it is not possible, with any approach to accuracy, to classify the whole number of schools, private and public, into grades of educational service. Nor is there in existence any list or register of these schools which pretends to be exhaustive. The whole subject is exceedingly obscure and has never been brought within the scope of comprehensive statistical inquiry."

The statistics in this return are based on information from 6309 schools, of which 1958 are for boys, 3273 for girls, and 1078 are mixed. The total number of boys was 158,502, and of girls 133,642. In 343 schools—224 for boys, with 13,248 scholars; 101 for girls, with 3864 scholars; and 18 mixed, with 2147 scholars—no day pupils were admitted.

***Endowments.*** Endowments have furnished from the earliest times a larger part of the provision for education in England than in any other country. But it is only within the present generation that a systematic attempt has been made to bring them under control and to provide a special tribunal for dealing with them. Before the Reformation there were schools attached to monasteries, chantries, cathedrals, and guilds; and the education given in them was chiefly directed to the training of choristers or priests. The description given by Mr J. B. Mullinger (in *The Schools of Charles the Great*) applies, not inaptly, to the schools attached to religious houses in England before the time of Henry VIII.: "They were designed mainly for the monastic life: boys were taught to read, that they might study the Bible and understand the services; to write, that they might multiply copies of the sacred books; to understand music, that they might give with due effect the Ambrosian chant. Even arithmetic found a place in the course of instruction, mainly on the plea that it enabled the learner to understand the *Computus*, and to calculate the return of Easter and the festivals." Mr A. F. Leach, whose industry has unearthed the names of 200 such schools, does not in his well-known book, *English Schools at the Reformation*, enable us to tell to what extent these schools were available for laymen, or how far they helped to provide general liberal education. Among them Winchester and Eton are the only notable survivors. The dissolution of monasteries and the policy of the Protector Somerset, under Edward VI., caused many of these schools to disappear in their old form; but a resolute effort was made to liberate them from purely ecclesiastical control, to re-establish them on a new footing, and to provide by these means a liberal education for all classes. The reign of Henry VIII. witnessed the foundation of 63 grammar schools; that of Edward VI., 51; that of Mary, 19; that of Elizabeth, 138; of James I., 84; and of Charles I., 59. The general characteristic of these schools was the provision in them for teaching the Latin and Greek languages, and for encouraging quick-witted and diligent learners in all classes of the community to qualify themselves for entrance to the Universities. After the time of the Commonwealth, and especially in the time of William and Anne, scholastic endowments took a new form, and were directed rather to the establishment of charity schools for the children of the poor than to the encouragement of liberal studies in the community at large. The 18th century endowments provided, in what were popularly called charity schools, gratuitous instruction of a very elementary kind, besides clothing and apprentice premiums for the children of the poor. These schools were in almost every case closely connected with the Established Church, and designed to attach scholars to that communion. Lord Brougham in 1816 persuaded Parliament to make an elaborate inquiry into the condition and resources of endowed charities generally, and the reports made in that and the following years gave many particulars respecting the incomes of the several trusts and the way in which they were administered. But the Commissioners to whom the work was entrusted were not charged with the duty of reporting on the educational efficiency of the schools. It was not till the year 1865 that the first serious attempt was made by the Legislature to ascertain the condition of secondary education and to take measures for its improvement. Two previous Commissions—that of Lord Clarendon in 1861 and that of the Duke of Newcastle in 1859—had reported, the former on the nine great foundations known *par excellence* as the "public schools"—Eton, Harrow, Winchester, Shrewsbury, St Paul's, Westminster, Merchant Taylors', Charterhouse, and Rugby—and the latter on the condition of popular or elementary education. Between these two there was a wide field for investigation and report, which was entrusted to the Schools Inquiry Commission of 1865. This body, under the presidency of Lord Taunton, made, with the assistance of Sir Stafford Northcote, Dr Temple, Matthew Arnold, and others, an elaborate investigation into the whole subject and an estimate of the provision then afforded, not only by endowed foundations, but also by private and proprietary establishments, for education other than elementary. The general character of the report, so far as ancient endowments were concerned, was extremely disappointing. A large number of the grammar schools were found to be in a feeble or decaying condition. The writer of this article was Assistant-Commissioner for the purpose of this inquiry, and his testimony, confirmed by that of all his colleagues, was that the number of scholars who were receiving the sort of classical education contemplated by the founders was very small and was steadily decreasing; that the general instruction in other subjects was seriously defective; and that the existence of statutes prescribing the ancient learning often served as a reason for withholding any modern addition to it. The causes of this deterioration were carefully examined and reported on by the Commission. They were declared to be (1) the faulty composition of the governing bodies, who were often little groups of persons renewing the trusts from time to time by co-optation, and in no wise representative of local wishes or needs; (2) the system of freehold masterships, which made it nearly impossible to remove incompetent teachers or to effect improvement; (3) the absence of any public or other supervising authority to ensure efficiency; and (4) the haphazard distribution of endowments, often in places where they were least suited to the requirements of the population. The elaborate reports of this Commission made a great impression on the public. They revealed a lamentable state of decay and uselessness in regard to many of the ancient "classical" foundations; they showed the supply of good intermediate schools, whether private or public, to be wholly inadequate; and they urged the necessity for legislation, to correct the abuses and revise the schemes of the grammar schools, and to co-ordinate, extend and improve, and bring under public supervision the work done by local and private bodies. The Endowed Schools Bill, brought into Parliament by Mr Forster in 1869, was the immediate fruit of this report. Its author contemplated a large and comprehensive measure

for the organization of secondary education. But the Bill consisted of two parts: the first calling into existence an executive body—the Endowed Schools Commission—to frame new schemes for educational endowments generally; and the second providing for the creation of local authorities and a central authority, also for a register of qualified teachers, and for the due examination and supervision of all intermediate and secondary schools, whether private or public. Of this great and statesmanlike proposal, the first part only received the sanction of Parliament, and the second was never revived. But the Endowed Schools Act—at first administered by a separate body of Commissioners, created *ad hoc*, under the presidency of Lord Lyttelton; and afterwards, in 1874, by a department of the Charity Commission—proved during the last quarter of the 19th century to be one of the most fruitful and most beneficial measures ever passed by Parliament. Under it new schemes were framed, which restored the vitality of hundreds of ancient and feeble endowed schools: governing bodies were reconstituted; obsolete and outworn restrictions were removed; freehold masterships were abolished; scholarships and free places, obtainable by merit only, were substituted for nominations by private favour and patronage; and many valuable reforms were effected in general harmony with the recommendations of the Schools Inquiry Report, which was, in fact, referred to in the preamble of the Act, and which serves as the key to the general policy which the Commissioners were enjoined to adopt. According to a return furnished by the Charity Commissioners to Parliament, schemes under the Endowed School Acts have provided for the reconstitution of 902 educational foundations in England, and received the Royal assent, since the passing of the Act of 1869. In the case of 203 charities which in their origin were partly educational and partly eleemosynary or religious, schemes for the due apportionment of the revenue to educational and non-educational objects respectively were framed so as to apply funds, in the form of scholarships or otherwise, to the improvement of education in the districts concerned. A later Royal Commission on Secondary Instruction, which was charged in 1894 with the duty of making a new inquiry, and which was presided over by Professor Bryce, himself one of the ablest and most influential of the Assistant-Commissioners under Lord Taunton's inquiry, brought down the history of the facts to more recent times, and made elaborate recommendations with a view to a more complete reorganization of secondary instruction in the light of the new resources and requirements of the times. It estimated the total annual value of the endowments applicable to secondary education in England at £735,000, excluding the value of sites and buildings. The principal legislative result of this Commission was seen in the enactment in 1899 of the statute creating a Board of Education for England and Wales, which took the place of the Education Department, the Science and Art Department, and also of the Charity Commission and the Board of Agriculture in matters appearing to the Sovereign "to relate to education." The Act abolishes the office of Vice-President of the Council, and the Board is to consist of a President, and of the Lord President of the Council (unless he is appointed President of the Board), the principal Secretaries of State, the First Commissioner of the Treasury, and the Chancellor of the Exchequer. With this Board is associated a Consultative Committee consisting, as to not less than two-thirds, of persons qualified to represent the views of University and other bodies interested in education, for the purpose (1) of framing a register of qualified teachers, and (2) of advising the Board of Education on any matter referred to the committee by the Board.

*Wales.*

The educational requirements of the Principality of Wales were dealt with in accordance with the recommendations of a special Royal Commission, which resulted in the enactment in 1889 of the Welsh Intermediate Education Act, providing for the creation in every county in Wales and in the county of Monmouth of a Joint-Education Committee, to consist of three persons nominated by the County Council, and two others, "being persons well acquainted with the condition of Wales and with the wants of the people," to be nominated by the Lord President of the Council. To these Education Committees is entrusted the duty of framing schemes for the establishment of intermediate and technical schools, for the right application of endowments, and for administering a contribution out of the county rate for the purposes of intermediate education generally. This Act has exercised a marked influence in the Principality, has multiplied secondary schools, and has been received with much favour by the inhabitants. In 1899 the Central Welsh Board was able to report that they had examined and inspected 93 intermediate schools, under the charge of 72 headmasters and 21 headmistresses, and that 7390 scholars (3877 boys and 3513 girls) were in attendance in these schools. The subsequent grant of a charter to the Welsh University, with which are federated the Colleges of Bangor, Aberystwyth, and Cardiff, has gone far to complete the equipment of Wales in the department of higher education.

*The University local examinations.*

In several notable ways the ancient Universities of Oxford and Cambridge have in recent years sought to enlarge the range of their intellectual influence beyond the traditional academic studies and discipline, and have exerted themselves with great effect to improve secondary schools. In 1857 the University of Oxford established a scheme for annual examinations of persons not members of the University. This step was taken chiefly at the instance of Sir Thomas Acland and Dr Temple, afterwards Archbishop of Canterbury, and in the following year a similar scheme of external examinations was adopted by the Senate of the University of Cambridge. Local examinations were established, and during the first seven years boys only were admitted. Each University offered two forms of certificate, the one for junior and the other for senior candidates. Besides the ordinary subjects of a good school course, these examinations offer a wide range of option, "in order to give as free a scope as possible to the development of schools belonging to different types." The far-reaching effect of these open examinations on intermediate schools, and on the aims and plans of their teachers, may be partly estimated by the fact that the report of the *Oxford Delegacy* for 1900 shows that in that year the total number of candidates examined was 9772, of whom 3391 (1739 boys and 1652 girls) were presented at the preliminary examination, 4455 (2590 boys and 1865 girls) were juniors, and 1926 (636 boys and 1290 girls) were senior candidates. The total number who satisfied the examiners was 6265, the numbers of the two sexes being nearly equal. Statistics for 1900 from the University of Cambridge show that examinations were held at 238 centres for boys and 221 for girls: 16,247 candidates presented themselves for examination, of whom 3423 boys and 2158 girls were entered for the preliminary examination, 5414 boys and 2965 girls under sixteen for the junior examination, and 921 boys and 1366 girls for the senior. The failures at the preliminary and at the junior examinations vary from 22 to 26 per cent., and at the examination for senior candidates under nineteen, from 23·8 to 29. Both at Cambridge and at Oxford arrangements have been made for the inspection and examination of schools, and a Joint Board of Examiners has been established by the

Universities for awarding to a scholar in a secondary or higher school a leaving certificate, which may be regarded either as a *terminus ad quem*, testifying that the scholar has reached a fair standard of general proficiency, or as a *terminus a quo*, serving as an entrance examination to the University, and accepted by nearly all the colleges of Oxford and Cambridge as an equivalent for a matriculation test. These particulars do not, however, furnish an adequate estimate of the influence which the ancient Universities have exercised on schools at a distance from academic centres. That influence has helped largely to widen and improve the standard of education in the schools, to encourage students, to give them a truer estimate of their own acquirements, and to give new suggestions and stimulus to teachers. The general confidence in the fairness of the examinations may safely be said to increase year by year.

**University extension.**

The Oxford Royal Commission of 1850, which reported in 1853, discussed several schemes for extending the usefulness of the University—*e.g.*, the establishment of new halls, as independent societies or in connexion with colleges; the permission to undergraduates to lodge in private houses, and to become members of the University; and the admission to professorial lectures of persons not matriculated members of the University. On these points the recommendations of the Commissioners were favourable, and had the effect of leading speedily to desirable reforms. On the thorny question of the abolition of religious tests at matriculation and graduation the Commissioners abstained from direct recommendation, although they expressed their "conviction that the imposition of subscription in the manner in which it was then imposed in the University of Oxford habituates the mind to give a careless assent to truths which it has never considered, and naturally leads to sophistry in the interpretation of solemn obligations." It was not till 1871 that full legislative effect was given to these views by the abolition of religious tests for the higher degrees, except theology, the obligation to sign the Thirty-nine Articles at matriculation having been previously removed in 1854. Another proposal by Mr Sewell for founding, by way of experiment, at Manchester and Birmingham, and in conjunction with Cambridge, local centres of academic teaching for persons who resided at a distance from the Universities, was considered by the Commissioners, but was not embodied in their recommendations. The project, however, was not allowed to drop. Lord Arthur Hervey, afterwards Bishop of Bath and Wells, put forth in 1855 a pamphlet urging the University to supply the literary and scientific and mechanics' institutions of Great Britain and Ireland with lecturers from the Universities, and so to furnish to the students more systematic and more continuous courses of instruction than the isolated popular lectures commonly given in these institutions. But it is to Professor Stuart of Cambridge that the honour of taking the first practical step in this new direction must be ascribed. In 1867 he gave several courses of scientific lectures to ladies at Leeds, Liverpool, Manchester, and Sheffield, on the invitation of the North of England Council for Promoting the Higher Education of Women, and in 1871 he addressed a letter to the resident members of the University of Cambridge describing his experience, and urging strongly that the Universities were not local clusters of private establishments, but national institutions, and that they should seek to enlarge the scope of their intellectual influence by taking up the question of "University extension" in a serious spirit. A syndicate was appointed in 1872 to consider the whole subject, and in the following year it reported in favour of adopting for an experimental period the proposed new scheme of local lectures. In 1876 a society was founded in London, under the presidency of Mr (afterwards Lord) Goschen, for organizing, with the help of representatives of the three Universities of Oxford, Cambridge, and London, the scheme of University extension lectures for the metropolis and its neighbourhood. At the second Oxford University Commission in 1877 evidence was given by Dr Jowett, afterwards Master of Balliol, in favour of the establishment of an office, and the appointment by the University of a secretary for University extension. He further suggested that the tenure of non-resident fellowships should be extended in the case of persons taking or holding professorships in the large towns. In the following year, 1878, the scheme was formally established, and Mr Arthur Acland, afterwards Vice-President of the Committee of Council, was appointed as the first secretary to the Delegacy. From that time the system has continued to develop steadily, with increasing public favour and usefulness, and with friendly co-operation and division of labour on the part of the two Universities. By degrees lectures became supplemented by class-work and the systematic direction of private reading. In 1885 travelling libraries were formed; and in 1888 the first of a most successful series of summer meetings, to assemble at Oxford and Cambridge in the long vacation in alternate years, was held at Oxford. At two or three centres—notably at Exeter and at Colchester—a strong local desire has had the effect of establishing a permanent college in connexion with the University. In a single session 192 courses of lectures were delivered in connexion with Oxford, 135 with Cambridge, 130 with London, and 7 with the Victoria University, giving a total of 464 courses, the number of lectures in a course varying from 8 to 12. The total of lectures in that session was 4408. In the same session 20,148 persons attended the Oxford courses, 10,947 the Cambridge courses, 12,923 the London courses, and 910 the Victoria courses. Besides the 1100 members who attended the Oxford summer meeting, there was thus a total of 46,028 attendants at the courses, the number of lecturers employed being 88.

**Provincial colleges.**

To this record of increasing activity in the older Universities is to be added the remarkable growth of local colleges of University rank in some of the most important industrial towns. In 1846 Mr Owens endowed with nearly £100,000 the college at Manchester which bears his name, in 1874 the Yorkshire College of Science at Leeds, and in 1878 University College at Liverpool, were founded; and these three institutions became federated, and received in 1880 a Royal Charter under the name of the Victoria University. The Durham College of Science was founded at Newcastle-on-Tyne in 1871, and has since become incorporated with the University of Durham. Mason College, Birmingham, was founded in 1875, and has been absorbed in the new University of Birmingham, which received a charter of incorporation in 1900. University College, Bristol, was established in 1876; Firth College, Sheffield, in 1879; and University College, Nottingham, in 1881, the last two owing their origin in large measure to the stimulus afforded by successful courses of local "extension" lectures. No one of these institutions was founded by Government. All of them owe their origin to local patriotism, and to the large gifts which have been made to them by rich citizens; the equipment in Manchester, Liverpool, Nottingham, and Newcastle being on an exceptionally liberal scale. But a Treasury Minute was issued in 1889 containing a provision that £15,000 a year should be distributed among these and similar colleges in sums varying from £1200 to £1800 a year each. King's College and University College and Bedford College for Women, in London, were admitted to participate

in this grant. There can be little doubt that all these modern developments of academic life and usefulness have supplemented the activity of the ancient Universities in a remarkably effective way. The provincial colleges are yearly adding to the number of their students. Their freedom from traditional restrictions has enabled them to adapt their courses of study to the industrial requirements of the several communities in which they are placed; and hence practical and experimental science in its special bearing on the manufacturing interests of the district has taken a conspicuous place in some of the programmes of the local colleges. Yet in all of them ample provision is made for the teaching of language, history, and philosophy, and generally for the "humanities," as the basis of a liberal education. Nor would it be right to overlook their indirect effect on the social and intellectual life of the great industrial centres, for this has been scarcely less valuable than the actual teaching given in the colleges themselves. It has long been a subject of concern that many of the richer and some of the more cultivated inhabitants of great manufacturing towns ceased after a time to reside in them, and betook themselves to London or the country. The permanent inhabitants were for the most part absorbed in business, and the lack has been felt of a class of persons engaged in intellectual pursuits, and obliged by the nature of their duties to become habitual residents. The professors of the new provincial colleges form such a class; and experience has shown that they have received cordial welcome, and that their influence on the local society has been generally recognized as a clear gain.

***University education in Ireland.***

The future organization of University education in Ireland is not yet (1901) finally decided, and is still a subject of much controversy in the sister island and in Parliament. A Royal Commission has been engaged in investigating the whole subject. The principal existing provision for academic education in Ireland consists of the ancient University of Trinity College, Dublin, the Royal University founded in 1880, and the Queen's Colleges. The Provost and Fellows of Trinity College were until recently required to be members of the Established Church, and the institution was long regarded as a stronghold of Evangelical Protestantism. But these restrictions and all religious tests have now been abolished. The Royal University consists of a Board empowered by charter to examine students and to confer degrees, but exercises no direct teaching functions. These provisions are not satisfactory to the heads of the Roman Catholic Church, who have made a strong effort to induce the Government to grant a charter to a new Roman Catholic University, which shall be largely under the supervision and influence of the hierarchy of that Church. The question thus raised is of great importance to the whole empire, since by recent legislation all theological tests, whether for the students or for the governing bodies, have been abolished at Oxford and Cambridge and at the Scottish Universities, and since every one of the newer academic institutions which are empowered to confer degrees, either in the United Kingdom or in the Colonies, is wholly unsectarian in its character. The University of Laval, in Lower Canada, is almost the only exception—and not a very important one—to this general statement. Those persons who object to the proposed new departure from all these precedents in the case of the Roman Catholics of Ireland, urge that there is a fundamental difference between a College and a University. While Colleges with a pronounced denominational character deserve full recognition and public aid, a University is something more than a College. It is a chartered corporation empowered to set up a standard of general scholarship and science, and to award degrees and distinctions, such as may have a recognized value in the learned world. In the discharge of this duty it is urged that theological considerations should have no place; and the establishment of a University under the management, and charged with the interests, of a particular Church would be a reactionary step of very serious import in a nation which has deliberately divested all its Universities of their exclusive sectarian privileges, and in which there is not, in fact, an Anglican, a Presbyterian, or a Wesleyan University. Accordingly, a very general opinion has been expressed that, while providing amply to meet the reasonable desire of Roman Catholics to maintain *teaching* institutions adapted to their own needs, the University which is to possess the degree-conferring power should be governed by persons distinguished for learning and science only, and not necessarily identified with a theological creed. It yet remains to be seen how far a compromise on these lines can be arrived at in view not merely of political exigencies, but also of the higher interests of scholarship and of intellectual progress.

***The University of London.***

The reconstitution of the University of London in the year 1900, under the Act of 1898, is a fact of great significance in the history of the higher education in England. That institution was founded in the first year of the reign of Victoria with a view to place the means of University training within the reach of students who were prevented by distance, by the existence of religious tests, or otherwise, from availing themselves of Oxford or Cambridge. At first its scope was limited to two or three colleges in London, and to a small number of provincial colleges; and the Senate was empowered, after due examination, to confer degrees on such students of these colleges as had fulfilled certain conditions of residence. But in the year 1858 a new charter practically abolished the connexion of the University with the affiliated colleges, and empowered the Senate to confer degrees and honours on all candidates, collegiate and non-collegiate alike, who could satisfy the examiners. After that time the University was mainly an examining board; year by year upwards of two thousand young persons presented themselves for matriculation, and the number of degrees conferred in the Faculties of Arts, Laws, Science, Medicine and Surgery steadily increased. A strong desire arose, however, that the Metropolitan University should influence teaching as well as examination, and that it should be brought again, though under altered conditions, into organic connexion with the great teaching bodies of London. After the reports of two Royal Commissions entrusted with the duty of making inquiries on this subject — the first under the presidency of Lord Selborne, in 1882, and the second, in 1892, under Lord Cowper—an Act of Parliament in 1898 reconstituted the University, on the principle that while continuing to discharge all its functions as an examining body for collegiate and non-collegiate students in all parts of the empire, it should also establish closer relations with the great London colleges and medical schools, give to the authorities of those institutions a larger share in the government of the University, and seek in other ways to co-ordinate and control the higher education of London. Statutes designed to give effect to this proposal received the royal assent in the year 1900. These statutes contemplated a wide extension of the usefulness of the University under its new conditions. In particular, they recognized it as a large part of the business of a University to ennoble and liberalize the higher professions generally, without the limitation to Divinity, Law, and Medicine, which have for so many years been regarded as *par excellence* the learned professions. To bring a high standard of general literary

culture to bear on the practice, *e.g.*, of engineering, of commercial and economical science, and of education considered both as an art and as a science, and to aid by means of post-graduate courses the practitioners of these and other callings in their efforts to find a scientific basis for their several professions, is part of the task which awaits the Senate of the reorganized University, and on which they entered under the most hopeful auspices.

But, on the whole, it cannot yet be said that the part played by the English Universities in the higher professions, or in the general culture of the nation, is so important as could be desired. In 1871 Professor Bryce computed that whereas in Germany, with a population of 45 millions, there were 24,187 University students, England, with a population of 26 millions, had fewer than 5500 such students. Notwithstanding all the recent additions to her academic resources, England is still far behind other countries in the provision it makes for University education.

***Continuation schools and polytechnics.***

Successive Acts of Parliament have recognized the age of 14 as the limit of primary education; and the Codes of the Education Department have from time to time prescribed that after passing the "standard" of instruction appropriate to that age, the grants on behalf of a scholar in a day-school should cease to be paid. Evening schools have, however, long been encouraged by special grants to give supplementary instruction to young people who had left the day-school. For a time these grants were made conditional, as in the day-schools, on the passing of the scholars in the examination in elementary subjects. Mr Acland, however, in 1893 framed new regulations for evening continuation schools. The Code of that year gave greater variety of choice to managers in relation to the subjects of instruction, and substituted grants, calculated on the number of hours of regular teaching, for payments on the results of examination. These regulations gave a considerable impetus to the establishment of evening continuation schools, and the report of the Committee of Council (1900) records a total of 6154 such schools or departments, and of 206,335 scholars in average attendance. Of these, the number of boys and men nearly doubles that of girls and women, and the total number of evening scholars in Board schools as distinguished from Voluntary schools is in the ratio of three to two.

In the article on Technical Education will be found particulars respecting the provision which has been made for the encouragement of scientific and manual training in its special relation to skilled industry. A strong feeling had, however, become manifest, that both in the primary schools and in the supplementary evening courses the instruction was too literary in its character, and that the practical side of life—that which is concerned with the training of hand and eye, the use of tools and measurement, and the study of those branches of science which are most nearly related to the arts of life—had been unduly neglected. How far the defects thus apparent could be remedied by an altered curriculum in either the primary or the secondary school, or by the establishment of new and separate agencies, is a question not without difficulty, and one on which neither the public nor the higher educational authorities are yet clearly in accord. The young men and women who have acquired at the elementary school the habit of application and an interest in their own mental improvement, and especially those who desire to devote part of their leisure to the attainment of such scientific, technical, artistic, or literary knowledge as is most closely akin to their own business or profession, form a class for which the provision has hitherto been inadequate, and which sorely needed, and still needs, further help and guidance.

In London part of the help thus needed came from an unexpected quarter. In 1878 a Royal Commission was appointed, with the late Duke of Northumberland as the chairman, for investigating the condition of the City parochial charities. It was proved that many of them had become, under the altered conditions—social and residential—of the present day, obsolete and useless. Doles and Christmas gifts, pensions and apprentice funds, and other like forms of benevolence which had once been of service when the citizens of London lived at their places of business, were no longer needed when the residents had flocked to the suburbs and lost all association with the London parishes. Moreover, the revenues of the charities had in many cases, owing to the greatly increased value of City property, grown out of all proportion to any wants of the few remaining City residents. The Commissioners, *e.g.*, refer to one parish, with a population of only 150 consisting chiefly of bank clerks, in which there was a pension fund of £1800 a year. Accordingly, Parliament in 1883, mainly at the instance of Mr Bryce, passed the City Parochial Charities Act, which empowered a small body of Commissioners, after making due reservation of ecclesiastical and other prior claims, to apply the revenues to other objects of utility more suited to the present needs and circumstances of the London population. The sum of £155,000 was appropriated to the purchase of open spaces and recreation grounds in London and its suburbs, and a like sum to the establishing of Free Libraries and of Polytechnics. Besides the capital sum thus expended, an annual revenue of about £50,000 was retained in the hands of the Commissioners, and has been employed in the maintenance and extension of similar institutions. The People's Palace in Mile End and the Borough Road and Battersea Polytechnics are among the best-known examples of the institutions which have thus been aided. In them provision has been made for evening classes and lectures of a varied and attractive kind; for manual and industrial training in workshops and in class-rooms; for gymnastics, and for field-naturalist, musical, debating, and similar clubs, as well as for drawing and design and other forms of art. There can be little doubt that these institutions, all of which are crowded with students, are exercising an important and increasing influence on the intellectual culture of London, and especially on the career of the more thoughtful and more aspiring of young people engaged in commerce or in manufactures in the City and its environs. Other grants from the fund have been made, and will probably continue to be made, at the discretion of the trustees, in aid of smaller classes and institutes, the colleges for working men and women, and the like useful objects.

Another windfall became available in the year 1890, which had a large influence in extending the opportunities for the literary and the industrial improvement of young men and women after quitting the elementary school. In the previous year the Technical Instruction Act had empowered local authorities to supply, by means of rates, technical or manual instruction, and had defined such instruction as "instruction in the principles of science and art applicable to industries, and in the application of special branches of science and art to specific industries or employments." But in 1890 certain local taxation (customs and excise) duties having been directed to be paid to the same local account as the local taxation probate duty, it became necessary to make legal provision for the distribution and application of the duties so paid. At first it was proposed by the Government to employ a substantial part of this sum in compensating publicans for the loss of their business. But Parliament showed great unwillingness to assent to

such an appropriation of the funds, and, mainly on the initiative of Mr A. H. Acland, the Local Taxation (Customs and Excise) Act was passed, practically permitting the application of the whole fund, after the deduction of a fixed sum reserved for the superannuation of the police, to the encouragement of technical instruction as defined by the Act of 1889. The total annual sum thus available was nearly one million sterling, and it was placed at the disposal of County Councils and County Boroughs, in proportion to the ratable value of the property in the several populations which they represented. The share of London, which in 1890 was £162,572, has since increased, until in the year 1900 it amounted to £225,728, of which £180,000 is allotted to technical education. The County Council appointed a special Board for the administration of this fund, and has applied it in various ways. The estimated expenditure for 1900–1 includes (*a*) Technical departments of Polytechnics, including contributions towards the erection of buildings, £36,650; (*b*) other technical schools and institutes, £24,664; (*c*) establishment and initial equipment of new institutions, £22,000; (*d*) technical departments of public secondary schools, £28,470; (*e*) higher education, £3500; (*f*) county scholarships, £30,362; (*g*) teaching in Art, Science, Technology, and manual instruction, including scholarships and pioneer lectures, £16,506; (*h*) domestic economy, £5874; (*i*) commercial subjects, £4798; (*j*) museums (art examples), £383; and (*k*) expenses of administration, £7860. One of the chief features of the London scheme is the liberal provision of scholarships offered annually by the Technical Education Board. There are 600 junior scholarships open to all London children under thirteen, and carrying with them the right of free education in some approved secondary or technical school, and in addition a gratuity of from £8 to £12. Other scholarships—*e.g.*, intermediate, commercial, art and artizan, domestic economy, horticulture and practical gardening, and cooking—are also provided; the general principles of award being that the scholarships are open to all residents in London, that boys and girls are alike eligible, and that the sum granted is partly expended in the payment of their fees in some school or technical college, and partly in a money payment in aid of the scholars' maintenance during the period of study. The number of such scholarships granted in 1899 was 1710, and the total sum thus expended by the Board was nearly £40,000. Throughout the country the sums of money thus specially assigned by the Act have been employed by the County Councils on educational objects more or less akin to the industrial and commercial requirements of the several districts. Without precedents to guide them in the exercise of their novel trust, many of the Councils have tried various experiments—*e.g.*, in seaports, schools of navigation; in Newcastle and other places where great engineering works existed, the study of mechanical science has been helped, partly by providing laboratories and apparatus and special teachers in existing schools, and partly by scholarships and exhibitions tenable in science colleges; in rural districts, the study of agriculture and horticulture, and the encouragement, by the help of peripatetic lecturers and otherwise, of systematic instruction in dairy work, bee-keeping, or cheese-making. The total effect of this beneficent Act in reviving many local industries, in encouraging educational enterprise and new forms of manual and scientific instruction, has already been powerfully felt, although the full application of the special fund thus received from the Exchequer still yet awaits further experience, and may require some modifications in the plans originally tried.

*Public libraries.*

The influence of the Public Libraries Acts, of which the first was passed mainly at the instance of Mr William Ewart in the session of 1850, has been very extensive and beneficial. At first the maximum rate which the various municipalities were empowered to levy was a halfpenny in the pound, but the Act of 1892 removed this restriction and empowered the inhabitants to determine for themselves the amount which might be applied to this object. A rate of one penny is generally found to suffice, but in Wigan the library rate has reached twopence in the pound. English municipalities were slow to recognize the great intellectual and social advantages of the Free Library, or to avail themselves of the permission given by the Act of 1850. In 1860 there were only twenty-one such libraries and reading-rooms; in 1870 there were thirty-five; in 1880 fifty more were added. In 1890 the total had reached 187; and there are now 340 free libraries in England and Wales. Of these, 36 are in the metropolitan districts. The total number of volumes in use, for reference or for distribution, is about six millions. Manchester furnishes 280,000; Birmingham, 215,000; Liverpool, 200,000; Leeds, 195,000; Sheffield, 110,000; Bristol 90,000; and Nottingham, 85,000. Most of these libraries are housed in costly and convenient buildings provided by the several municipalities, and all of them are visited by increasing numbers of readers. It is becoming more and more evident that the public library is an indispensable adjunct to the other agencies by which primary, secondary, and technical education are being promoted. Within the last few years the growth of public libraries has been stimulated to a large extent by the remarkable munificence of a private citizen. Mr J. Passmore Edwards has devoted more than a quarter of a million sterling to the erection, maintenance, or equipment of libraries, picture galleries, or other kindred institutions. He has been singularly fortunate in the wise choice of objects, which are wholly outside the category of ordinary charities, and are all intended in various ways to help forward the intelligence and the social enjoyment of the people.

*Women's education.*

No survey of the educational history of the Victorian era would be complete if it omitted all reference to the remarkable increase of late years in the public and professional activity and in the intellectual influence of women. Access for the first time in English history has been found for them not only to the medical profession, and to high and responsible employments in the Civil Service, but also to many posts in connexion with commerce and with journalism; to engagements as librarians and secretaries, and as superintendents of skilled labour, in gardens, in offices, and in factories. Women have also been employed, both by the Central Education Department and by local Boards, as inspectresses and organizing mistresses. In art also, and in literature, and in scientific research, women have achieved success, and even eminence, to an extent unknown two or three generations ago. Besides new avenues to honourable and lucrative employment in professions and trades, there has been a large increase in the amount and value of the unpaid public services which women are now rendering to the community. Many have become members of School Boards and of Boards of Guardians, trustees of endowed foundations, or skilled administrators of charity. Some have been placed by the Government on various Royal Commissions of Inquiry; three were included in the Consultative Committee to be attached to the new Board of Education; and three have recently been nominated as members of the Senate of the University of London. In all of these ways, and in many others, women are taking daily a larger and more important share in the public life of England, and are rendering signal service. It cannot be doubted that in this way the whole

community has been enriched by the application of powers and talents which, under other conditions, would have remained undiscovered and therefore unused; and that in enlarging the range of intellectual interests open to women, they themselves have found new opportunities of useful activity, and new means of adding to the dignity and the happiness of their lives.

But all these important changes have presupposed as essential conditions increased educational advantages, and a higher standard of what is suitable and necessary for the instruction of girls. In the sphere of primary education the action of the Education Department has from the first been favourable. The standards of instruction which have been prescribed from time to time have, except so far as needlework is concerned, been practically the same for girls as for boys. The qualifications of pupil teachers and for head teachers of both sexes have, with a few unimportant exceptions, been identical. The total number of certificated mistresses recognized by the Board of Education is 36,435, as compared with 23,439 certificated schoolmasters; while of assistant teachers 4065 are young men and 22,671 are young women. This disproportion has a tendency to increase year by year, as a larger share in elementary work falls into the hands of female teachers. In this connexion it is interesting to consider the experience of the United States. The statistics of the American Bureau of Education include teachers of all ranks, from the kindergarten to the higher colleges and universities, and the last returns show that in all 131,750 men and 277,443 women were engaged in education, and that the proportion of men to women had since 1870 steadily diminished. In 1870 it was 42 per cent., in 1889 it had fallen to 34·5 per cent., and in 1898 to 32 per cent. In the Department of Secondary Education in England a like change is taking place. Formerly all the more pretentious private "seminaries" for girls prided themselves on the number of visiting masters, who gave lessons in arithmetic, or history, or music, or astronomy and the use of the globes. But in just the proportion in which a liberal education has become accessible to women, the need for masters is fast disappearing; since it is a familiar fact of experience that, given an equal amount of knowledge, women are likely to be better teachers of the young than men, as they have greater natural aptitude and a finer intuitive insight, enabling them to know the needs of childhood and to adapt lessons to these needs. What they know they can teach. The only reason why this fact has been so slowly recognized, is that the opportunities for obtaining sound and thorough scholarship were so long withheld. Of the public measures that have affected the intermediate education of women in England, one of the most effective was the report of the Schools Inquiry Commission in 1867, in which the defects of girls' secondary instruction were characterized as "want of thoroughness and foundation; want of system; slovenliness and showy superficiality; inattention to rudiments; undue time given to accomplishments, and those not taught intelligently or in any scientific manner; and a complete absence of proper organization." In the Endowed Schools Act of 1869 there was inserted the 12th clause, "In framing schemes under this Act provision shall be made, as far as conveniently may be, for extending to girls the benefits of endowments." The last report of the Charity Commission shows that, in obedience to this clause, eighty-two new secondary schools for girls had been established, and that sixty-two other schemes contain *inter alia* special provisions for enabling girls to share, either by scholarships or otherwise, the advantage of ancient grammar school endowments. Schemes for some of the wealthier foundations, notably St Paul's School and Christ's Hospital, provide liberally for the future application of large funds to the maintenance of secondary and higher schools for girls. The opening of the local examinations of the two Universities to girls has already been referred to, and has had a marked effect in raising the standard of efficiency in the intermediate schools for girls. In 1874, when the public had been much impressed with the serious revelations of the Schools Inquiry Commission, Mrs William Grey and her sister Miss Shirreff, with the subsequent aid of Miss Mary Gurney, founded the Girls' Public Day School Company, with a view to familiarize the public with an improved type of schools. The experiment has proved remarkably successful. The company possessed in 1900 thirty-three high schools, with upwards of 7000 pupils; and its example has been followed in many places, where schools of a similar character, under the care of qualified teachers and the government of responsible public bodies, have been founded independently. Before this effort, two of the most remarkable institutions for the secondary instruction of girls had furnished the pattern which the company to a large extent followed. The Ladies' College at Cheltenham had been founded in 1854, and under the skilful supervision of Miss Dorothea Beale had grown into one of the most important institutions in England. It is unrivalled in the completeness of its material equipment, in the qualifications of its teachers, and in the successes it has won in all the most important examinations open to women. Including its kindergarten and its training department for teachers, it numbers upwards of nine hundred pupils, of whom about half are boarders, and the rest are the daughters of residents in Cheltenham, many of whom have settled in the town and neighbourhood for the express purpose of availing themselves of the exceptional advantages which the college offers. The North London Collegiate School for Girls, which originated in the remarkable efforts of Miss Frances Buss in the year 1850, and which has gradually become a public foundation school of a high type, has served as a model, since largely imitated by the founders of local high schools for girls. Bedford College and Queen's College in London were established in 1848, with a view to place opportunities of higher education within reach of girls who desired to prolong their education beyond the ordinary term of school-life; and the names of Professor F. D. Maurice, Charles Kingsley, Miss Anna Swanwick, and Miss Frances Martin have been honourably associated with the early successes of these institutions.

But the most important aid which women have received in regard to advanced education has been furnished by the English and Scottish Universities. In 1867 the first attempt was made to establish in England a college of University rank for women. A house was taken at Hitchin, midway between London and Cambridge, and fitted for the reception of six students. In 1873 the college was removed to new premises at Girton, near Cambridge. By successive additions it has been enabled to receive 150 students, and it will probably be still further enlarged. From the first the governing body of Girton College, prominent upon which were Miss Emily Davies and Lady Stanley of Alderley, sought to avail itself to the full of the academic education provided by the University, and to maintain the standard of learning in the college on the same level as that prescribed for men. In 1871 a similar enterprise was started under the care of Miss A. J. Clough, who took a house at Cambridge to prepare students for such examinations as were then open to women, and in this way established the institution known as Newnham College, which has been from from time to time enlarged, until it contains three halls of residence and accommoda-

tion for 150 students. Both colleges are thriving, and have always been well filled. In some minor respects the arrangements of Newnham are more elastic than those of Girton, since its students are not all required to pass through the regular University curriculum. But from the first both institutions have sought recognition from the University; and steps were taken to obtain for the students of the colleges admission to the examinations for degrees. At first personal application was made by Girton to the examiners, with the cognizance of the Council of the Senate, requesting them to examine some of the college students, and to conduct the *vivâ voce* examination, reporting on the attainments of the students according to the University standard; and up to 1881 degree examinations were carried on by the courtesy of the examiners, on an informal but strictly regular system, simultaneously with those of undergraduates of the University. In 1881 the Senate by formal grace extended to women the "Little-go" and the Honour examinations, though not the examination for the ordinary degree; and since that date the students of both colleges have been admissible to the Previous and to the Tripos examinations, and have received from the University a formal certificate attesting the result of the examination, though not at present conferring the actual academic title. The total number of students admitted to Girton from the time the college was opened till 1901 was 757, of whom 496 obtained honours according to the Cambridge University standard, 146 having passed in the Classical and 134 in the Mathematical Tripos, and others in History, Mediæval and Modern Languages, or Natural Science. Newnham College also secured between 1880 and 1900 upwards of 500 places in the Tripos examination. In the single year 1899, 12 students passed in the first class, 29 in the second, and 20 in the third, besides 3 students who attained the standard qualifying for the ordinary degree.

The University of Oxford has followed the example of Cambridge somewhat slowly and gradually, but with very notable results. Three colleges for female students have been established—Somerville College, Lady Margaret Hall, and St Hugh's Hall. The University instituted special examinations for women in 1875; but in 1884 these special examinations were practically abolished, and a statute was passed in Convocation opening to women the ordinary Honour Moderations (Classics and Mathematics), and the Final Honour Schools of Mathematics, Natural Science, and Modern History. In 1886 women were admitted to Responsions, in 1888 to the Honour School of *Literæ Humaniores*, in 1890 to the Honour School of Jurisprudence, in 1893 to the Honour Schools of Theology and of Oriental Studies, and in 1894 to the remaining examinations for the degree of B.A. In all, between 1884 and 1900, 56 women presented themselves for honours at moderations in Classics, and 17 in Mathematics; for final honours, 146 in Modern History, 22 in Natural Science, 7 in Mathematics, 17 in *Literæ Humaniores*, 2 in Jurisprudence, 22 in English Language and Literature, and 47 in Modern Languages; of these, 56 passed in the first class and 119 in the second at the Final Honour School.

Holloway College, near Egham, founded and munificently endowed by the late Mr Thomas Holloway in 1876, has taken high rank as a college for women, and is recognized as one of the schools of the University of London in the Faculties of Arts and Science. In the year 1899 it had 108 students, and a large staff of professors and lecturers. It is exceptionally rich in scholarships, of which 12 are open for competition on entrance, and 2 others for students of merit in the college.

The University of London, as a comparatively modern institution, unhampered by tradition or ancient statutes, has found itself free to take a step which has at present proved impossible in the two older Universities. In 1878 the Senate, with the concurrence of Convocation, obtained from the Crown a charter enabling persons of both sexes to graduate in all the Faculties on perfectly equal terms. Up to the year 1900, 5185 women passed the examination for Matriculation, 1383 the Intermediate examination in Arts; 861 obtained the full degree of B.A., and 63 that of M.A. In the Faculty of Science, 266 passed the Intermediate examination, and 145 obtained the degree of B.Sc., while 9 proceeded to the D.Sc. degree. In Medicine, 74 obtained the degree of M.B., 21 that of M.D., and 23 that of Bachelor in Surgery.

The example of the London University has since been followed by the Victoria University, by the Scottish and Welsh Universities, and by Durham University, with which is now incorporated the flourishing College of Science in Newcastle-on-Tyne. The University of Birmingham also receives as students, and admits as candidates for degrees, women as well as men. Proposals have sometimes been put forth by influential persons for establishing a women's University. But they have not proved acceptable to academic or public authorities, nor indeed to women themselves. Women's *colleges* supply already a great want, and they will probably increase in number and in usefulness. But for a women's *University*, which shall give a separate feminine degree, and set up a special standard of liberal education supposed to be adapted to the intellectual needs of women only, there is at present no general demand. Nor is it probable that such a demand will arise in any practical form until philosophy and experience shall have enabled us to differentiate the mental characteristics of men and of women, and to determine in what departments of human knowledge each of them should be encouraged or required to excel. Meanwhile the chief advocates of the intellectual progress of women are content to ask the Universities to afford access to the same variety of optional courses, and the same rigorous tests of attainment which experience has shown to be needed by men, and then to leave female students at liberty to exercise their own choice. Hitherto the British Universities have given a generous response to this appeal, and there can be little doubt that in any future development of academic institutions in England the claims of women to share in the highest intellectual privileges will be more and more recognized.

***A notable endowment for women's higher education.***

It is right to record here a recent and significant fact in the history of educational endowments. Mr Pfeiffer, a London merchant, and his wife, Mrs Emily Pfeiffer, determined in 1884 to bequeath the whole of their residuary estate, amounting to nearly £70,000, "to charities and educational establishments on behalf of women, and of women solely"; and the will expressly specified that what the testator desired most was the intellectual or professional training of women, "theirs being to my mind the great influence of the future." The persons entrusted with the distribution of this fund were the Vice-President of the Council of Education, Miss Anna Swanwick, and the writer of this article. The bequest became available in 1890, and under the sanction of the Court was distributed, in sums varying from £2000 to £5000, to Girton and Newnham and Somerville Colleges, the training colleges for secondary teachers at Cambridge and in London, Bedford and Queen's Colleges, the Halls of Residence for women students attached to Universities and Colleges in London, Edinburgh, Dublin, Cardiff,

St Andrews, and Aberystwyth, the London School of Medicine for Women, the College for Working Women, and similar institutions. In this way, either by the erection of new buildings or by the establishment of studentships and prizes, substantial help has been given to some of the most promising of the modern enterprises by which the intellectual advance of women has been stimulated in the United Kingdom.

*Training of teachers.*

Recent years have witnessed a great change in the state of public opinion in regard to the professional qualifications of teachers. That teaching is a fine art, that underneath its rules and processes there lie principles which deserve investigation, and that the skilled practitioner is distinguished from the unskilled by his knowledge of the history and philosophy of his art, and of the reasons why some methods of instruction and discipline are right and others are wrong, are truths which are being slowly recognized by public authorities, as well as by teachers themselves. The full appreciation of the importance of training began at the lower end of the social scale. Shuttleworth and Tufnell in 1846 urged the necessity of special training for the primary teacher, and hoped to establish State Training Colleges to supply this want. The opposition of the Churches prevented the fulfilment of this design, and the one college at Battersea which was founded as an experiment was soon transferred to the National Society. Before this, Bell and Lancaster had made arrangements in their model schools for the reception of a few young people to learn the system by practice in the schoolroom, and to pursue their studies in the after hours. In Glasgow, David Stow, who founded in 1826 the Normal Seminary which afterwards became the Free Church College, was one of the first to insist on the need of systematic professional preparation. The religious bodies in England, notably the Established Church, availed themselves promptly of the failure of the central Government, and 12 diocesan colleges for men and 16 for women have been since established. In 1854 the British and Foreign School Society placed their establishments at the Borough Road and Stockwell on a collegiate footing, and subsequently founded other colleges at Swansea, at Bangor, at Darlington and Saffron Walden; the Roman Catholic Church provided two colleges for women and one for men; and the Wesleyans two—one for students of each sex. Other training institutions have since come into being. The newly founded provincial colleges of University rank have been invited by the Education Department to attach normal classes to their ordinary course, and to make provision for special training and for suitable practice in schools for those of their students who desired to become teachers, but who pursue their general literary and scientific studies in common with other learners who are not intending to enter the profession. Thus the Education Department came to recognize two kinds of training institutions—the residential colleges of the old type, and the day colleges attached to institutions of University rank. Both are subsidized by liberal grants from the Treasury, and are regularly inspected. The report of the Department for 1899 showed that in that year there were 3700 students in residence and 1230 day students. As the period of training is two years, these figures show a yearly increment to the ranks of certificated teachers of about 2400. But this supply is insufficient to meet the annual demand; and 28·57 per cent. of masters and 51·18 per cent. of mistresses still enter the profession by serving as assistants and passing the certificate examination, but without receiving regular collegiate training. There is thus still need of more training school accommodation, and this is being gradually furnished by voluntary and municipal effort. But regular provision for training has hitherto been available for elementary teachers only. Fashions, either in social usages or in dress, descend readily from one stratum of society to a lower, but they seldom ascend; and the accident which caused the earliest pedagogic experiments to be tried in connexion with the teachers of primary schools has led to a general impression that training was needed for lower but not for higher educational work. Hence it has happened that only slowly, and not without reluctance, teachers and public authorities have come to the conclusion that a like training and discipline might with great advantage be made available in higher and intermediate schools. The University of Cambridge in 1879 took a step which has had far-reaching consequences in this direction. It entrusted a special syndicate with the duty of providing public lectures on educational principles and practice, and of examining candidates for a special teacher's diploma. Since 1882 the University has awarded certificates in the theory, history, and practice of education to 60 men and 1477 women. The University of London in 1883, and the Victoria University in 1895, instituted similar examinations; and in such great provincial colleges of University rank as have been founded in Manchester, Liverpool, Newcastle, Bristol, Birmingham, Nottingham, Leeds, and Cardiff, as well as in the older Universities, efforts are already made to provide courses of special preparation for secondary as well as for primary teachers. More recently, the University of Oxford has adopted a scheme for granting certificates in education. This scheme, while providing special courses of instruction and a comprehensive syllabus of examination, insists on evidence of regular and continuous practice in teaching under due observation as an indispensable qualification for the University diploma. The two permanent institutions for the training of high school mistresses are the Maria Grey Training College, near London, and the Training College at Cambridge; but several of the leading high schools for girls—notably the Ladies' College at Cheltenham and the Datchelor School at Camberwell—have attached to themselves a training department which is becoming year by year more efficient. These institutions prepare their students for the Teacher's Diploma of either Cambridge or London University. All these movements are symptoms of an increased sense of the need of skilled training for the teacher's profession, and all will be greatly strengthened and encouraged by the clause in the Board of Education Act of 1899 which provides for a public registration of qualified teachers, and for the gradual elimination from the profession of those who are unqualified. But the question will still remain, How and where are the needful qualifications to be obtained, since the Government has not established a Training College of its own, and since it is hardly to be expected that the want will be supplied by the voluntary efforts of societies or by private initiative? In London and some of the larger towns it is already proposed to apply some of the funds available under the Excise Act to the training of teachers. It is to the Universities chiefly that the public has a right to look for at least a partial solution of this difficult problem. Experience is gradually revealing to us the conditions under which those corporations will be able to take an increasing share in the duty of giving professional training to teachers, and thus to render new and signal services to the State. These conditions are: (1) that the function of the teacher shall be recognized as one of the learned professions, and take honourable rank with Law, Medicine, and Theology; (2) that the University shall provide a Professor of Didactics or Pedagogy, whose duty it shall be, by means of post-graduate courses of study and by requiring systematic practice in the art of teaching under due supervision and criticism, to give to the future schoolmaster both a practi-

cal and a theoretical acquaintance with the principles of his profession; (3) that the University shall institute an examination for all students who may have passed through the prescribed course, and that this examination shall set up a high standard of qualification in regard to the practice and the history of education, and to so much of mental and moral philosophy as stands in the closest relation to teaching, whether considered as an art or as a science. The third of these requirements is already fulfilled by Oxford and Cambridge and by most of the English and Scottish Universities, although there is at present no general agreement as to the ideal standard of professional qualifications, or as to the best way of testing these qualifications. In regard to the second of these conditions, the Universities of Edinburgh and St Andrews were enabled, by means of the fund bequeathed by Dr Andrew Bell, to be the first British Universities to create a Professorship of Education; and the Victoria University has lately taken the bold step of establishing a special Chair, whose occupant shall have the same rank as the other Professors of Science or of the Humanities. But until all three of the conditions here described shall have been fulfilled, the British Universities will fail to exercise their legitimate influence on public education, and will neglect a great opportunity of ennobling and liberalizing the teacher's profession.

**Administrative co-operation.** Among the administrative reforms yet needed there is one which will probably engage the early attention of Parliament. Several of the great departments of the public service are incidentally and in a subordinate sense concerned with education, and are at present in no official relation with the central Board of Education. For example, Marine and Dockyard Schools have long been maintained at the various naval stations by the Board of Admiralty, with a view to supply elementary instruction to the children of the sailors and workmen employed at these stations. The supervision of these schools has for many years been entrusted to the Chaplain of the Fleet and to various naval officers. A like arrangement has long prevailed in the army. The Local Government Board, under which the Poor Laws are administered, is necessarily concerned with the maintenance of schools for all the children whose maintenance is chargeable to the rates, and this Board has its own staff of inspectors, both for workhouses and for workhouse schools. The management of industrial and reformatory schools falls within the province of the Home Office, which is responsible for the efficiency of those institutions, but which is in no sense aided or advised by the Board of Education. The newly-constituted Board of Agriculture also is in a position to exercise much influence over rural education. It is manifest that in all those departments of the public service which have been created for other than educational objects, and have nevertheless been incidentally charged with educational responsibilities, there should be established such a *rapport* between them and the Board of Education as would result in a division of labour and in greater administrative simplicity. If all the schools under the care respectively of the War Office, the Admiralty, the Local Government Board, the Home Office, and the Board of Agriculture were subject to the visitation of H.M. Inspectors, and to the same tests and influences by which public elementary schools are yearly controlled and improved, many advantages would accrue. There would be less waste of power; the schools and teachers would benefit by stimulus and comparison; and the several public departments would be relieved of a duty which they are not in a position to fulfil satisfactorily. Moreover, they would yet retain, as recognized local managers, all their present influence in respect of the non-educational and special interests pertaining to the several establishments. The need of such a simple measure of administrative reform has been strongly urged upon the Government by three Departmental Committees or Commissions—that on the Marine and Dockyard Schools, that on the Poor Law Schools, and that on the Reformatory and Industrial Schools; but at present recommendations to this effect have only been adopted in one case, that of the navy. By an agreement, the annual inspection of the Marine Schools and of Greenwich Naval School has been entrusted by the Lords of the Admiralty to the Board of Education, and the result has proved so satisfactory as to furnish a very valuable precedent for future imitation.

**Voluntary efforts needed.** Notwithstanding the far-reaching effect of recent legislation, especially the establishment of a Board of Education charged with the duty of co-ordinating the varied provision for primary, secondary, and technical instruction, there is still, and will probably long remain, ample room for voluntary effort on the part of societies, and for personal initiative on the part of individual thinkers and teachers. The two great societies which took the lead in promoting elementary education—the British and Foreign School Society, founded in 1808, and the National Society for educating the poor in the principles of the Established Church, founded in 1811—still continue to flourish and to render valuable public service, although the area of their useful action is practically restricted to the vindication of the principles which they represent, the encouragement of voluntary effort, and the training of teachers, a work in which both societies, by means of their Normal Colleges, take a leading and effective part. The Roman Catholic Poor School Committee, and the Wesleyan Connexional Committee, are charged with their respective denominational interests, and co-operate heartily with the central government. The *National Association for the Promotion of Secondary and Technical Education* has given a powerful stimulus to public opinion, and has been of special service in furnishing information to County Councils in relation to the duties which the Local Taxation Act cast upon them. Other Voluntary societies have been formed with a view to give greater solidity and corporate life to the teaching profession itself. The *Head Masters' Conference*, which met for the first time at Uppingham in 1869, at the instance of Mr Thring, has become in the course of years very influential, by holding periodical conferences, and by concentrating for the benefit of the schools and of the public at large the experience and knowledge of headmasters of the public schools of the highest rank. Another society, the *Incorporated Association of Head Masters* (1890), admits to membership a larger body of teachers engaged in endowed or other public secondary schools. It numbers 450 members, and in connexion with recent legislation affecting the work of the Board of Education, the registration of teachers, and the organization of higher grade schools, its representations to the Government and to the public have exercised considerable influence. The *Association of Head Mistresses of Endowed and Proprietary Schools* was organized in 1874, with Miss Buss as its first president, and numbers 180 members. Other societies, such as that of *Head Masters of Private Schools*, of *Higher Grade and Science Schools*, and of *Preparatory Schools* respectively, have since been founded, with successful results. The *College of Preceptors*, a chartered society chiefly composed of private teachers, was incorporated in 1849, and was one of the first professional bodies to institute regular courses of pedagogic lectures, and to award after due examination the titles of Licentiate and Associate to teachers. It has also, by means of its

system of examining pupils, given a valuable stimulus to educational progress, especially in many schools which, while distinctly above the rank of elementary, have not availed themselves of the Oxford and Cambridge local examinations. The conferences and discussions which are held at the college during each session have proved of considerable value, both as a help to the members and other teachers in dealing with professional problems, and also as a means of enlisting the attention and sympathy of the general public in relation to these problems. By far the largest of the professional associations is the *National Union of Teachers.* It was established in 1870, and is composed mainly of teachers engaged in public elementary schools. It has 20 district unions, 430 local associations, and nearly 44,000 members; and it holds in turn at each of the great provincial centres an annual conference, generally attended by 1500 members. It has a considerable revenue, and maintains two orphanages, a system of annuities, and a provident fund. Three of its most active officers became Members of Parliament.

All of these are sectional organizations, concerned mainly with the professional interests of one class of teachers. All of them have tended to promote mutual helpfulness and a sense of corporate life among particular groups of members of the teachers' calling. One only of the professional associations has a broader and more comprehensive design. The *Teachers' Guild*, founded in the year 1885, aims at bringing together teachers of both sexes and of all ranks. It has held from time to time many influential public meetings and discussions on questions of educational principles and policy, and it already numbers 4300 members. It has sought from the first to associate in one strong society teachers of all classes; it has concerned itself rather with those problems and discussions which are common to all enlightened teachers alike than with the narrower professional or pecuniary interests of particular classes of teachers or of schools. The combined effect of all these efforts will probably be to raise the profession in public repute and influence. It would be a misfortune, however, if it tended to create a close profession, or to exclude from the ranks of teachers persons distinguished by originality, enthusiasm, and natural aptitude, though unqualified by formal membership. The *National Home Reading Union*, a society which seeks, by the formation of local centres for reading, and by the suggestion of lists of books, to encourage efforts after self-improvement, exercises a beneficent and increasing influence in many parts of England, especially in places and among persons remote from the chief centres of educational activity. It now numbers 13,500 members. The *Working Men's College*, founded in 1854 by Frederic Denison Maurice, and the *College for Working Women* have proved to be the exemplars of many similar institutions in London and the provinces.

**Competition for the public service.**

In estimating the various agencies by which, in England, educational progress has been influenced, it is impossible to overlook the importance of the opening of various employments in the public service to general competition. The number of persons so engaged has increased as new departments have been created and new functions have been assumed by the central Government. The appointment to these offices once rested largely in the hands of the political heads of the several departments, and entailed considerable responsibility. In 1853 Sir Stafford Northcote and Sir Charles Trevelyan reported on the unsatisfactory results of this system, and recommended the formation of a separate and independent Board to test the fitness of candidates for public employment in certain offices. In 1855 the Civil Service Commission was created, and for a time its duties were limited to the holding of qualifying examinations and to the ascertainment of necessary facts respecting age, health, and character. In 1859 the Civil Service of India was thrown open, mainly at the instance of Lord Derby, the Secretary of State for India, and with the energetic support of Macaulay, whose own experience during his four years of office (1834–1838) as legal member of the Supreme Council of India had led him to take great interest in the question. Since that date the principle of open competition has been applied in succession to many branches of the public service. In 1870 an Order in Council made it applicable to home clerkships generally, as well as to many other offices; and more recently candidates for the colonial, the naval, and the military services have been examined by the Civil Service Commissioners. The following statistics are from the report of the Commission for the year 1899:—In all, 38,739 cases have been dealt with, of which 11,478 were those of candidates nominated singly, 4891 were nominated to compete, and 22,360 were examined for open competition. Of these, 3306 succeeded at an open competition, and 7094 in the restricted competition after nomination. The list of offices thus rendered available includes clerkships in the Foreign and Colonial Offices, the Treasury, and the higher departments of the public service, the Indian Civil Service, commissions in the army and navy, surveyors, dockyard schoolmasters, writers, post and telegraph clerks (male and female), and many minor offices in all the Government departments.

The effects of this great revolution in the administrative work of the State are far-reaching, and cannot even yet be fully estimated. The first and most obvious is that thereby Ministers and members of Parliament are saved from much importunity, and from a personal responsibility which it was very difficult for them to exercise with entire fairness and a sole regard to the public interests. The practical abolition of favouritism and of personal patronage in Great Britain has in itself done much to purify the public service and to satisfy the national sense of justice. As a democratic measure, the invitation to persons of all classes, without distinction of rank or social position, to compete on equal terms for honourable employment, has been generally welcomed and valued. There can be little doubt that an effective stimulus has been given to the efforts of many young people towards self-improvement, by the opening of a career as a reward and an encouragement to intellectual merit alone. There remain, however, some questions to which experience has not yet given a final answer, although the evidence which has been already accumulated is weighty and, on the whole, highly encouraging. They are: (*a*) Is the effect of the system to give to the State a more capable and better qualified body of public servants than would be procurable under other conditions? (*b*) What effect has open competition had on the character of the education in the schools and colleges from which the candidates are drawn? and (*c*) How far has it tended to improve or to lower the national estimate of the true worth of education, and its relation to the active business of life? To the first question the answers are not absolutely unanimous. There will always be some cases in which the system of selection by competitive examination appears to be unsatisfactory. But, *exceptis excipiendis*, the general testimony of experience is emphatically favourable, and leads to the conclusion that on the whole the system does succeed in bringing to the front the best men. The warmest advocates of the system cannot, however, overlook its necessary limitations. There are virtues which do not "pay" in examinations, and there are grave faults of character which cannot be detected by any examination, and yet which are not

incompatible with intellectual success. Manliness, courtesy, promptitude, flexibility of mind, a conscientious sense of duty, and a respect for the feelings and the rights of others are all valuable and indeed indispensable attributes for an efficient public officer either in the civil or the military service. But these are precisely the qualities which no conceivable system of examination can adequately test. We can examine only what is examinable. The qualifications which can be tested by examination are accurate knowledge, general intelligence, ability to think and to express the result of thinking in an orderly, coherent, and logical way. These qualifications are not less valuable than the others, and are at least as likely to coexist with them as to be possessed independently. And on this point the judgment expressed by the Civil Service Commissioners in their thirty-third report is on the whole ratified by subsequent experience and by the general verdict of responsible statesmen and of the public. The Commissioners say :—

"We think it sufficient to refer to the reports of the Royal Commission on Civil Establishments, the report of the Public Service Commission (India), and the statements of the military authorities, which show that the persons selected by means of our examinations are well qualified for the public service. The Royal Commissioners on Civil Establishments, in their second report, paragraph 32, say of the lower division clerks: 'As stated in our former report, paragraph 109, we are of opinion that the young men of this grade who have entered the service since the Order in Council of 1876 are of excellent quality and capacity.' This statement is further confirmed by the fact that out of 3241 men clerks appointed between 1876 and 1888 only 23 have been rejected on probation on the score of inefficiency. A favourable opinion is also expressed of the officers of the higher division in paragraph 109 of the first report. The Public Service Commission (India) reports that 'on more than one occasion inquiries have been made by Government into the working of the competitive system, with the result that it has been generally acknowledged to have procured for the ranks of the Indian Civil Service officers who, as a body, are eminently qualified for the performance of the duties which devolve upon them, and many of whom have earned a reputation for administrative capacity of a high order.' They believe themselves to be justified in the conclusion that, 'apart from questions of detail as to the age of candidates, and the subjects, standards, and conditions of examination, the general results of competition, as applied to the India Civil Service, have been satisfactory, and that the system should accordingly be maintained.' We have reason to believe that the military authorities are equally satisfied with the officers who have entered the army by means of our examinations."

The medical officer who in 1900 examined the selected candidates for the Civil Service of India reported most favourably of their physique. He said: "They presented no indication of physical depreciation or damage to be attributed to the influences of study. For the most part they presented the evidence of vigorous health, and bore the stamp of the University and the public school."

The Civil Service Commissioners provide for several grades of examination, which may roughly be described as falling under one of these five heads :—

(1) *University type :* Indian Civil Service and Class I. of the Home Civil Service.
(2) *First Grade or Public School type :* Army and Navy Examinations, *e.g.*, Sandhurst and Woolwich.
(3) *Second Grade School type :* Second division clerks.
(4) *Elementary School type :* Boy copyists and minor offices.
(5) *Technical and Professional groups :* Various special examinations.

The subjects and the scope of these several examinations are in all cases determined by the Commissioners, after full communication with the heads of the various departments concerned and with the Treasury.

It is important to consider the influence exerted by the competitive system on the aims and work of the places of education from which the ranks of public servants are from time to time recruited. At first there was on the part of teachers and professors a disposition, easily explicable, to object to the setting up by any external body of an independent standard of attainment; and the examinations of the Civil Service Commissioners were for nearly thirty years practically ignored by University authorities and by the masters of the great public schools, notwithstanding the great variety of optional subjects offered to candidates. Hence parents who desired to obtain commissions or public employment for their sons were fain to resort to private tutors, who made it their business to understand thoroughly the conditions of success in examination, and who often achieved great success in passing their candidates. They were sometimes vaguely denounced as "crammers," and their methods as contrivances for enabling young learners to deceive the examiners by the appearance without the reality of knowledge, and by crude and hasty efforts of memory rather than by diligent and solid study. There was no doubt some real danger in this direction, a danger from which the Universities themselves, in preparing undergraduates for Honour examinations, are not wholly free. But the best of the private tutors sought to guard against possible evil of this kind, partly by declining to accept as pupils youths who, owing to deficient preliminary training or to any other cause, had no reasonable prospect of success, and partly by insisting on diligent attention to a serious course of study and discipline, such as would enable candidates to systematize and arrange their knowledge and express it in the best form. Nevertheless it has been more and more strongly felt that the break in the continuity of a youth's studies caused by his premature removal from a public school or a University to a private teacher had often an unfavourable effect both on his moral and his intellectual discipline. Hence it has become evident that the standard of qualification required for entrance into the public service ought to be as nearly as possible assimilated to the standard which is attained in a good school. To a large extent this object has been achieved. On the one hand, all the recent policy of the Commissioners has been in favour of taking the course prescribed in the Universities and public schools, from which the candidates are recruited, as the best practical measure of the qualifications which ought to be required at the competitive examination. And on the other hand, the public schools and University authorities have co-operated with the Commissioners by widening their curriculum, and helping to render the services of special tutors outside the schools to a large extent unnecessary, except in the case of special technical departments. On this point the testimony of Dr Magrath, the Provost of Queen's College, and lately the Vice-Chancellor of the University of Oxford, is significant and valuable. He says :—

"I strongly feel that, as at present conducted, the higher of these examinations directly and efficiently contribute to the maintenance of a considerable element of general culture in the studies of those schools in England which keep their pupils to seventeen or beyond. The excessive and unreasonable desire for the introduction of what are called useful, *i.e.*, professional, subjects into all forms of education, from the highest to the lowest, would, I believe, have much more extensively affected the curricula of these schools if the Civil Service Commissioners had not framed their examinations with a view to securing for the higher class of posts in the service those who have received the best general education. It is a curious example of the funny paradoxical way in which we blunder eventually into the best course, that it was not professional educators, or even members of what might be called our educational hierarchy, who have brought about this result, but persons appointed to secure fair play among those who aimed at administrative posts thrown open on the abolition of patronage and favouritism. It is the fact that these posts have been secured to a large extent by lower middle class men who have had the ability and the good fortune to be able to continue their general studies for a longer period than usual, which has set before the parents of such boys an object of ambition on the boys' behalf, which has stimulated these parents to make often very considerable efforts to secure for their sons such educational

advantages as might enable them to compete with some degree of success for these posts; and this result has reached already down to schools of a much lower educational class than could have been supposed to be affected by it. Its effects have been, I think, wholly beneficial."

To this weighty experience may be added that of Dr Warre, the headmaster of Eton, who says, in reference to competition for the army:—

'The army examination has had a very considerable influence here. It has caused the institution of an army class, the aim of which is to send boys straight from the school to Woolwich and Sandhurst, saving them from having to go to a private tutor for special preparation.

"The institution of the army class has reacted distinctly upon the school and its work. Formerly the boys who chose the army for their profession (mostly vigorous and high-spirited lads) were as a rule the idlest and the most difficult to manage, and consequently maintained a low standard of industry and discipline and of interest in their work. The army class has changed all this, and these lads are now among the hardest working and steadiest in the school.

"This has had its effect upon the rest. The consequence, briefly stated, is that the rank and file throughout the school do better as regards work. The general average of work has, in my opinion, distinctly improved in the last ten years, and among the causes I think that the institution of the army class has no small share, and this is therefore due to the public competition for entrance into Woolwich and Sandhurst."

In another great public school—that of St Paul's in London—the master of the army class points out "that although the aim of the form is mainly admission to Woolwich, and is based upon the syllabus of the Woolwich Entrance Examination, not more than two-thirds of the boys are candidates for the army. Others desire to proceed to Cooper's Hill, the City and Guilds of London Technical Institute, or the navy as engineer-students, or to prepare for such examinations as the Institute of Actuaries, in which mathematics play an important part. In respect of the qualities of character and intellect, the army form may be fairly taken as representative of the school as a whole, and discipline is maintained with the same ease. The intimate association of the two elements, the military and the civil, benefits the whole form, and the boys in this department have always taken a prominent part in the athletics of the school." From many quarters other evidence comes showing that, in the opinion of the teachers, the examinations of the Civil Service Commissioners have been much improved, and that as experience grows there is greater similarity in aim and method between the views and plans of good teachers and the requirements of the Civil Service Commissioners.

**Educational literature.**

The last quarter of the 19th century was characterized by considerable activity and productiveness in the literature of education. Except Ascham's *Scholemaster*, Mulcaster's *Positions*, Milton's *Tractate*, and Locke's *Thoughts*, the England of former generations had contributed little to pedagogic theory. But in recent years contributions to the history, the philosophy, and the practice of education have been very numerous in Great Britain as well as in Germany, France, and the United States. For a general bibliography of the subject the student will do well to consult, in German, W. Rein's *Encyclopädisches Handbuch des Pädagogik*, and K. A. Schmid's *Encyclopädia der gesammten Erziehungs- und Unterrichtswesens;* in French, F. Buisson's *Dictionnaire de pédagogie;* and in English, W. S. Munroe's *Bibliography of Education*, Henry Barnard's *English Pedagogy*, and Sonnenschein's *Cyclopædia of Education.* The history of the growth of ideas and theories on education can best be studied in Professor S. Laurie's *Historical Survey of Pre-Christian Education* and *Life of Comenius*, Oscar Browning's *Educational Theories*, H. T. Mark's *Outlines of the History of Educational Theories*, Compayré's *History of Pedagogy*, Mahaffy's *Old Greek Education*, and Donaldson's, Hailmann's, or Joseph Payne's *History of Education*, J. B. Mullinger's *The Schools of Charles the Great*, J. H. Newman's *Rise and Progress of Universities*, R. H. Quick's *Educational Reformers*, J. M. Leitch's *Practical Educationists*, Sir J. K. Shuttleworth's *Four Periods of Education*, Matthew Arnold's article on "Schools" in Humphry Ward's *Reign of Queen Victoria*, and his *Popular Education in France* and official *Reports to the Education Department*, edited by Lord Sandford, Stanley's *Life of Dr Arnold*, Meiklejohn's *Life of Dr Andrew Bell*, Lupton's *Life of Dean Colet*, three *Lives of Pestalozzi*, by De Guimps, Dr Biber, and Karl von Raumer, John Morley's *Rousseau*, J. P. Richter's *Autobiography*, Hugh Miller's *My Schools and Schoolmasters*, Sir Henry Craik's *The State and Education*, the volumes of *Special Reports* issued by the Board of Education, and the series of *Great Educators* published by Heinemann. From the theoretical or speculative as well as the practical side, other additions to educational literature have been Herbert Spencer's *Education; Intellectual, Moral, and Physical*, Bain's *Education as a Science*, Herbart's *Science of Education*, F. Fröbel's *Education of Man*, Pestalozzi's *Leonard and Gertrude*, J. P. Richter's *Levana*, the Reports of the American *Committee of Fifteen*, *Educational Aims and Methods*, and the *Lectures on Teaching*, delivered before the University of Cambridge by the present writer, M. Bréal's *Quelques mots sur l'instruction publique*, Lloyd Morgan's *Psychology for Teachers*, Edward Thring's *Theory and Practice of Teaching* and *Education and the School*, President Eliot's *Educational Reform*, and Professor N. Murray Butler's *The Meaning of Education*, P. A. Barnett's *Common Sense Applied to Education*, and Bernard Bosanquet's *The Education of the Young* (in the *Republic* of Plato). The official Reports of *Royal Commissions*, notably those of the *Schools Inquiry* of 1867, Lord Cross's Commission on *Primary Education*, 1887, and Mr Bryce's Commission on Secondary Instruction, 1894, deserve special attention, and the Annual Reports of the Department now known as the Board of Education will always be found to give the latest financial and other statistical details respecting the number of teachers and scholars in the elementary and other schools under the supervision of that Department.

**The problems of the future.**

At the beginning of the 20th century the outlook on the future of English education is, though somewhat obscure, full of promise. The latest Act of the Government, constituting a central Board with power to co-ordinate the scattered agencies hitherto concerned with public elementary schools, with science and art, and with technical education, as well as with the administration of the Endowed Schools Acts, has possibilities of usefulness in it which are not yet fully realized. It will, it may be hoped, succeed in giving unity of purpose to the whole educational machinery of England, and will define the several duties of the School Boards, the County Councils, and other local authorities, and their relations to the central Government and to each other. It will provide for the information of parents an annual register of qualified teachers and of approved schools. It will furnish large and equal opportunities to promising learners in all classes of the community to pursue their studies and to cultivate their different powers and aptitudes. It will so far stimulate local authorities as to secure that there is as ample a provision of secondary as already exists for primary schools all over England. It will afford to the public a guarantee of efficiency, by means of a judicious combination of inspection with examination, following in this particular the weighty recommendation

of the Royal Commission of 1895. "Education," says the Report (vol. i. p. 120), "needs organization, but it would be destroyed by uniformity: it is stimulated by inspection, but it would be crushed by a Code. In the public service, where the chief object is administrative efficiency, the individual officer is necessarily subordinate; in education, where a chief object is the discovery of more perfect methods of teaching, the individual teacher must be left comparatively free. Every good teacher is a discoverer, and in order to make discoveries he must have liberty of experiment." It is not by larger grants of public money alone that educational progress can be secured. The subsidies already paid out of the Treasury to elementary schools are very liberal, and the various religious bodies cannot reasonably ask for more pecuniary help than they at present receive, unless they are prepared to give their schools a more national character by accepting representatives of the public as colleagues in the management. But public funds for the erection of good secondary, technical, and commercial schools will, however, be needed, and the source from which these funds will be derived, and the constitution of the authority which is to control their administration, have yet to be determined. Endowments for schools and scholarships need to be made still more efficient; they are inadequate in amount, and too capriciously distributed, to supply all modern needs. The parent who does not desire to avail himself of the public elementary school, and whose sons are not likely to succeed in a competitive examination, has still to complain that advanced education is more costly in England than in any other country, and that institutions with moderate fees such as the *Lycées* of France, or the *Realschulen* or the *Gymnasien* of Germany, are not accessible to him. There is therefore room for some further action on the part of the State. But it is not to legislation exclusively, or even mainly, that we must look for the completion of the edifice of public education. That part of the work of the future "which kings or laws can cause or cure" is comparatively a small part. Parliament must in the last resort receive its mandate from the people, and can do little more than seek to fulfil the national ideals. The motive force which we need must be found in a higher and truer popular conception of a liberal education, and of its relation to the formation of character and to the duties of industrial, civic, and family life. That the acquisition of knowledge, though obviously the prominent business of a school, is not the whole of education, and that knowledge consciously directed to the special professional and industrial needs of life is of far less real value than the knowledge which helps to bring out the best powers of the reflective and accomplished man, are truths which are yet imperfectly recognized. We yet need a more general agreement as to the place which the training of the hand and eye, and the constructive and inventive faculties, should hold in a scheme of intellectual culture. And in an age in which merely ecclesiastical influence over public education is waning, we need to hold fast by all such agencies as exist for the cultivation of the spiritual part of man, his emotions, and his aspirations after goodness, and his love of truth. How to cultivate in schools a genuine yet modest patriotism, and a desire to render service in municipal or public life; how to give to parents a stronger interest in the education of their children, and increased opportunities of co-operating with the teachers; how to enlarge the boundaries of educational science, and to give increased freshness and vitality to the methods of instruction—all these are problems which await solution in the 20th century. They were only partially and imperfectly solved in the 19th. (J. G. F.)

## Education in the United States.

***Beginnings.*** The first white settlers who came to North America were typical representatives of those European peoples who had made more progress in civilization than any other in the world. Those settlers, in particular those from England and from Holland, brought with them the most advanced ideas of the time on the subject of education. The conditions of life in the New World emphasized the need of schools and colleges, and among the earliest public acts of the settlers were provisions to establish them. The steps taken between 1619 and 1622 to provide schools for the colony of Virginia were frustrated by the Indian war which broke out in the latter year, and were never successfully renewed during the colonial period. In New York, where the influence of the Dutch was at first predominant, elementary schools were maintained at the public expense, and were intended for the education of all classes of the population. This policy reflected the very advanced views as to public elementary education which were then held in the Netherlands. The assumption of control in the colony of New York by the English was a distinct check to the development of public elementary education, and little or no further progress was made until after the Revolution. The most systematic educational policy was pursued in the colony of Massachusetts. As early as 1635, five years after it was founded, the town of Boston took action to the end that "our brother Philemon Pormort shall be entreated to become schoolmaster for the teaching and nurturing children with us." The General Court of the colony in 1636 made the first appropriation for what was to become Harvard College, taking its name in honour of the minister, John Harvard, who died in 1638, leaving his library and one-half of his property, having a value of £800, to the new institution. The amount of this appropriation of 1636 (£400) was remarkable in that it was probably equal to the whole colony tax for a year. In 1642 followed a legislative Act which, while saying nothing of schools, gave to the selectmen in every town power to oversee both the education and the employment of children. It is made the duty of the selectmen to see that the children can read and understand the principles of religion and the capital laws of the country, and that they are put to some useful work. Five years later, in 1647, was enacted the law which is not only the real foundation of the Massachusetts school system, but the type of later legislation throughout the United States. This epoch-making Act, the first of its kind in the world, represented the public opinion of a colony of about 20,000 persons, living in thirty towns. It required every town of fifty householders to establish a school, the master of which should be paid either by the parents of the children taught or by public tax, as the majority of the town committee might decide; and it further required every town of one hundred families or householders to set up a grammar school in which pupils might be prepared for the "University," as the new institution at Cambridge was designated. Moreover, a penalty was attached to neglect of this legislative requirement, in the form of a fine to be devoted to the maintenance of the nearest school. Horace Mann said of the Act of 1647: "It is impossible for us adequately to conceive the boldness of the measure, which aimed at universal education through the establishment of free schools. As a fact, it had no precedent in the world's history; and, as a theory, it could have been refuted and silenced by a more formidable array of argument and experience than was ever marshalled against any other institution of human origin. But time has ratified its soundness. Two centuries of successful operation now proclaim it to be as wise as it was courageous, and as beneficent as it was disinterested." The significance

of these Acts of 1642 and 1647 is that they foreshadow the whole American system of education, including elementary schools, secondary schools, and colleges, and that they indicate the principles upon which that system rests. These principles as summarized by George H. Martin in his *Evolution of the Massachusetts Public School System* are the following:—(1) The universal education of youth is essential to the well-being of the State. (2) The obligation to furnish this education rests primarily upon the parent. (3) The State has a right to enforce this obligation. (4) The State may fix a standard which shall determine the kind of education and the minimum amount. (5) Public money raised by general tax may be used to provide such education as the State requires. The tax may be general, though the school attendance is not. (6) Education higher than the rudiments may be supplied by the State. Opportunity must be provided at the public expense for youths who wish to be fitted for college. These principles have now found expression in the public Acts of every State, and upon them education in the United States is founded.

*Development.* Despite the praiseworthy attempts made in New York, New Jersey, and Pennsylvania to develop schools and school systems, very little was accomplished in those colonies which was permanent. The sentiment in the more southern colonies was, as a rule, unfriendly to free schools, and nothing of importance was attempted in that section of the country until the time of Thomas Jefferson. Through religious zeal or philanthropy colleges were founded as far south as Virginia, and no fewer than ten of these institutions were in operation in 1776. Their present names and the dates of their foundation are: Harvard University, Massachusetts (1636); College of William and Mary, Virginia (1693); Yale University, Connecticut (1701); Princeton University, New Jersey (1746); Washington and Lee University, Virginia (1749); University of Pennsylvania, Pennsylvania (1751); Columbia University, New York (1754); Brown University, Rhode Island (1764); Rutgers College, New Jersey (1766); and Dartmouth College, New Hampshire (1770). In the colleges the ecclesiastical spirit was at first almost uniformly dominant. The greater number of their students were preparing for the ministry in some one of the branches of the Protestant Church. These facts caused the grammar schools to take on more and more the character of college-preparatory schools; and when this was brought about they supplied the educational needs of but one portion of the community. As time passed, the interdependence of governmental and ecclesiastical interests began to weaken in the colonies, and there arose among those who represented the new secularizing tendency a distrust of the colleges and their influence. This gave rise to a new and influential type of school, the academy, which took its name from the secondary schools established in England by the dissenting religious bodies during the latter part of the seventeenth century at the suggestion of Milton. These academies were intended to give an education which was thought to be more practical than that offered by the colleges, and they drew their students from the so-called middle classes of society. The older academies were usually endowed institutions, organized under the control of religious organizations or of self-perpetuating boards of trustees. Their programme of studies was less restricted than that of the grammar schools, and they gave new emphasis to the study of the English language and its literature, of mathematics and of the new sciences of nature. For two generations the academies were a most beneficent factor in American education, and they supplied a large number of the better-prepared teachers for work in other schools. These schools were in a sense public in that they were chartered, but they were not directly under public control in their management. Early in the 19th century there arose a well-defined demand for public secondary schools—high schools, as they are popularly known. They were the direct outgrowth of the elementary school system. Boston, Philadelphia, Baltimore, and New York were the first of the large cities to establish schools of this type, and they spread rapidly. These public secondary schools met with opposition, however, springing partly from the friends of the academies, and partly from those who held that governmental agency should be restricted to the field of elementary education. The legal questions raised were settled by a decision of the Supreme Court of Michigan, which contained these words: "Neither in our State policy, in our constitution, nor in our laws do we find the primary school districts restricted in the branches of knowledge which their officers may cause to be taught, or the grade of instruction that may be given, if their voters consent, in regular form, to bear the expense and raise the taxes for the purpose." This decision gave marked impetus to the development of public secondary, or high schools, and they have increased rapidly in number. The academies have relatively declined, and in the Western States are almost unknown.

Meanwhile the elementary school system had grown rapidly. The school district, the smallest civil division, was created in Connecticut in 1701, in Rhode Island about 1750, and in Massachusetts in 1789. From the point of view of efficient, well-supported schools, it has been felt since the time of Horace Mann that the substitution of the small school district for the town as the unit of school administration was a mistake. Yet the school district has exercised a profound influence for good upon the American people. In New York State, for example, there were in 1900 over eleven thousand school districts, and in Illinois over twelve thousand. The districts are small in extent and often sparsely settled. Their government is as democratic as possible. The resident legal voters, often including women, hold a meeting at least once a year. They elect trustees to represent them in the employment of the teacher and the management of the school. They determine whether a new schoolhouse shall be built, whether repairs shall be made, and what sum of money shall be raised for school purposes. In the rural districts this system has often been itself a school in patriotism and in the conduct of public affairs. Recently the tendency is to merge the school districts into the township, in order that larger and better schools may be maintained, and that educational advantages may be distributed more evenly among the people. Most of the Southern states have the county system of school administration. This is because the county, rather than the township, has been the political unit in the South from the beginning. Special laws have been made for the school system in cities, and the form of these laws differs very much. In nearly every city there is a separate board of education, sometimes chosen by the voters, sometimes appointed by the mayor or other official, which board has full control of the schools. The city board of education has as its executive officer a superintendent of schools, who has become a most important factor in American educational administration. He exerts great influence in the selection of teachers, in the choice of text-books, in the arrangement of the programme of studies, and in the determination of questions of policy. Sometimes he is charged by law with the initiative in some or all of these matters. He is usually a trained administrator as well as an experienced teacher. The first superintendent was appointed in 1837 at Buffalo. Providence followed in 1839, New Orleans in 1841, Cleveland in 1844, Baltimore in 1849, Cincinnati in 1850, Boston in 1851, New York, San Francisco, and Jersey City in 1852, Newark and

Brooklyn in 1853, Chicago and St Louis in 1854, and Philadelphia in 1883. In general, it may be said that the progress of public education in the United States is marked by (1) compulsory schools, (2) compulsory licensing of teachers, (3) compulsory school attendance, and (4) compulsory school supervision, and by the increasingly efficient administration of these provisions. The compulsion comes in each case from the State government, which alone, in the American system, has the power to prescribe it and to enforce it. Each one of the 45 States is therefore an independent educational unit, and there is no single, uniform American system of education in any legal sense. In fact, however, the great mass of the American people are in entire agreement as to the principles which should control public education; and the points in which the policies of the several States are in agreement are greater, both in number and in importance, than those in which they differ. An American educational system exists, therefore, in spirit and in substance, though not in form.

***National policy.***

Neither in the Declaration of Independence nor in the Constitution of the United States is there any mention of education. The founders of the nation were by no means indifferent to education, but they shared the common view of their time, which was that the real responsibility for the maintenance of schools and the expense of maintaining them should fall upon the several local communities. The relation of government to education was not then a subject of ordinary consideration or discussion. Later, when this question did arise and the power of taxation was involved, the several States assumed control of education, as it was necessary that they should do. Nevertheless, from the very beginning the national government has aided and supported education, while not controlling it. This policy dates from 13th July 1787, when there was passed the famous "Ordinance for the Government of the Territory of the United States North-West of the River Ohio," meaning the territory north and west of the Ohio river now represented by the states of Ohio, Indiana, Illinois, Michigan, Wisconsin, and the eastern side of Minnesota, embracing more than 265,000 square miles of territory. This Ordinance contains this declaration: "Religion, morality, and knowledge being necessary to good government and the happiness of mankind, schools and the means of education shall for ever be encouraged." The Ordinance of 1787 also reaffirmed the provisions of the so-called Land Ordinance of 1785, by which section No. 16 in every township (a township consists of 36 numbered sections of one square mile each), or one thirty-sixth of the entire North-West Territory, was set aside for the maintenance of public schools within the township. The funds derived from the sale and lease of these original "school lands" form the major portion of the public school endowment of the States formed out of the North-West Territory. The precedent thus established became the policy of the nation. Each State admitted prior to 1848 reserved section No. 16 in every township of public land for common schools. Each State admitted since 1848 (Utah being an exception, and having four sections) has reserved sections No. 16 and No. 36 in every township of public lands, for this purpose. These national grants of land in aid of common schools amount to 67,893,919 acres. In addition, the national government has granted two townships in every State and Territory containing public lands for seminaries or universities. These grants amount to 1,165,520 acres. A third land grant is that made in 1862 for colleges of agriculture and the mechanical arts; this amounts to 9,600,000 acres. The sum total of these three land grants is 78,659,439 acres, to which there must be added various special grants made from time to time to the States and devoted to education. The portion of the public domain so set apart amounts in all to 86,138,473 acres, or 134,591 English square miles. This is an area greater than those of the six New England States, New York, New Jersey, Maryland, and Delaware added together. It is a portion of the earth's surface as great as the kingdom of Prussia, about seven-tenths as great as France, and considerably greater than the combined areas of Great Britain (including the Channel Islands) and the kingdom of Holland. Besides the enormous grants of land in aid of education, the national government has maintained since 1802 a military academy at West Point, New York, for the training of officers for the army, and since 1845 a naval academy at Annapolis, Maryland, for the training of officers for the navy. It has also taken charge of the education of the children of uncivilized Indians, and of all children in Alaska. It has voted, by Act of 1887, a perpetual endowment of $15,000 a year for each agricultural experiment station connected with a State agricultural college, and, by Act of 1890, an additional endowment of $25,000 a year for each of the agricultural colleges themselves. The aggregate value of land and money given by the national government for education in the several States and Territories is about $300,000,000.

***Bureau of education.***

In 1867 the Congress established a bureau of education, presided over by a Commissioner who is under the jurisdiction of the Secretary of the Interior, the purpose of which is declared to be to collect "such statistics and facts as shall show the condition and progress of education in the several States and Territories, and of diffusing such information respecting the organization and management of school systems and methods of teaching as shall aid the people of the United States in the establishment and maintenance of efficient school systems, and otherwise promote the cause of education throughout the country." The bureau has therefore no direct power over the educational policy of the several States. It has, however, exercised a potent influence for good in its advisory capacity. Up to 1900 this bureau had published 360 separate volumes and pamphlets, including 31 annual reports, covering from 800 to 2300 pages each. These are standard works of reference, and are distributed gratuitously in large numbers to libraries, school officials and other persons interested, and to foreign Governments. The several commissioners of education have been: Henry Barnard of Connecticut, 1867–1870; John Eaton of Ohio, 1870–1886; Nathaniel H. R. Dawson of Alabama, 1886–1889; William T. Harris of Massachusetts, 1889 to date.

***State governments and education.***

In the United States the sovereign powers are not all lodged in one place. Such of those powers as are not granted by the Constitution to the national government are reserved to the States respectively, or to the people. The power to levy taxes for the support of public education has been almost universally held to be one of the powers so reserved. The inhabitants of the several local communities, however indisposed they may have been to relinquish absolute control of their own schools, have been compelled to yield to the authority of the State government whenever it has been asserted, for except under such authority no civil division—county, city, township, or school district—possesses the power to levy taxes for school purposes. Moreover, since the exercise of State authority has uniformly improved the quality of the schools, it has usually been welcomed, not resisted. In general, it may be said that the State has used its authority to prescribe a minimum of efficiency which schools and teachers must reach, and it enforces this minimum through inspection

and the withholding of its proper share of the State school fund from any locality where schools or teachers are permitted to fall below the required standard. In extreme cases the State authorities have interfered directly to prevent the evil results of local inefficiency or contumacy. In addition, the States, almost without exception, maintain at their own expense schools for the training of teachers, known as normal schools. Many of the States also offer inducements to the cities, towns, and districts to exceed the prescribed minimum of efficiency. Through the steady exercise of State supervision the school buildings have improved, the standard for entrance upon the work of teaching has been raised, the programme of studies has been made more effective and more uniform, and the length of the school term has increased. The Constitution of every State now contains some provision as to public education. Each State has an executive officer charged with the enforcement of the State school laws. Sometimes, as in New York, this official has plenary powers; sometimes, as in Massachusetts and Ohio, he is little more than an adviser. In twenty-nine States this official is known as the superintendent of public instruction; in Massachusetts and Connecticut he is called secretary of the State board of education; other titles used are commissioner of public schools, superintendent of common schools, and superintendent of public schools. The schools are administered, on behalf of the taxpayers, by an elected board of school trustees in rural school districts, and by an elected (though sometimes appointed) board of education or school committee in cities and towns. In 836 cities and towns there is a local superintendent of schools, who directs and supervises the educational work and acts as the executive officer of the board of education. The schools in the rural districts are under the direct supervision of a county superintendent of schools or similar official, who is often chosen by the people, but who sometimes is named by the State authorities. The county and city superintendents are often charged with the duty of holding examinations for entrance upon the work of teaching, and of issuing licences to those persons who pass the examinations. This system works best where it is carefully regulated by State law. Thirty States, one Territory, and the District of Columbia have enacted compulsory education laws, but the enforcement of them is usually very lax. In fifteen States and Territories there are no compulsory education laws, although there are in existence there fully organized school systems free to all children. The usual age during which school attendance is required is from 8 to 14. Provision is made in Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Indiana, Minnesota, and Michigan, for sending habitual truants to some special institution. Laws forbidding the employment of children under a specified minimum age in any mercantile or manufacturing establishment are in force in twelve States, and are usually administered in connexion with the compulsory education laws. The universal establishment of public secondary schools (high schools), and the existence of State universities in all of the States south and west of Pennsylvania, has brought into existence a system of State education which reaches from the kindergarten and the elementary school to the graduate instruction offered at State colleges and universities. This system includes (1) about 1500 free public kindergartens scattered over fifteen States; (2) free public elementary schools within reach of almost every home in the land; (3) free public secondary schools (high schools) in every considerable city or town and in not a few rural communities; (4) free land grant colleges, supported in large part by the proceeds of the nation's endowment of public lands, paying particular attention to agriculture and the mechanical arts, in all the States; (5) State universities, free or substantially so, in all the States south and west of Pennsylvania; (6) free public normal schools, for the professional training of teachers, in every State except Nevada and Wyoming, and in every Territory except Indian Territory; (7) free schools for the education of defectives in nearly all the States; and (8) the national academies at West Point and Annapolis for the professional training of military and naval officers respectively.

*Kindergartens.*

Miss Susan E. Blow, herself the leading exponent of kindergarten principles in the United States, has pointed out that the history of the kindergarten movement reveals four distinct stages in its development: the pioneer stage, having Boston as its centre; the philanthropic stage, which began in the village of Florence, Mass., and reached its climax at San Francisco, California; the national or strictly educational stage, which began at St Louis; and the so-called maternal stage, which from Chicago as a centre is spreading over the entire country. During the first stage public attention was directed to a few of the most important aspects of Froebel's teaching. During the second stage the kindergarten was valued largely as a reformatory and redemptive influence. During the third stage the fundamental principles underlying kindergarten training were scientifically studied and expounded, and the kindergarten became part of the public school system of the country. The fourth stage, which, like the third, is fortunately still in existence, aims at making the kindergarten a link between the school and the home, and so to use it to strengthen the foundations and elevate the ideals of family life. In 1898 there were 4363 kindergartens in the United States (1365 of which were public), employing 9937 teachers (2532 in the public kindergartens) and enrolling 189,604 children (95,867 in the public kindergartens). Of the 164 public normal schools, 36 make provision for training kindergarten teachers. The scientific and literary activity of some of the private kindergarten training classes is very great, and they exert a beneficial and stimulating effect on teaching in the elementary schools. It is generally admitted that from the point of view of the children, of the teachers, of the schools, and of the community at large, the kindergarten has been and is an inspiration of incalculable value.

*Elementary schools.*

The elementary school course is from six to nine years in length, the ordinary period being eight years. The pupils enter at about six years of age. In the cities the elementary schools are usually in session for five hours daily, except Saturday and Sunday, beginning at 9 a.m. There is an intermission, usually of an hour, at midday, and short recesses during the sessions. In the small rural schools the pupils are usually ungraded, and are taught singly or in varying groups. In the cities and towns there is a careful gradation of pupils, and promotions from grade to grade are made at intervals of a year or of a half-year. The best schools have the most elastic system of gradation and the most frequent promotions. In a number of States there are laws authorizing the conveyance of children to school at the public expense, when the schoolhouse is unduly distant from the homes of a portion of the school population. Co-education of the sexes in the elementary school is the salutary and almost uniform practice in the United States. Fewer than 6 per cent. of the cities offer exceptions to this rule, and in most of these the separation of boys and girls has arisen from the position or original arrangement of the school buildings, and is likely to be discontinued under more favourable conditions. The programme of studies in the elementary school includes English (reading, writing, spelling, grammar, composition), arithmetic (sometimes elementary algebra

also, or plane geometry in the upper grades), geography, history of the United States, and elementary natural science, including human physiology and hygiene. Physical training, vocal music, drawing, and manual training are often taught. Sometimes a foreign language (Latin, German, or French) and the study of general history are begun. Formal instruction in manners and morals is not often found, but the discipline of the school offers the best possible training in the habits of truthfulness, honesty, obedience, regularity, punctuality, and conformity to order. Religious teaching is not permitted, although the exercises of the day are often opened with reading from the Bible, the repetition of the Lord's Prayer, and the singing of a hymn. Corporal punishment is not infrequent, but is forbidden by law in New Jersey, and in many States may be used only under restrictions. Text-books are used as the basis of the instruction given, and the pupils "recite" in class to the teacher, who, by use of illustration and comment, makes clear the subject-matter of the prescribed lesson. The purpose of the recitation method is to make the work of each pupil help that of his companion. Skilfully used, it is the most effectual instrument yet devised for elementary school instruction. In 1897–98 there were 14,589,036 pupils enrolled in the public elementary schools. The average length of the school term was 143·1 days. There were about 380,000 teachers engaged in the elementary schools. About 1,250,000 pupils were at the same time receiving elementary instruction in private or parochial schools.

***Secondary schools.***

The secondary school course is normally four years in length. The principal subjects studied are Latin, Greek, French, German, algebra, geometry, physics, chemistry, physical geography, physiology, rhetoric, English literature, civics, and history. Although but 11·36 per cent. of the students in public high schools, and 25·36 per cent. of those in private secondary schools, are preparing for a college or scientific school, yet the conditions prescribed by the colleges for admission to their courses affect powerfully both the secondary school programme and the methods of teaching. Of late years no educational topic has been more widely discussed than that as to the proper relations of secondary schools and colleges. As a result, special examinations for admission to college are either greatly simplified or entirely abolished, and the secondary studies are much more substantial and better taught than formerly. An increasing proportion of secondary school teachers are college graduates. In 1897–98 there were 5315 public secondary schools and 1990 private secondary schools, or 7305 in all. In these schools 27,298 teachers were employed, 14,681 of them being women. The secondary school students numbered 554,825, of whom 449,600 were in public high schools. The boys numbered 241,359 and the girls 313,466. The most extraordinary characteristic of secondary education in recent years is the rapid increase in the number of students taking Latin as a school subject. In nine years the number of such students has increased from 100,144 (33·62 per cent. of the total) to 274,293 (49·44 per cent.). Meanwhile the proportion of those studying physics and chemistry has fallen off slightly. The rate of increase in the number of pupils who study Latin is fully twice as great as the rate of increase in the number of secondary school students. Between 1890 and 1896, while the number of students in private secondary schools increased 12 per cent., the number of students in public secondary schools increased 87 per cent. Since 1894 the number of students in private secondary schools has steadily declined. In 1897–98 there were 34 public high schools for boys only, 29 for girls only, and the remainder (5252) were co-educational. In the same year there were 351 private secondary schools for boys only, 537 for girls only, and 1212 which were co-educational.

***The colleges.***

The American college, although it is the outgrowth of the English colleges of Oxford and of Cambridge, has developed into an institution which has no counterpart in Europe. The college course of study, at first three years in length, was soon extended to four years, and the classes are uniformly known as the freshman, the sophomore, the junior, and the senior. Whether or not, in view of changed educational and social conditions, a college course of four years is not too long is a question now under serious discussion. The traditional degree which crowns the college course is that of Bachelor of Arts (A.B.). The studies ordinarily insisted on in the case of candidates for this degree are Latin, Greek, mathematics, English, philosophy, political economy, history, at least one modern European language (French or German), and at least one natural science. The degrees of Bachelor of Science (B.S.), Bachelor of Philosophy (Ph.B.), and Bachelor of Letters (B.L.) are often conferred by colleges upon students who have pursued systematic courses of study which do not include Greek or the amount of Latin required for the degree of Bachelor of Arts. The best colleges give instruction which is similar in character to that given in Germany in the three upper classes of the gymnasium and in the introductory courses at the universities, in France in the two upper classes of the lycée and in the first two years of university study, and in England in the upper form of the public schools and during the years of undergraduate residence at Oxford and Cambridge. Since 1870 the colleges have developed enormously. Their resources have multiplied, the number of their students has increased by leaps and bounds, the programme of studies has broadened and deepened, the standards have been raised, and the efficiency of the instruction has greatly increased. Rigidly prescribed courses of study have given way to elective courses, and a knowledge of Greek is no longer required for the degree of A.B. at such influential colleges as Harvard, Columbia, Cornell, and Williams. A strong effort is being made to have the leading colleges give but one degree, that of Bachelor of Arts, and to confer that upon those who complete any substantial course of college studies. A marked change has taken place in the attitude of the college authorities toward the students. A generation ago the college president was a paterfamilias. He knew each student and came into direct personal contact with him. The president and the faculty had supervision not only of the studies of the students, but of their moral and religious life as well. The older type of college professor was not always a great scholar, but he was a student of human nature, with keen intuitions and shrewd insight. The new type is more scholarly in some special direction, often regards teaching as a check upon opportunities for investigation, and disdains troubling himself with a student's personal concerns or intellectual and moral difficulties. The change has not been altogether for the better, and a desirable reaction is now under way. Each college, however small or ill-equipped, exercises a helpful local influence. Ninety per cent. of all college students attend an institution not more than one hundred miles from their own homes. Few colleges have a national constituency, and even in these cases an overwhelming preponderance of the students come from the immediate neighbourhood. This explains, in a measure, the powerful influence which the college has exercised in the life of the nation. While hardly more than one in a hundred of the white male youth of the country has had a college education, yet the college graduates have furnished one-half of all the Presidents of

the United States, most of the justices of the Supreme Court, about one-half of the Cabinet officers and United States senators, and nearly one-third of the House of Representatives. Before the Revolution eleven colleges were founded. From 1776 to 1800, twelve more were added; from 1800 to 1830, thirty-three; from 1830 to 1865, one hundred and eighty; from 1865 to 1898, two hundred and thirty-six. The present total is 472. Their standards, efficiency, and equipment are very diverse, many of the so-called colleges being less effective than some of the better organized secondary schools. Except in New York and Pennsylvania, there is no statutory restriction upon the use of the name college. This is an abuse which is beginning to attract public attention. The number of undergraduate collegiate and technical school students has increased from 573 to each million of inhabitants in 1872, to 1193 in 1898. In 1897 the whole number of professedly collegiate students enrolled in colleges for men, for women, and for both sexes was 84,955, of whom 52,439 were men. There was, therefore, one college student to each 831 of population. There are 114 colleges, exclusive of those for women, enrolling 31,941 students, and as a rule possessing the largest endowments, which are under no ecclesiastical control. Fifty-nine colleges, enrolling 5954 students, are Roman Catholic. Two hundred and eighty-four, enrolling 29,104 students, are under the control of some one of the Protestant denominations.

*The universities.*

In the United States the title "university" is used indiscriminately of institutions which are in reality universities, of institutions which are colleges, and of institutions which are so ill-equipped as not to take rank with good secondary schools. Only time and a greatly increased capacity to distinguish the various types of higher schools will remedy this error. Putting aside tentative and unsuccessful attempts to develop genuine university instruction much earlier, it may safely be said that the opening of the Johns Hopkins University at Baltimore in 1876 began the present movement to organize carefully advanced study and research, requiring a college education of those who wish to enter upon it. This is university instruction properly so-called, and though found elsewhere, it is given chiefly at fourteen institutions: California University, Catholic University of America, Chicago University, Clark University, Columbia University, Cornell University, Harvard University, Johns Hopkins University, Michigan University, Pennsylvania University, Princeton University, Stanford University, Wisconsin University, and Yale University. All of these institutions, except the Catholic University and Clark University, are also colleges. The combination of collegiate and university instruction under one corporation and one executive administration is distinctive of higher education in the United States, and its chief source of strength. The crowning honour of the university student is the degree of Ph.D., although that of A.M.—obtainable in less time and much easier conditions—is also sought. The minimum period of study accepted for the degree of Ph.D. is two years after obtaining the bachelor's degree; but in practice, three, and even four, years of study are found necessary. In addition to carrying on an investigation in the field of his main subject of study, the candidate for the degree of Ph.D. is usually required to pass examinations on one or two subordinate subjects, to possess a reading knowledge of French and German (often of Latin as well), and to submit—usually in printed form—the dissertation which embodies the results of his researches. The methods of instruction in the universities are the lecture, discussion, and work in laboratory or seminary—the latter transplanted from the German universities. The degree of Master of Arts is conferred upon students who, after one year of university residence and study, pass certain prescribed examinations. This degree, like those of D.D., S.T.D., and LL.D., is often conferred by colleges and universities as a purely honorary distinction. The degree of Ph.D. is not so conferred any longer by the best universities. Not a few of the universities maintain schools of law and medicine. Harvard and Yale universities maintain schools of theology as well. The learned publications issued by the universities, or under the direction of university professors, are of great importance, and constitute an imposing body of scientific literature. The national and State governments make increasing use of university officials for public service requiring special training or expert knowledge. In 1871–72 there were only 198 resident graduate (or university) students in the United States. In 1887 this number had risen to 1237, and in 1897 to 4392. These figures are exclusive of professional students, and include only those who are studying in what would be called, in Germany, the philosophical faculty. (See also UNIVERSITIES.) Most extensive provision is made for professional, technical, and special education of all kinds, and for the care and training of the dependent and defective classes, as well as for the education of the Indian and—in the Southern states—of the negro.

The most complete exposition of education as it now exists will be found in Butler, *Education in the United States*, Albany, N.Y., 1900, a series of nineteen monographs which, taken together, cover the whole educational activity of the United States, prepared for the Government educational exhibit at the Paris Exposition of 1900. The official Reports, issued annually, of the Commissioner of Education, at Washington, contain the latest and most authoritative educational statistics of every sort. They also include treatises on special topics, and are indispensable works of reference. The only historical sketch is Boone's *History of Education in the United States*, New York, 1889. Martin, *Evolution of the Massachusetts School System*, New York, 1894, is accurate and valuable. Contemporary discussions of educational topics of interest are provided from year to year in the published *Proceedings* of the National Educational Association, a voluntary organization of teachers of every grade. (N. M. B.)

**Edward VII.** (ALBERT EDWARD), King of Great Britain and Ireland, and of the British Dominions beyond the Seas, Emperor of India, (1841– ——), the eldest son and second child of Queen Victoria and of Albert, Prince Consort, was born at Buckingham Palace on 9th November 1841. He was created prince of Wales and earl of Chester on 4th December following, and was baptized by the archbishop of Canterbury on 25th January 1842. In his childhood he was carefully educated, under the immediate supervision of the Queen, by the Dowager Lady Lyttelton, governess of the royal children; and in his boyhood successively by the Rev. Henry Mildred Birch, formerly an assistant master at Eton, and by Mr F. W. Gibbs, assisted by the Rev. C. F. Tarver and Mr Herbert W. Fisher. He afterwards resided successively at Edinburgh, studying chemistry in its industrial applications under Professor (afterwards Lord) Playfair at the University; at Christ Church college, Oxford; and at the University of Cambridge, where he was a student at Trinity under Dr Whewell. In November 1858 he was made a Knight of the Garter, and received a commission as colonel in the army, ascending in due time to the rank of field-marshal. In 1859 he travelled in Italy and Spain, returning to pursue his studies at the universities, and availed himself of the long vacation of 1860 to pay a visit, under the incognito of "Lord Renfrew," to the United States, where he was received with cordiality, and to Canada, which welcomed him with enthusiasm. The duke of Newcastle, secretary of state for the colonies, acted as his guide and

H.M. King Edward VII.

*(Photograph by W. and D. Downey, London.)*

From an original graciously selected by His Majesty for the New Volumes.

mentor upon this occasion. Upon the completion of his Cambridge course in June 1861 he joined the camp at the Curragh, where he acquainted himself with the details of military duty. While thus engaged he was, in common with the entire nation, overwhelmed by the unexpected death of his father, 13th December 1861, after a very brief illness. For long the prince remained in absolute seclusion, but in 1862 fulfilled a wish of the deceased Prince Consort by undertaking a tour in the Holy Land under the guidance of Arthur Penrhyn Stanley, afterwards dean of Westminster, who had already travelled in the East and written *Sinai and Palestine*. The travellers departed in February and returned in June. Stanley's *Sermons preached in the East* was among the fruits of their expedition. Early in 1863 the prince was sworn of the Privy Council, and took his seat in the House of Lords as duke of Cornwall. About the same time the estate of Sandringham, in Norfolk, was purchased for him out of the savings of his minority. His town residence was fixed at Marlborough House. His impending marriage to the Princess Alexandra, daughter of Christian IX., king of Denmark (born 1st December 1844), had already been announced, and took place on 10th March in St George's Chapel, Windsor. From her first appearance on British soil the princess captivated the heart of the nation, and Tennyson uttered the public sentiment when he sang, in his ode as poet-laureate, "We are all of us Danes in our welcome of thee." Parliament granted the prince an income of £40,000 a year, exclusive of the revenues of the duchy of Cornwall, and he relinquished his right of succession to the duchy of Saxe-Coburg-Gotha. Prince Albert Victor, afterwards duke of Clarence, was the first offspring of the marriage, being born on 17th January 1864. The births followed of Prince George Frederick Ernest Albert, duke of York, born 3rd June 1865; Princess Louise Victoria Alexandra Dagmar, by marriage duchess of Fife, born 20th February 1867; Princess Victoria Alexandra Olga Mary, born 6th July 1868; and Princess Maud Charlotte Mary Victoria, born 26th November 1869, married to Prince Charles, second son of the Crown Prince of Denmark. From the time of their marriage the prince and princess were more conspicuously before the country than had ever before been the case with any princely pair of the same position. The deep affliction of the widowed sovereign, and the burden of public care which she was now compelled to undertake, unrelieved by the participation of her mainstay and chief adviser, incapacitated her for the performance of most of the social functions of Royalty. The prince and princess of Wales stepped forward to fill her place, and by their tact and the affability of their bearing, and their diligence and punctuality in satisfying every public claim, frequently at great inconvenience to themselves, contributed not a little to that general popularity of the British monarchy among all classes which has proved so important a factor in national politics. The prince's readiness to promote every worthy cause was most marked; no one was a more constant attendant at the meetings and gatherings for objects of public utility in which his position as a prince of the blood royal would permit him to take part, and his speeches were always most effective from their excellent sense and clear enunciation. The most important external event of these years was a tour to Egypt, undertaken in 1869 in company with the duke of Sutherland, Sir Samuel Baker, and others, an account of which was published by Mrs William Grey. The prince also visited Ireland more than once, and opened the International Exhibition of 1871.

On 23rd November 1871 it was announced that the prince would be prevented from paying a visit which had been arranged to the Maharajah Dhuleep Singh by a feverish attack. It soon appeared that the malady was typhoid, contracted, as was supposed, on a visit to Scarborough. The case became so serious that on 29th November the Queen and Princess Alice hurried to Sandringham, where the prince had repaired on feeling the first symptoms of illness. On 1st December there was a slight rally, but on 8th December so serious a relapse occurred that all the royal family came to Sandringham, and for some days the prince's life was despaired of. Under the skilful treatment of Sir William Jenner, Sir William Gull, and Sir James Paget, however, the crisis was surmounted by 16th December, and by Christmas Day the danger was regarded as virtually over. On 27th February 1872 a public thanksgiving was held at St Paul's, amid the most imposing and most affecting demonstrations of public joy and gratitude throughout the empire. The importance attaching to the life of the heir to the Throne was emphasized by the consciousness of his danger and his escape. A republican agitation, indeed, which had seemed to be gathering strength throughout the year in connexion with labour disputes, collapsed entirely, and has never been revived.

In January 1874 the prince of Wales attended the marriage at St Petersburg of his brother, the duke of Edinburgh, with the Grand Duchess Marie of Russia. In the same year he paid a historic visit to Birmingham, where Mr Joseph Chamberlain, not yet a member of Parliament, received him officially as mayor. In March 1875 it was officially announced that he would make a visit to India, carrying out an idea originally conceived by the first Indian viceroy, Earl Canning. He was supposed to travel as heir-apparent, not as representative of the Queen; but the characters could not be kept apart, and in fact the prince's visit was a political event of great importance. Leaving England on 11th October, he was received at Bombay by the viceroy, Lord Northbrook. Here he met a very large number of Indian feudatory princes, whose acquaintance he subsequently improved by visiting at their courts during the seventeen weeks which he spent in the country. During these four months the prince travelled nearly 8000 miles by land and 2500 miles by sea, became acquainted with more rajahs than had all the viceroys who had reigned over India, and saw more of the country than any living Englishman. The rajahs were enchanted by his tact and urbanity. The visit, moreover, led up, as was probably intended, to the Queen's assumption of the title of empress of India in the following year.

The prince's life after this date was full of conspicuous public appearances. In 1885 he visited Ireland at a time of much political excitement, and was received enthusiastically in many quarters and without symptoms of ill-will in any. In 1886 he filled the presidency of the Indian and Colonial Exhibition, opened the Mersey Tunnel, and laid the first stone of the Tower Bridge. In 1887 a large share of the arrangements for the Queen's Jubilee devolved upon him. On 27th July 1889 his eldest daughter, Princess Louise, was married to the duke of Fife. In the autumn he paid a semi-incognito visit to Paris, where he has always been highly popular, viewed the Exhibition, and ascended the Eiffel Tower. In 1890 he opened the Forth Bridge. On 14th January 1892, however, a heavy blow fell upon him and his house by the death of his eldest son, Prince Albert Victor, duke of Clarence and Avondale, after only five days' illness. The young prince, who with his brother had made the tour of the world in H.M.S. *Bacchante*, and after a short career at Oxford and Cambridge was just settling down to play his part in public life, had recently become engaged to Princess Victoria Mary of Teck (born 26th May 1867), and the popularity of the

heir to the Crown had been increased by the expression of his satisfaction at his son's union to an Englishwoman. On 6th July 1893 the broken thread was reunited by the marriage of the princess (popularly known as Princess May) to the brother of the deceased prince, George Frederick, duke of York.

The year 1894 was a busy one for the prince of Wales, who became a member of the Royal Commission on the Housing of the Poor, opened the Tower Bridge, attended the Welsh Eisteddfod and was duly initiated, and paid two visits to Russia—one on the marriage of the Grand Duchess Xenia, the other on the death of the Tsar, his brother-in-law. In 1896 he became first Chancellor of the University of Wales, and his first act after his installation at Aberystwith was to confer an honorary degree upon the princess. He had already been for some years a trustee of the British Museum, and participated actively in its administration. On 22nd July 1896 the prince's third daughter, Princess Maud, was married to Prince Charles of Denmark. The arrangements for the Queen's Jubilee of 1897 depended upon the prince even more than those of the corresponding celebration in 1887: he rode on the Queen's right at the great procession to St Paul's, and as an Admiral of the Fleet presided at the naval review at Spithead, a spectacle unparalleled in the history of the world. In July 1898 the prince had the misfortune to fracture his knee-cap while on a visit to Baron Ferdinand de Rothschild, but completely recovered from the effects of the accident. In December 1899, while passing through Brussels on his way to St Petersburg, he was fired at by a miserable lad named Sipido, crazed by reading anarchist literature. Fortunately, no injury was done.

It was the especial distinction of Albert Edward, prince of Wales, to have been an ornament and support of the throne before he was called upon to fill it himself. This cannot be said of any of his predecessors except Edward the Black Prince. Most princes of Wales have either died or attained the regal dignity too early to leave any conspicuous mark in history as princes. Since the days of the Black Prince only two have enjoyed a popularity comparable to Prince Albert Edward's—Henry of Monmouth and Henry, the son of James I. The glories of Henry V. have cast a veil over the irregularities of Prince Hal; and the popularity of the Stuart Prince Henry arose in great measure from his suppressed antagonism to his father, and the expectation that he would reverse the latter's policy. The other two princes of Wales who have filled a conspicuous place in the public eye, Prince Frederick and George IV., were neither dutiful nor popular. It was reserved for the son of Queen Victoria to show what strength an heir-apparent exemplary in the discharge of the duties of his station can bring to a monarchy, and how important a place, even with the most scrupulous abstinence from party politics, he can fill in the life of a self-governing nation. He was a keen patron of the theatre, and made it his business to know and remember all the distinguished men of the time in arts and letters. His thoroughly British taste for sport was as pronounced as his inclination for most of the contemporary amusements of Society. The "Tranby Croft Case" (1890), in which Sir William Gordon Cumming brought an unsuccessful libel action for having been accused of cheating at a game of baccarat, caused some comment in connexion with the Prince's appearance in the witness-box on behalf of the defendants. But it did him no disservice with the people to have twice won the Derby with his horses Persimmon (1896) and Diamond Jubilee (1900), and his interest in yacht-racing was conspicuously shown at all the important fixtures, his yacht *Britannia* being one of the best of her day. In other respects his activity in the life of the nation and his wide interests may be illustrated by his establishment (1897) of the "Prince of Wales's Hospital Fund," his devotion to the cause of Masonry (he was first elected Grand Master of the Freemasons of England in 1874), and his position as a Bencher of the Middle Temple, where he also became (1887) Treasurer. It was on the occasion of his first appearance at "Grand Night," that the students were for the first time allowed to follow the Prince's example and to smoke in Hall; and this was only one instance of the influence in this respect which the Prince's taste for tobacco had on English society.

On the death of Queen Victoria on 22nd January 1901, the question what title the new king would assume was speedily set at rest by the popular announcement that he would be called Edward the Seventh. The new reign began auspiciously by the holding of a Privy Council at St. James's Palace, at which the King announced his intention to follow in his predecessor's footsteps and to govern as a constitutional sovereign, and received the oaths of allegiance. On 14th February the King and Queen opened Parliament in state. Shortly afterwards it was announced that the visit of the duke and duchess of York to Australia, in order to inaugurate the new Commonwealth, which had been sanctioned by Queen Victoria, would be proceeded with; and on 16th March they set out on board the *Ophir* with a brilliant suite. The tour lasted till 1st November, the duke and duchess having visited Australia, New Zealand, the Cape, and Canada; and on their return the King, on 9th November, created the duke prince of Wales and earl of Chester. In the meanwhile Parliament had settled the new Civil List (*q.v.*) at £470,000 a year. On 22nd May the King had a narrow escape in Southampton Water, on board Sir T. Lipton's yacht *Shamrock II.* (which was to compete for the America Cup). The yacht had her masts, spars, and entire spread of canvas carried away in a squall; but the King suffered no injury. The question of enlarging the Royal title to include specific mention of the colonial empire had been discussed during the year, and on 30th July Parliament passed a Bill to enable the King to style himself "Edward VII., by the grace of God of the United Kingdom of Great Britain and Ireland, and of all the British Dominions beyond the Seas, King, Defender of the Faith, Emperor of India." The Coronation was fixed for 26th June 1902. Two days earlier, however, the King was announced to be suffering from perityphlitis, and on 24th June an operation was performed by Sir Frederick Treves. The Coronation was consequently postponed. On 27th June the King was pronounced "out of immediate danger," and up to 1st July, when this volume was printed, he was stated to be progressing favourably.

The grandchildren of King Edward VII. are—children of the prince and princess of Wales—(1) Prince Edward Albert Christian George Andrew Patrick David, born 23rd June 1894; (2) Prince Albert Frederick Arthur George, born 14th December 1895; (3) Princess Victoria Alexandra Alice Mary, born 25th April 1897; (4) Prince Henry William Frederick Albert, born 15th March 1899. Children of the duke and duchess of Fife—(1) Lady Alexandra Victoria Alberta Edwina Louise Duff, born 17th May 1891; (2) Lady Maud Alexandra Victoria Georgina Bertha Duff, born 3rd April 1893.

**Edwardsville,** capital of Madison county, Illinois, U.S.A., on Cahokia creek, at an altitude of 554 feet. It has three railways, the Wabash, the Toledo, St Louis, and Kansas City, and the Chicago, Peoria, and St Louis. Population (1880), 2887; (1890), 3561; (1900), 4157

**Edwardsville,** a borough of Lucerne county, Pa., U.S.A., in the anthracite coal region, on the north branch of the Susquehanna river. The official name of the post office is Edwardsdale. Population (1900), 5165.

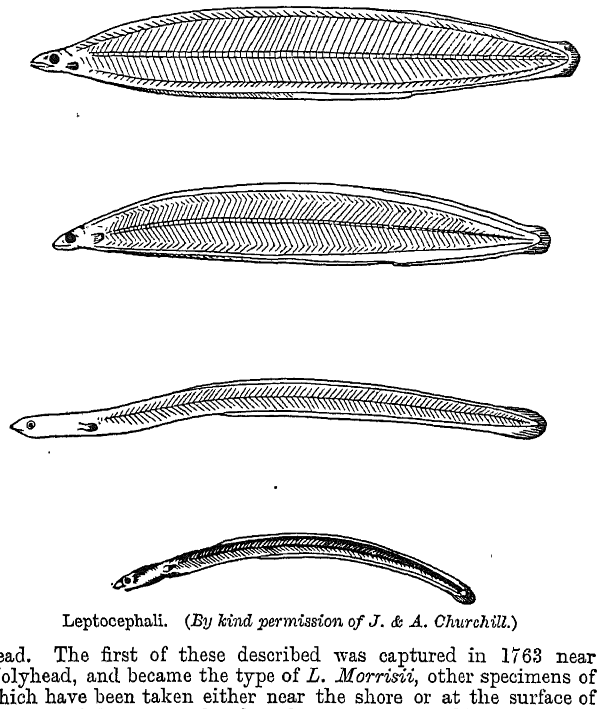
**Eel.**—The common fresh-water eel belongs to a group of soft-rayed fishes distinguished by the presence of an opening to the air-bladder and the absence of the pelvic fins. With its nearest relatives it forms the family Murænidæ, all of which are of elongated cylindrical form. The special peculiarities of the eel are the rudimentary scales buried in the skin, the well-developed pectoral fins, the rounded tail fin continuous with the dorsal and ventral fins. Only one other species of the family occurs in British waters, namely, the conger, which is usually much larger, and lives in the sea. In the conger the eyes are larger than in the eel, and the upper jaw overlaps the lower, whereas in the eel the lower jaw projects beyond the upper. Both species are voracious and predatory, and feed on almost any animal food they can obtain, living or dead. The conger is especially fond of squid or other Cephalopods, while the eel is partial to carrion. The common eel occurs in all the rivers and fresh waters of Europe, except those draining towards the Arctic Ocean, the Black Sea, and the Caspian Sea. It also occurs on the Atlantic side of North America. The conger has a wider range, extending from the western and southern shores of Britain and Ireland to the East Indian Archipelago and Japan. It is common in the Mediterranean.

The ovaries of the eel resemble somewhat these of the salmon in structure, not forming closed sacs, as in the majority of Teleostei, but consisting of laminæ exposed to the body cavity. The laminæ in which the eggs are produced are very numerous, and are attached transversely by their inner edges to a membranous band running nearly the whole length of the body-cavity. The majority of the eels captured for market are females with the ovaries in an immature condition. The male eel was first discovered in 1873 by Syrski at Trieste, the testis being described by him as a lobed elongated organ, in the same relative position as the ovary in the female, surrounded by a smooth surface without laminæ. He did not find ripe spermatozoa. He discovered the male by examining small specimens, all the larger being female. Jacoby, a later observer, found no males exceeding 19 inches in length, while the female may reach a length of 39 inches or more. Dr Petersen, in a paper published in 1896, states that in Denmark two kinds of eels are distinguished by the fishermen, namely, yellow eels and silver eels. The silver eels are further distinguished by the shape of the snout and the size of the eyes. The snout in front of the eyes is not flat, as in the yellow eels, but high and compressed, and therefore appears more pointed, while the eyes are much larger and directed outwards. In both kinds there are males and females, but Petersen shows that the yellow eels change into silver eels when they migrate to the sea. The sexual organs in the silver eels are more developed than in the yellow eels, and the former have almost or entirely ceased to take food. The male silver eels are from 11½ to 19 inches in length, the females from 16½ to about 39 inches. It is evident, therefore, that if eels only spawn once, they do not all reach the same size when they become sexually mature. The male conger was first described in 1879 by Hermes, who obtained a ripe specimen in the Berlin Aquarium. This specimen was not quite 2½ feet in length, and of the numerous males which have been identified at the Plymouth Laboratory, none exceeded this length. The large numbers of conger above this size caught for the market are all immature females. Female conger of 5 or 6 feet in length and weighing from 30 to 50 ℔ are common enough, and occasionally they exceed these limits. The largest recorded was 8 feet 3 inches long, and weighed 128 ℔.

There is every reason to believe that eels and conger spawn but once in their lives, and die soon after they have discharged their generative products. When kept in aquaria, both male and female conger are vigorous and voracious. The males sooner or later cease to feed, and attain to the sexually mature condition, emitting ripe milt when handled and gently squeezed. They live in this condition five or six months, taking no food, and showing gradual wasting and disease of the bodily organs. The eyes and skin become ulcerated, the sight is entirely lost, and the bones become soft through loss of lime. The females also after a time cease to feed, and live in a fasting condition for five or six months, during which time the ovaries develop and reach great size and weight, while the bones become soft and the teeth disappear. The female, however, always dies in confinement before the ova are perfectly ripe and before they are liberated from the ovarian tissue. The absence of some necessary condition, perhaps merely of the pressure which exists at the bottom of the sea, evidently prevents the complete development of the ovary. The invariable death of the fish in the same almost ripe condition leads to the conclusion that under normal conditions the fish dies after the mature ova have been discharged. Grassi states that he obtained ripe male eels, and ripe specimens of Muræna, another genus of the family, in the whirlpools of the Strait of Messina. A ripe female Muræna has also been described at Zanzibar. Gravid female eels, *i.e.*, specimens with ovaries greatly enlarged, have been occasionally obtained in fresh water, but there is no doubt that, normally, sexual maturity is attained only in the sea.

Until recent years nothing was known from direct observation concerning the reproduction of the common eel, or any species of the family. It was a well-known fact that large eels migrated towards the sea in autumn, and that in the spring small transparent eels of 2 inches in length and upwards were common on the shore under stones, and ascended rivers and streams in vast swarms. It was reasonable, therefore, to infer that the mature eels spawned in the sea, and that there the young were developed.

A group of peculiar small fishes were, however, known which were called Leptocephali, from the small proportional size of the head. The first of these described was captured in 1763 near Holyhead, and became the type of *L. Morrisii*, other specimens of which have been taken either near the shore or at the surface of the sea. Other forms placed in the same genus had been taken by surface fishing in the Mediterranean and in tropical ocean currents. The chief peculiarities of Leptocephali, in addition to the smallness of the head, are their ribbon-like shape and their glassy transparency during life. The body is flattened from side to side, and broad from the dorsal to the ventral edge. Like the eels, they are destitute of pelvic fins, and no generative organs have been observed in them (see Fig. above).



Leptocephali. (*By kind permission of J. & A. Churchill.*)

In 1864 the American naturalist, Gill, published the conclusion that *L. Morrisii* was the young or larva of the conger, and Leptocephali generally the young stages of species of Murænidæ. In 1886 this conclusion was confirmed from direct observation by Yves Delage, who kept alive in a tank at Roscoff a specimen of *L. Morrisii*, and saw it gradually transformed into a young conger. From 1887 to 1892 Professor Grassi and Dr Calandruccio carried on careful and successful researches into the development of the Leptocephali at Catania, in Sicily. The specimens were captured in considerable numbers in the harbour, and the transformation of *L. Morrisii* into young conger, and of various other forms of Leptocephalus into other genera of Murænidæ, such as *Muræna*, *Congromuræna*, and *Ophichthys*, was observed. In 1894 the same authors published the announcement that another species of Leptocephalus, namely, *L. brevirostris*, was the larva of the common eel. This larval form was captured in numbers with other Leptocephali in the strong currents of the Strait of Messina. In the metamorphosis of all Leptocephali a great reduction in size occurs. The *L. brevirostris* reaches a length of 8 cm., or a little more than 2½ inches, while the perfectly-formed young eel is 2 inches long or a little more.

The Italian naturalists have also satisfied themselves that certain pelagic fish eggs originally described by Raffaele at Naples are the eggs of Murænidæ, and that among them are the eggs of

Conger and Anguilla. They believe that these eggs, although free in the water, remain usually near the bottom at great depths, and that fertilization takes place under similar conditions. No fish eggs of the kind to which reference is here made have yet been obtained on the British coasts, although conger and eels are so abundant there. Raffaele described and figured the larva newly hatched from one of the eggs under consideration, and it is evident that this larva is the earliest stage of a Leptocephalus.

See "The Eel Question," *Report U.S. Commissioner of Fisheries for 1879.* Washington, 1882.—Cunningham, "Reproduction and Development of the Conger," *Journ. Mar. Biol. Assn.* vol. ii.—Petersen, *Report Dan. Biol. Station,* v., 1894.—Grassi, *Quart. Journ. Mic. Sci.* vol. xxxix., 1897. (J. T. C.)

**Eger,** the chief town of the government district of the same name in Bohemia; connected by rail with Nuremberg, Prague, Vienna, Reichenberg, &c. Population (1890), 18,658; (1900), 23,665, almost exclusively German (estimated at 91 per cent. Roman Catholic, 6 per cent. Protestant, and 3 per cent. Jewish). There is a garrison of 1069 men. Latterly Eger has been very prominent on account of its strong Pan-Germanic sentiment. The town is exceptionally interesting from its ancient buildings, collection of historical relics of Wallenstein, &c. There is a considerable textile industry, together with the manufacture of shoes, machinery, brewing, milling, &c. The inhabitants of the district are still distinguished from the surrounding population by their costumes, language, manners, and customs.

**Egham,** a town and railway station in the Chertsey parliamentary division of Surrey, England, on the Thames, 21 miles west by south of London by rail. The parish church contains monuments by Flaxman. Within the parish are the Royal Indian Engineering College on Cooper's Hill, the hill celebrated in Sir John Denham's poem, 1642, the Royal Holloway College for Women, the Holloway sanatorium for the treatment of mental ailments, and a cottage hospital; also the field of Runnymede, where King John signed Magna Carta, and (partly in Berkshire) Virginia Water, a large artificial lake in the south of Windsor Great Park. Area of parish (with Englefield), 7786 acres. Population (1881), 8692; (1901), 11,894.

**Egin** (Armenian, *Agn,* "the spring"), an important town in the Memuret el-Aziz viláyet of Asiatic Turkey (altitude, 3300 feet). It is picturesquely situated in a theatre of lofty, abrupt rocks, on the right bank of the Western Euphrates, at the point where the Kharpút-Erzingan road crosses the river by a wooden bridge. The stone houses stand in terraced gardens and orchards, and the streets are mere rock-ladders. The population numbers 10,000 (Moslems 6000, Armenians 4000). Egin was settled by Armenians who emigrated from Van in the 11th century with Senekherim. On 8th November 1895 many Armenians were massacred.

**Egorievsk,** a district town of Russia, government and 74 miles north-east of Ryazañ, connected by a branch line (14 miles) with the Moscow to Ryazañ main line. Its cotton mills (yielding over £500,000 a year) and other factories give occupation to 6000 persons. It has important fairs for trade in grain, hides, &c., exported. Population, 20,000.

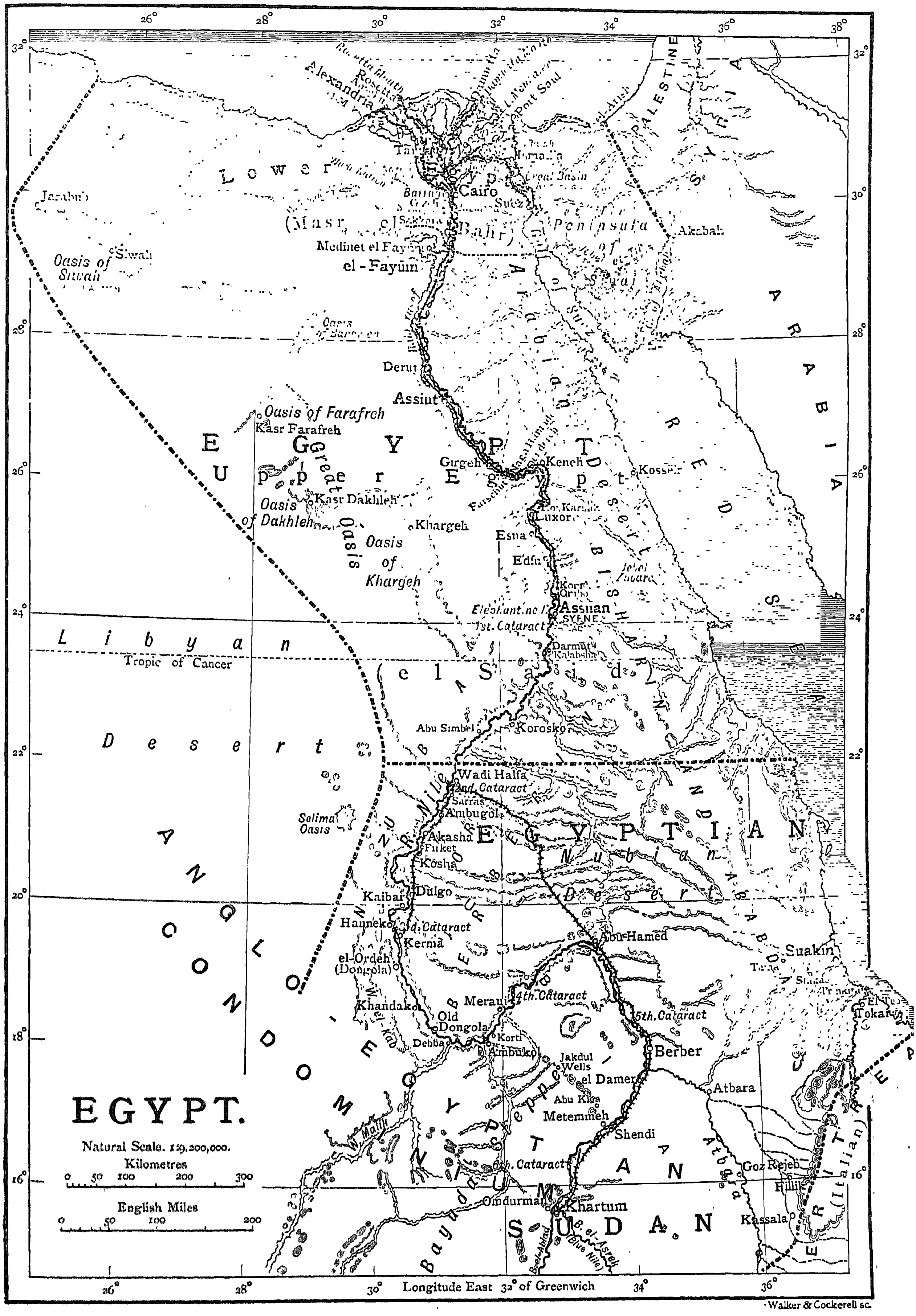
# EGYPT.

## Geography and Statistics.

The salient physical features of Egypt may be grouped as follows, each division having its own characteristic features, due essentially to the geological structure of the country:—(1) the Delta, (2) the Trough or "Rift" Valleys, (3) the Desert Plateaux, (4) the mountainous region in the east and north-east. The Nile must also be considered separately.

*The Delta.*—The delta of the Nile occupies a triangular area north of Cairo, measuring 100 miles from south to north, and having a width of 155 miles on the shore of the Mediterranean between Alexandria on the west and Port Said on the east. Beyond these two points the low hills of the desert form the coast-line, while between them the low sandy shore of the delta, slowly increasing by the annual deposit of silt by the river, is a barren area of sand hills and salty waste land, except in a few parts where reclamation has already made progress. Southwards the quality of the soil rapidly improves, and becomes the most fertile part of Egypt. This area is watered by the Damietta and the Rosetta branches of the Nile, and by the network of canals which, beginning at Cairo and the Barrage, intersects the whole delta and extends eastwards through the Wadi Tumilat as far as Suez. The soil of the delta is a dark grey fine sandy soil, becoming at times almost a stiff clay by reason of the fineness of its particles, which consist almost wholly of extremely small grains of quartz with a few other minerals, and often numerous flakes of mica. This deposit varies in thickness, as a rule, from 55 to 70 feet, at which depth it is underlain by a series of coarse and fine yellow quartz sands, with occasional pebbles, or even banks of gravel, while here and there thin beds of clay occur. These sand-beds are sharply distinguished by their colour from the overlying Nile deposit, and are of considerable thickness. A boring made in 1886 for the Royal Society at Zagazig attained a depth of 375 feet without reaching rock, and another, recently sunk near Lake Abukir (close to Alexandria) by a company, reached a depth of 405 feet with the same result. Numerous other borings to depths of 100 to 200 feet have given similar results, showing the Nile deposit to rest generally on these yellow sands, which provide a constant though not a very large supply of good water; near the northern limits of the delta this cannot, however, be depended on, since the well water at these depths has proved on several occasions to be salt. The surface of the delta is a wide alluvial plain sloping gently towards the sea, and having an altitude of 29 feet above it at its southern extremity. The only inequalities are the mounds, formed of ruined mud-brick dwellings, which mark the site of ancient towns, or on which the present towns and villages stand, occupying often the same site as their predecessors of earlier times. Its limits east and west are determined by the higher ground of the deserts, to which the silt-laden waters of the Nile in flood time cannot reach.

*The Valleys.*—The valleys, which are a remarkable feature of the country, are those occupied respectively by the Nile, the Gulf of Suez, and the Gulf of Akaba, and each of these is a rift-valley determined by the subsidence of a narrow belt in the neighbourhood of a line of fracture on the earth's surface. In the Gulf of Suez, certainly, an upward movement is still in progress, as salines along the coast are still being formed as the land rises; but in the Nile Valley north of Assuan this is more difficult to determine, though certain slight local earthquake shocks, which occasionally occur, seem to point to the fact that that movement has not wholly ceased. The trough so


EGYPT.
Natural Scale. 1:9,200,000.
Kilometres
English Miles
Longitude East 32° of Greenwich
Walker & Cockerell sc.
Lower Egypt
(Masr el Bahri)
Upper Egypt
Libyan Desert
Arabian Desert
Nubian Desert
ANGLO-EGYPTIAN SUDAN
Alexandria
Cairo
Suez
Port Said
Medinet el Fayum
el-Fayum
Oasis of Siwah
Derut
Assiut
Oasis of Farafreh
Kasr Farafreh
Girgeh
Keneh
Kosseir
Oasis of Dakhleh
Kasr Dakhleh
Khargeh
Oasis of Khargeh
Luxor
Esna
Edfu
Assuan
1st. Cataract
Tropic of Cancer
Abu Simbel
Korosko
Wadi Halfa
2nd. Cataract
Selima Oasis
Akasha
Kosha
Dulgo
3rd. Cataract
Kerma
el-Ordeh (Dongola)
Abu Hamed
Suakin
Merawi
4th. Cataract
5th. Cataract
Old Dongola
Korti
Berber
Atbara
Shendi
Metemmeh
6th. Cataract
Omdurman
Khartum
Kassala
SUDAN
ERITREA (Italian)
Peninsula of Sinai
Akabah
PALESTINE
SYRIA
ARABIA
RED SEA

formed has been filled by deposits of coarse and fine sand and gravel, containing numerous fragments of igneous rocks, which underlie the present Nile mud deposit, as in the Delta; and similarly, also, deep borings have reached no rock-floor up to the present. At Beni Suef, with the Tertiary limestone plateaux of the desert 3 miles distant, 400 feet of sands and clays were penetrated without any sign of rock, and at Medinet el Fayum a boring of 450 feet gave the same result.

Entering Egypt proper, a little to the north of the Second Cataract, the Nile flows through a valley in sandstone beds of Cretaceous age as far as latitude 25° N., and throughout this part of its course the valley is extremely narrow, rarely exceeding 2 miles in width. At two points, namely, Kalabsha and Assuan (First Cataract), its course is interrupted by outcrops of granites and other crystalline rocks, which have been uncovered by the erosion of the overlying sandstone, and to-day form the mass of islands, with numerous small rapids, which have been described not very accurately as cataracts; no good evidence exists in support of the view that they are the remains of a massive barrier, broken down and carried away by some sudden convulsion. From latitude 25° N. northwards for 518 miles the valley is of the "rift-valley" type, a level depression in the limestone plateau, enclosed usually by steep cliffs, except where the tributary valleys drained into the main valley in early times, when there was a larger rainfall, and which now carry off the occasional rainstorms that burst on the desert. The average width of the cultivation is about 10 miles, of which the greater part lies on the left bank of the river; and outside this is a belt, varying from a few hundred yards to 3 or 4 miles, of stony and sandy ground, reaching up to the foot of the limestone cliffs, which rise in places to as much as 1000 feet above the valley. This continues as far as latitude 29° N., after which the hills that close in the valley become lower, and the higher plateaux lie at a distance of 10 or 15 miles back in the desert. The fertile province of the Fayum, on the left bank of the Nile and separated from it by 6 miles of desert, seems to owe its existence to movements similar to those which determined the valley itself. Surrounded by Tertiary limestone strata on the north, west, and south, the boring above mentioned met with no representatives of these beds in the 450 feet which were penetrated. Lying in a basin sloping in a series of terraces from an altitude of 65 feet above sea-level in the east to about 140 feet *below* sea-level on the north-west, at the margin of the Birket-el-Kerun, this province is wholly irrigated by a large canal, the Bahr Yusef, which, leaving the Nile at Deirut in Upper Egypt, follows the western margin of the cultivation in the Nile Valley, and at length enters the Fayum through a gap in the desert hills by the XIIth Dynasty pyramids of Lahun and Hawara.

*The Desert Plateaux.*—Speaking generally, Egypt consists of a broad plateau of sedimentary rocks, lying on the western side of a band of crystalline rocks which occupy the southern part of the peninsula of Sinai and the western side of the Red Sea from latitude 29° N. southwards. In the north, where beds of Upper Tertiary age occur, the desert plateaux are comparatively low, but from Cairo southwards, as the Eocene limestones come in, they rise to 1000 and even 1500 feet above sea-level. Formed mostly of horizontal strata of varying hardness, they present a series of terraces of minor plateaux, rising one above the other, and intersected by small ravines worn by the occasional rainstorms which burst in their neighbourhood. The weathering of this desert area is probably fairly rapid, and the agents at work are principally the rapid heating and cooling of the rocks by day and night, and the erosive action of sand-laden wind on the softer layers; these, aided by the occasional rain, are ceaselessly at work, and produce the successive plateaux, dotted with small isolated hills and cut up by valleys (wadis), which occasionally become deep ravines, thus forming the principal type of scenery of these deserts. From this it will be seen that the desert in Egypt is mainly a rock desert, where the surface is formed of disintegrated rock, the finer particles of which have been carried away by the wind; and east of the Nile this is almost exclusively the case. In the western desert, however, those large sand accumulations which are usually associated with a desert are met with. They occur as lines of dunes formed of rounded grains of quartz, and lie in the direction of the prevalent wind, usually being of small breadth as compared with their length; but in certain areas, such as that lying south-west and west of the Oases of Farafreh and Dakhleh, these lines of dunes, lying parallel to each other and about half a mile apart, cover immense areas, rendering them absolutely impassable except in a direction parallel to the lines themselves. East of the Oases of Baharieh and Farafreh is a very striking line of these sand dunes; rarely more than 3 miles wide, it extends almost continuously from Moghara in the north, passing along the west side of Khargeh Oasis to a point near the Nile in the neighbourhood of Abu Simbel in Nubia—having thus a length of nearly 550 miles. In the northern part of this desert the dunes lie about N.W.–S.E., but farther south incline more towards the meridian, becoming at last very nearly north and south.

*Oases.*—In the western desert lie the five large oases of Egypt, namely, Siwah, Baharieh, Farafreh, Dakhleh, and Khargeh, occupying depressions in the plateau or, in the case of the last three, large indentations in the face of the escarpment formed by the Lower Eocene and Upper Cretaceous Limestones. Their fertility is due to a plentiful supply of water furnished by a sandstone bed 300 to 500 feet below the surface, whence the water rises through natural fissures or artificial boreholes to the surface, and sometimes to several feet above it. These oases were known and occupied by the Egyptians as early as 1600 B.C., and Khargeh rose to special importance at the time of the Persian occupation.

*The Mountainous Region.*—The mountainous part of the country is that occupied by the crystalline rocks in the southern part of Sinai, and the belt occupying the western shore of the Gulf of Suez and Red Sea, where the principal peaks rise to heights of 6000 and 7000 feet. Owing to the slight rainfall, and the rapid weathering of the rocks by the great range of temperature, these hills rise steeply from the valleys at their feet as almost bare rock, supporting hardly any vegetation. In some of the valleys, wells or rock-pools filled by rain occur, and furnish drinking-water to the few Arabs who wander in these hills. Farther south, where the rainfall is greater, the valleys are more fertile, and support considerable numbers of camels, sheep, and goats.

*The Egyptian Nile.*—The Nile (*q.v.*) enters Egypt proper a little to the north of the Second Cataract, and between there and the First Cataract has a length of 200 miles and a slope of $\frac{1}{12500}$. From this point to the Barrage at the apex of the Delta the length is 605 miles and the slope $\frac{1}{13000}$, and thence to the sea, by either the Rosetta or Damietta branch, is 145 miles more. The Nile is at its lowest at Assuan at the end of May, then rises slowly until the middle of July, and rapidly throughout August, reaching its maximum at the beginning of September; it then falls slowly through October and November. At Cairo the lowest level is reached about the middle of June, after which the rise is slow in July and fairly rapid in August, reaching the maximum at the beginning of

October. In the month of June the water is clear and carries practically no suspended matter, but by August it is full of dark red-brown sediment brought down by the Blue Nile and the Atbara from the plateaux of Abyssinia, and is estimated to be then carrying 8 cubic yards per second; by September this has been reduced to half the amount, and then diminishes rapidly. On the island of Elephantine at Assuan is the well-known Nilometer, dating from ancient Egyptian times, and altered and extended in Roman times, while the remains of other ancient Nilometers exist at Philæ, Edfu, and Esna, together with inscriptions recording about forty high Niles in the XXVth Dynasty, recently discovered on a quay wall of the temple of Karnak. The data furnished by these give about 4½ inches per century as the rate at which the Nile is silting up its bed north of the First Cataract.

*Climate.*—Except a narrow belt on the north along the Mediterranean shore, Egypt lies in an almost rainless area, where the temperature is high by day and sinks quickly at night in consequence of the rapid radiation under the cloudless sky. The mean temperature at Alexandria and Port Said varies between 57° F. in January and 81° F. in July; while at Cairo, where the proximity of the desert begins to be felt, it is 53° F. in January, rising to 84° F. in July. January is the coldest month, when occasionally in the Nile Valley, and more frequently in the open desert, the temperature sinks to 32° F., or even a degree or two below. The mean maximum temperatures are 99° F. for Alexandria and 110° F. for Cairo. Farther south the range of temperature becomes greater as pure desert conditions are reached.

*Mean Temperature.*

| Place. | January. | July. | Year. | Annual Maximum. | Annual Minimum. |
|---|---|---|---|---|---|
| Assuan | 62° | 95° | 80° | 118° | 42° |
| Wadi Halfa | 61 | 93 | 79 | 117 | 41 |
| Khartum | 71 | 93 | 84 | 114 | ... |

The relative humidity varies greatly. At Assuan the mean value for the year is only 38 per cent., that for the summer being 29 per cent. and for the winter 51 per cent.; while for Wadi Halfa the mean is 32 per cent., and 20 per cent. and 42 per cent. are the mean values for summer and winter respectively. In Alexandria and on all the Mediterranean coast of Egypt rain falls abundantly in the winter months, amounting to 8 inches in the year; but southwards it rapidly decreases, and south of latitude 31° N. but little falls.

*Rainfall.*

| Place. | Inches per Annum. |
|---|---|
| Alexandria | 8·1 |
| Port Said | 3·4 |
| Ismailia | 2·1 |
| Suez | 1·1 |

Recent records at Cairo show that the rainfall is very irregular, and is furnished by occasional storms rather than by any regular rainy season; still, most falls in the winter months, especially December and January, while, on the other hand, none has been recorded in June and July.

*Rainfall in Cairo in Inches.*

| | 1887. | 1888. | 1889. | 1890. | 1891. | 1892. | 1893. | 1894. | 1895. | 1896. | 1897. | 1898. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Inches | 0·86 | 1·73 | 0·64 | 2·15 | 1·60 | 0·27 | 1·30 | 0·66 | 1·70 | 1·43 | 0·3 | 16·1 |

In the open desert rain falls even more rarely, but it is by no means unknown, and from time to time heavy storms burst, causing sudden floods in the narrow ravines, and often drowning both men and animals. These are more common in the mountainous region of the Sinai Peninsula, where they are much dreaded by the Arabs. Snow is unknown in the Nile Valley, but on the mountains of Sinai and the Red Sea Hills it is not uncommon, and a temperature of 18° F. at an altitude of 2000 feet has been recorded in January.

The atmospheric pressure varies between a maximum in January and a minimum in July, the mean difference being about 0·29 inch. The following are the mean values for Cairo for the years 1885–1898:—

| Year. | Temp. ° Fahr. | Atmospheric Pressure. Inches. | Year. | Temp. ° Fahr. | Atmospheric Pressure. Inches. |
|---|---|---|---|---|---|
| 1885 | 70·3 | 29·84 | 1892 | 70·3 | 29·89 |
| 1886 | 69·6 | 29·86 | 1893 | 68·4 | 29·89 |
| 1887 | 70·6 | 29·87 | 1894 | 69·2 | 29·87 |
| 1888 | 71·6 | 29·87 | 1895 | 69·5 | 29·87 |
| 1889 | 72·0 | 29·88 | 1896 | 69·5 | 29·87 |
| 1890 | 71·5 | 29·84 | 1897 | 68·5 | 29·90 |
| 1891 | 71·4 | 29·88 | 1898 | 68·7 | 29·88 |

The most striking meteorological factor in Egypt is the persistence of the north wind throughout the year, without which the climate would be very trying. In December, January, and February, at Cairo, the north wind slightly predominates, though those from the south and west often nearly equal it, but after this the north blows almost continuously throughout the year. In May and June the prevailing direction is north and north-northeast, and for July, August, September, and October north and north-west. From the few observations that exist, it seems that farther south these southern winter winds decrease rapidly, becoming westerly, until at Assuan and Wadi Halfa the northerly winds are almost invariable throughout the year. The *Khamsin*, or hot sand-laden winds of the spring months, come invariably from the south. They are preceded by a rapid fall of the barometer for about a day, until a gradient from south to north is formed, then the wind commences to blow, at first gently, from the south-east; rapidly increasing in violence, it shifts through south to south-west, finally dropping about sunset. The same thing is repeated on the second and sometimes the third day, by which time the wind has worked round to the north again. During a Khamsin the temperature is high and the air extremely dry, while the dust and sand carried by the wind form a thick yellow fog obscuring the sun. The southern winds of the summer months which occur in the low latitudes north of the equator are not felt much north of Khartum.

*Minerals.*—The minerals of Egypt which are worked at present are very few. The salines at Meks, near Alexandria, supply all the salt needed for the country, except a small quantity used for curing fish at Lake Menzaleh; while the lakes in the Wadi Natron, 45 miles north-west of the pyramids of Gizeh, furnish carbonate of soda in large quantities. The alum of the Western Oases is no longer worked, on account of the cost of transport. The turquoise mines of Sinai, in the Wadi Moghara, are worked regularly by the Arabs of the peninsula, who sell the stones in Suez; while the emerald mines of Jebel Zubara, south of Kosseir, have been recently examined, to see if they could be profitably worked. Petroleum occurs at Jebel Zeit, on the west shore of the Gulf of Suez, but up to the present attempts to obtain it in any quantity have not proved successful. Considerable veins of hæmatite of good quality occur both in the Red Sea Hills and in Sinai, but difficulty of transport and want of fuel render them unimportant.

*Flora.*—Since practically the whole of the country which will support vegetable life is under cultivation, the flora of Egypt is limited. Besides the industrial crops cultivated throughout the country, the most important tree is the date palm, which grows all over Egypt and in the Oases. The dom palm is first seen a little north of latitude 26° N., and extends southwards. The vine grows well, and in ancient times was largely cultivated for wine; oranges, lemons, and pomegranates also abound. The sunt tree (*Acacia Nilotica*) grows everywhere, as well as the tamarisk and the sycamore. In the deserts several kinds of thorn bushes grow; and wherever rain or springs have moistened the ground, numerous wild flowers thrive. This is especially the case where there is also shade to protect them from the midday sun, as in some of the narrow ravines in the eastern desert and in the palm groves of the oases, where various ferns and flowers grow luxuriantly round the springs. Of late years new avenues and gardens have been extensively planted, especially near the towns; and among many trees which have been imported, the "lebbek" (*Albizzia Lebbek*) thrives especially, and has been very largely employed.

*Fauna.*—Besides the ordinary domestic animals, the camel, horse, donkey, goat, sheep, cow, water buffalo, &c., there are few wild animals. The principal are the hyæna, jackal, and fox; numerous gazelles in the deserts; the ibex in Sinai and the Red Sea Hills; and rarely the moufflon, or maned sheep, is met. The crocodile is never

now seen in Egypt. Birds are fairly numerous, and include eagles, vultures, kites, owls, as well as several kinds of plover; sand grouse and pigeons are abundant, the latter being kept for their dung, which is used as manure. Quails arrive from the north about September, and return in the spring, passing through Egypt in February and March. Aquatic birds are very numerous—pelicans, storks, cranes, herons, geese, and duck.

*Area and Population.*—The total area of Egypt proper, including the Oases in the Libyan Desert, the regions between the Nile and the Red Sea, and El-Arish in Syria, but excluding the Sudan, is about 400,000 square miles; but the cultivated and settled area, that is, the Nile Valley and Delta, covers only 12,980 square miles. Canals, roads, date plantations, &c., cover 1900 square miles; 2850 square miles are comprised in the surface of the Nile, marshes, lakes, and desert.

The population is generally divisible into—

(1) The fellahin, or the peasant population of the Nile Valley;
(2) The Beduin, or nomad Arabs of the desert;
(3) The Nuba or Berberin, inhabitants of the Nile Valley between Assuan and Dongola.

The first of these includes both the Moslem and Coptic inhabitants, who have probably changed but little since ancient Egyptian times, in spite of their conquest at different periods by various nations, each of whom has left but little mark on the inhabitants, except the change of religion.

The Beduin, or the Arabs of the desert, are of two different classes: first, the Arabic-speaking tribes, who have probably immigrated from Arabia and Syria, and who occupy the deserts as far south as latitude 26° N.; secondly, the tribes who occupy the desert from Kosseir to Suakin, namely, the Hadendoa, Bisharin and the Ababda tribes, who speak a language of their own, and are probably the descendants of the Blemmyes, who occupied these parts in ancient times.

The population according to the census of 1897 was 9,734,405, compared with 6,813,919 in 1882, being an increase of 43·5 per cent. in 15 years. In the two following tables are given the numbers for Upper and Lower Egypt, as well as the number of foreigners resident in the country; while in others are given the division by sex and mode of life, taken from the census of 1897:—

| | 1882. | 1897. | Increase per cent. in 15 Years. |
|---|---|---|---|
| Population of Lower Egypt | 4,008,746 | 5,676,109 | 41·5 |
| Population of Upper Egypt | 2,805,173 | 4,058,296 | 45 |
| Total population . | 6,813,919 | 9,734,405 | 43 |
| Egyptians . . . | 6,723,033 | 9,621,831 | 43 |
| Foreigners . . . | 90,886 | 112,574 | 24 |
| Town population . . | 857,617 | 1,225,365 | 42·8 |
| Number of towns, villages, and hamlets, &c. . | 13,247 | 18,141 | 37 |

| | Males. | Females. | Total. |
|---|---|---|---|
| Total population . . | 4,947,850 | 4,786,555 | 9,734,405 |
| *Mode of Life.* | | | |
| Sedentaries— | | | |
| Natives of fixed residence | 4,550,504 | 4,420,159 | 8,970,663 |
| Natives settled among Beduins . . . | 25,042 | 24,699 | 49,741 |
| Foreigners . . . | 64,249 | 48,325 | 112,574 |
| Total . . . | 4,639,795 | 4,493,183 | 9,132,978 |
| Semi-Sedentaries— | | | |
| Beduins resident in the villages . . . | 147,456 | 142,619 | 290,075 |
| Beduins among native sedentary population | 124,303 | 116,577 | 240,880 |
| Total . . . | 271,759 | 259,196 | 530,955 |
| Nomad— | | | |
| Beduin . . . . | 36,296 | 34,176 | 70,472 |

*Population according to Occupation.*

| | Males. | Females. | Total. |
|---|---|---|---|
| Agriculturists . . . | 2,049,643 | ... | 2,049,643 |
| Exercising professions or trades . . . . | 1,013,758 | 35,825 | 1,049,583 |
| Servants . . . . | 113,377 | 35,346 | 148,723 |
| Without profession, over 10 years of age . . . | 147,398 | 3,118,902 | 3,266,300 |
| Without profession, under 10 years of age . . . | 1,623,674 | 1,596,482 | 3,220,156 |

Egypt is divided into 6 governorships and 14 provinces, of which 6 belong to Lower Egypt and 8 to Upper Egypt.

The governorships are: Cairo, Alexandria, Damietta, Suez Canal, Suez, El-Arish.

Lower Egypt includes the provinces of: Behera, Gharbieh, Menufieh, Dakahlieh, Kaliubieh, Charkieh.

Upper Egypt: Gizeh, Beni Suef, Fayum, Minia, Assiut, Girgeh, Keneh, Assuan.

The following tables give the population of each governorship and province, with the number of persons per square mile in each:—

| | Area in Square Miles. | Population, 1882. | Population, 1897. | Population per Sq. Mile, 1897. |
|---|---|---|---|---|
| GOVERNORSHIPS. | | | | |
| *Lower Egypt*— | | | | |
| Cairo . . | 6 | 374,838 | 570,062 | 95,010 |
| Alexandria . | 76 | 231,396 | 319,766 | 4,568 |
| Damietta . | 4½ | 43,616 | 43,751 | 9,722 |
| Suez Canal . | 10½ | 21,296 | 50,179 | ... |
| Suez . . | | 11,175 | 24,970 | ... |
| El Arish . | ½ | 2,936[1] | 16,991 | ... |
| PROVINCES. | | | | |
| *Lower Egypt*— | | | | |
| Behera . . | 932 | 401,730 | 631,225 | 677 |
| Gharbieh . | 2340 | 936,276 | 1,297,656 | 554 |
| Menufieh . | 639 | 646,013 | 864,206 | 1,352 |
| Dakahlieh . | 931 | 588,644 | 736,708 | 791 |
| Kaliubieh . | 352 | 271,391 | 371,465 | 1,055 |
| Charkieh . | 905 | 471,139 | 749,130 | 826 |
| *Upper Egypt*— | | | | |
| Gizeh . . | 370 | 283,833 | 401,634 | 1,085 |
| Beni Suef . | 501 | 219,573 | 314,454 | 627 |
| Fayum . . | 493 | 228,709 | 371,006 | 752 |
| Minia . . | 772 | 315,803 | 548,632 | 711 |
| Assiut . . | 840 | 563,049 | 782,720 | 932 |
| Girgeh . . | 631 | 521,413 | 688,011 | 1,090 |
| Keneh . . | 544 | 486,827 | 711,457 | 1,308 |
| Assuan or Nubia . | ... | 158,265 | 240,382 | ... |

[1] Without Arabs, who were included in the figures for 1897.

*Government and Administration.*—The Central Government consists of the Khedive, together with a Council of six Ministers of State, under the presidency of a Prime Minister. To these is added the British Financial Adviser, who attends all meetings of the Council of Ministers, but has not a vote; on the other hand, no financial decision may be taken without his consent. The Ministries are those of the Interior, Finance, Public Works, Justice, War, and Public Instruction, and in each of these are prepared the drafts of decrees, which are then submitted to the Council of Ministers for approval, and on being signed by the Khedive become law. The control of the different parts of the country is carried on by governors of the governorships, and *mudirs* of the provinces, each of whom is under the Ministry of the Interior. The provinces are further divided into districts, each of which is under a *mamur*, who in his turn supervises and controls the *omda*, or head-man, of each village in his district.

*Justice.*—In Egypt there are four judicial systems:—(1) the *Mekhemehs* or courts of the religious law, concerned

mainly with questions affecting the personal status of Mahommedans; (2) the Mixed Courts, instituted in 1875, dealing with civil actions between persons of different nationalities, and to some extent with criminal offences of foreigners; (3) the Consular Courts, where foreigners accused of crime are tried; (4) the Native Courts, for civil actions between natives or crimes by natives. The Native Courts, instituted 1884–89, with both foreign and native judges, now consist of 6 courts of first instance, an appeal court at Cairo, and 42 summary courts for cases of moderate importance. With special reference to these tribunals a British judicial adviser was appointed in 1891. A committee of judicial surveillance watches the working of the courts of first instance and the summary courts, and endeavours, by letters and discussions, to maintain purity and sound law. There is a *Procureur-Général*, who, with other duties, is entrusted with criminal prosecutions. His representatives are attached to each tribunal, and form the "parquet" under whose orders the police act in bringing criminals to justice. The police service, which has been subject to frequent modification, was in 1895 put under the orders of the Ministry of the Interior, to which a British adviser and British inspectors are attached. The provincial police is under the direction of the local authorities, the *mudirs* or governors of provinces, and the *mamurs* or district officials; to the *omdas* or village headmen, who are responsible for the good order of the villages, a limited criminal jurisdiction has been entrusted.

*Religion.*—The religion of the country is essentially Moslem, and its adherents far outnumber those of all other creeds. The Christians are mostly of the Orthodox Greek Church. Jews are not very numerous, and are mostly found in the towns. In the following table, under the heading Orthodox are included Orthodox Copts, Orthodox Greeks, Greek Orthodox Syrians, and Orthodox Armenians; while with the Catholics are included Roman Catholics, Coptic Catholics, Syrian Catholics, Maronites, and Armenian Catholics:—

| Creed. | Lower Egypt. | Per cent. | Upper Egypt. | Per cent. | Total. | Per cent. |
|---|---|---|---|---|---|---|
| Mahommedans . | 5,407,794 | 95·3 | 3,569,908 | 88·0 | 8,977,702 | 92·2 |
| *Christians*— | | | | | | |
| Orthodox . | 174,516 | 3·0 | 471,259 | 11·6 | 645,775 | 6·6 |
| Catholic . | 56,660 | 1·0 | 4,391 | ·1 | 61,051 | ·6 |
| Protestant | 11,901 | 0·2 | 12,508 | ·3 | 24,409 | ·3 |
| Total . | 243 077 | 4·2 | 488,158 | 12·0 | 731,235 | 7·5 |
| Jews . | 24,973 | 0·5 | 227 | ... | 25,200 | ·3 |
| Various . | 265 | ... | 3 | ... | 268 | ... |

*Education.*—Under the Ministry of Public Instruction there is now a graduated system of teaching, commencing with the "kuttabs" or village schools attached to mosques, passing on to the primary and secondary schools, and finally the two technical schools, and the schools of agriculture, medicine, and law. Besides these there are nine missionary and other schools of all grades. In 1898 there were in all 9702 kuttabs, with 14,700 teachers for the 183,470 pupils who attend them; but only a few of these, at present about 100, are under Government inspection and receive the grant in aid to which it entitles them. In the rest the education given is of small value. There were 240 higher grade primary schools, and 28 secondary schools, besides 3 training colleges for teachers. The University of El-Azhar attracts students to the number of nearly 8000, of whom some 2000 are resident, from all parts of the Mahommedan world. Including this and the 3 training colleges, there are 26 higher or professional schools, with 486 teachers and 12,706 students. In 1897, of the sedentary Egyptian population over seven years of age, there could read and write in Lower Egypt 7 per cent., in Upper Egypt, 4·07 per cent., in all Egypt, 5·8 per cent.; of the foreign population over seven years of age in all Egypt, 74 per cent. could read and write.

*Agriculture.*—The total area of land, either cultivated, under reclamation, or which may later be reclaimed, is 6,250,000 acres, of which 4,690,000 pay full taxes, and 1,060,000 are in course of reclamation, paying a proportional tax. The remaining 500,000 acres are still waste land. The most important crops are those of cotton and sugar.

The seasons for agriculture are—

Summer, from 1st April to 1st August.
Flood, ,, 1st August ,, 1st December.
Winter, ,, 1st December ,, 1st April.

The approximate area and average yield in each season is as follows:—

| Season. | Area in Acres. | Yield. |
|---|---|---|
| | | £E. |
| Summer . . . | 2,046,500 | 15,177,500 |
| Flood . . . | 1,510,000 | 6,870,000 |
| Winter . . . | 4,260,000 | 17,013,000 |

The crops cultivated in the different seasons are as follows:—

*Upper Egypt.*

| Season. | Crop. | Area. | Value |
|---|---|---|---|
| | | Acres. | £E. |
| Summer . . | Sugar-cane . | 75,000 | 1,200,000 |
| | Cotton . . | 110,000 | 1,100,000 |
| | Vegetables, &c. | 15,000 | 150,000 |
| | Melons . . | 12,500 | 127,500 |
| | Sorghum . . | 160,000 | 960,000 |
| Flood . . . | Dates . . | 5,200,000 | 1,040,000 |
| | Sorghum . . | 510,000 | 2,040,000 |
| | Rice . . | 20,000 | 80,000 |
| Winter . . . | Wheat . . | 600,000 | 3,000,000 |
| | Beans . . | 500,000 | 2,145,000 |
| | Clover . . | 500,000 | 2,000,000 |
| | Barley . . | 250,000 | 875,000 |
| | Lentils . . | 140,000 | 420,000 |
| | Flax . . | 1,000 | 8,000 |
| | Onions . . | 15,000 | 150,000 |
| | Vetches . . | 115,000 | 290,000 |

Double cropped area = 703,500 acres.

*Lower Egypt.*

| Season. | Crop. | Area | Value. |
|---|---|---|---|
| | | Acres. | £E. |
| Summer . . | Cotton . . | 1,500,000 | 10,500,000 |
| | Sugar-cane . | 4,000 | 40,000 |
| | Vegetables, &c. | 70,000 | 700,000 |
| | Rice . . | 100,000 | 400,000 |
| Flood . . . | Dates . . | 2,200,000 | 440,000 |
| | Maize . . | 900,000 | 3,150,000 |
| | Rice . . | 80,000 | 120,000 |
| Winter . . . | Wheat . . | 600,000 | 2,700,000 |
| | Barley . . | 330,000 | 660,000 |
| | Clover . . | 955,000 | 3,395,000 |
| | Beans . . | 180,000 | 630,000 |
| | Vegetables, &c. | 70,000 | 700,000 |
| | Flax . . | 4,000 | 40,000 |

Double cropped area = 1,363,000 acres.

The following table gives the cotton and sugar crops for twenty years:—

| Year. | Cotton Crop in Cantars 98 1 lb. | Sugar-Cane in Tons. |
|---|---|---|
| 1878 | 1,700,000 | ... |
| 1890 | 4,100,000 | 52,000 |
| 1894 | 4,600,000 | 62,000 |
| 1895 | 5,200,000 | 83,000 |
| 1896 | 5,800,000 | 91,000 |
| 1897 | 6,500,000 | 74,000 |
| 1898 | 5,600,000 | ... |

In Upper Egypt there are 1,731,800 acres under flood irrigation, and 587,500 acres under perennial irrigation; while in Lower Egypt 3,437,800 acres are dependent on the great perennial canals. The ownership of the land is shown in the following table:—

| Class. | Acres owned by | |
|---|---|---|
| | Upper Egypt. | Lower Egypt. |
| State Domains | 47,399 | 192,910 |
| Daïra Sanieh | 306,955 | 31,581 |
| Religious Bodies | 16,622 | 56,638 |
| Banks, Foreigners, &c. | 64,645 | 519,537 |
| Non-Resident Egyptians | 394,808 | 1,982,558 |
| Resident Egyptians | 1,488,905 | 1,654,603 |

The land is everywhere subdivided into extremely small plots, each of which is often owned by the members of a family, each having a share. Out of 767,260 proprietors of land in 1897, 611,074 owned less than 5 acres. Cattle and farm animals, including horses and camels, number 1,669,000.

The only fisheries of importance are those of Lake Menzaleh, which produce a net revenue of about £E.60,000 annually.

*Commerce.*—Since 1875 the commerce has increased rapidly. Great Britain is the largest importer and exporter, and next come France, Turkey, Russia, Austria, and the United States, though the trade of Germany and Belgium is also rapidly increasing.

The exterior commerce, comprising imports and exports of all kinds of merchandise and of specie, is given at the following figures since 1880:—

| Year. | Merchandise. | | Specie. | |
|---|---|---|---|---|
| | Imports. | Exports. | Imports. | Exports. |
| | £E. | £E. | £E. | £E. |
| 1880 | 6,549,933 | 12,983,203 | 4,791,700 | 405,600 |
| 1890 | 8,081,297 | 11,876,086 | 2,971,461 | 2,085,455 |
| 1895 | 8,389,933 | 12,632,450 | 4,319,265 | 2,322,190 |
| 1897 | 10,603,672 | 12,321,220 | 2,921,722 | 2,369,479 |
| 1898 | 11,033,219 | 11,805,179 | 2,730,116 | 1,891,513 |
| 1899 | 11,441,802 | 15,350,908 | 4,515,917 | 1,502,485 |
| 1900 | 14,112,369 | 16,766,609 | 4,114,612 | 2,602,790 |

The following table shows the value of the commercial intercourse of Egypt with different foreign countries in 1900:—

| Country. | Imports from. | Exports to. |
|---|---|---|
| | £E. | £E. |
| Great Britain | 5,300,447 | 9,141,932 |
| British Colonies in the Mediterranean | 144,431 | 4,404 |
| British Colonies in the Extreme East | 696,351 | 187,813 |
| Germany | 485,933 | 900,824 |
| America | 289,331 | 1,035,600 |
| Austria-Hungary | 900,958 | 642,477 |
| Belgium | 494,751 | 126,165 |
| China and Extreme East | 124,198 | 149,347 |
| France and Algeria | 1,314,869 | 1,430,153 |
| Greece | 121,468 | 5,246 |
| Italy | 661,347 | 601,496 |
| Morocco | 40,157 | 2,692 |
| Persia | 42,778 | 4,642 |
| Russia | 608,901 | 1,209,563 |
| Turkey | 2,220,966 | 290,193 |
| Other countries | 354,505 | 1,030,136 |
| Total | 13,801,391 | 16,757,683 |

The value of the leading exports and imports of Egypt in 1900 is shown in the following table:—

| Merchandise. | Imports. | Exports. |
|---|---|---|
| | £E. | £E. |
| Animals and animal food products | 652,357 | 129,733 |
| Skins and leather goods | 206,860 | 84,855 |
| Other animal products | 84,373 | 41,611 |
| Cereals, vegetables, &c. | 1,532,341 | 2,615,433 |
| Provisions and drugs | 404,735 | 676,226 |
| Spirits, oils, &c. | 815,888 | 16,318 |
| Rags, paper, books | 177,103 | 15,690 |
| Wood and coal, cane-work, &c. | 2,093,061 | 16,350 |
| Stone, lime, glass, &c. | 399,008 | 1,528 |
| Dyeing materials, &c. | 282,875 | 21,112 |
| Chemical products | 276,509 | 15,547 |
| Textiles,[1] mainly raw cotton | 4,011,498 | 13,104,860 |
| Metals and metal goods | 1,817,971 | 5,691 |
| Sundries | 439,609 | 12,689 |
| Tobacco | 577,203 | ... |
| Total | 13,801,391 | 16,757,683 |

[1] In 1897 the cotton tissues imported amounted to £E.1,798,600; and in 1900 to £E.1,987,095. In the cotton season of 1896-97 the quantity of raw cotton exported was 5,177,495 cantars, valued at £E.10,088,838; in 1897-98, 5,764,636 cantars, valued at £E.9,040,150; in 1898-99, 6,001,222 cantars, valued at £E.11,598,222; and in 1899-1900, 4,868,596 cantars, valued at £E.13,039,003.

The receipts from tobacco were: in 1896, £E.1,006,526; in 1897, £E.1,044,780; in 1898, £E.1,080,669; in 1899, £E.1,068,497.

Of the total imports in 1899 the value of £E.9,945,165, and of the exports the value of £E.15,068,722, passed through the port of Alexandria.

*Shipping and Navigation.*—The following tables show the nationality and tonnage of vessels arriving and clearing at Alexandria. Great facilities have been afforded to steamers since the completion of the docks, wharves, and quays; and in order still further to facilitate navigation the Government have constructed a new pass, 300 feet wide, to enable vessels, which have often been delayed off the port during stormy weather, to make a direct run into harbour. The new pass, 30 feet deep, was opened to navigation in July 1894.

Arrivals and clearances of commercial vessels at Alexandria in five years:—

| Year. | Arrivals. | | Clearances. | |
|---|---|---|---|---|
| | Vessels. | Tons. | Vessels. | Tons. |
| 1895 | 2393 | 2,206,667 | 2339 | 2,194,964 |
| 1896 | 2132 | 2,123,591 | 2105 | 2,094,684 |
| 1897 | 2203 | 2,267,120 | 2143 | 2,270,836 |
| 1898 | 2454 | 2,555,396 | 2428 | 2,559,876 |
| 1899 | 2805 | 2,414,674 | 2758 | 2,389,058 |

The following table shows the nationality of commercial vessels arrived and cleared in 1898, and the totals for 1899:—

| Nationality. | Arrivals. | | Clearances. | |
|---|---|---|---|---|
| | Vessels. | Tons. | Vessels. | Tons. |
| British | 729 | 1,111,481 | 734 | 1,117,161 |
| French | 125 | 263,778 | 126 | 265,314 |
| Austrian | 139 | 254,703 | 140 | 261,125 |
| Turkish | 847 | 151,461 | 827 | 147,487 |
| Russian | 95 | 185,940 | 95 | 188,971 |
| Italian | 153 | 281,373 | 153 | 279,426 |
| Greek | 163 | 66,781 | 155 | 63,755 |
| Swedish and Norwegian | 36 | 59,221 | 34 | 57,809 |
| German | 27 | 52,230 | 27 | 54,754 |
| Egyptian | 82 | 85,547 | 79 | 82,566 |
| Other countries | 58 | 43,881 | 58 | 41,508 |
| Total for 1898 | 2454 | 2,556,396 | 2428 | 2,559,876 |
| Total for 1899 | 2805 | 2,414,674 | 2758 | 2,389,058 |

*Suez Canal.*—The following table shows the number and gross tonnage of vessels of all nationalities that passed through the Canal in 1898 :—

| Country. | No. | Gross Tonnage. |
|---|---|---|
| Great Britain | 2295 | 8,691,093 |
| Germany | 356 | 1,353,161 |
| France | 221 | 891,642 |
| Holland | 193 | 526,478 |
| Austria-Hungary | 85 | 300,251 |
| Japan | 46 | 261,602 |
| Russia | 48 | 243,381 |
| Spain | 49 | 232,358 |
| Italy | 74 | 208,418 |
| Norway | 47 | 109,709 |
| Turkey | 54 | 83,541 |
| Denmark | 8 | 30,228 |
| Egypt | 10 | 15,705 |
| China | 4 | 6,181 |
| America | 4 | 3,162 |
| Greece | 2 | 1,941 |
| Rumania | 1 | 1,703 |
| Sweden | 2 | 1,021 |
| Portugal | 3 | 606 |
| Argentine Republic | 1 | 451 |
| Total | 3503 | 12,962,632 |

In 1899 the British ships numbered 2310, with a tonnage of 9,046,031 ; and the German 387, with a tonnage of 1,492,657.

The number and gross tonnage of vessels that have passed through the Suez Canal, and the gross receipts of the company, were as follow during the twenty years after 1880 :—

| Year. | No. of Vessels. | Gross Tonnage. | Receipts. |
|---|---|---|---|
| | | | £ |
| 1880 | 2026 | 4,344,519 | 1,593,620 |
| 1890 | 3389 | 9,749,130 | 2,679,360 |
| 1895 | 3434 | 11,833,637 | 3,124,149 |
| 1896 | 3409 | 12,039,859 | 3,182,800 |
| 1897 | 2986 | 11,123,403 | 2,913,222 |
| 1898 | 3503 | 12,962,632 | 3,411,791 |
| 1899 | 3607 | 13,815,992 | 3,652,751 |

The number of passengers who went through the Canal in 1899 was 221,347 as against 219,671 in 1898, and 191,224 in 1897.

*Canals.*—The canals, being designed specially for perennial or flood irrigation, are only partially used for communication, since the Nile serves for this purpose through the country. In the Delta, however, the large canals, Raya Behera, Raya Menufieh, Bahr Shebin, Mahmudieh Canal, Raya Tewfiqieh, and the Ismailieh Canal, are largely used to reach parts of the Delta which would otherwise be far from water transport.

*Roads.*—Until quite recently there were no roads laid out and maintained as such, except in the immediate neighbourhood of the large towns, and the only communication was by the footpaths across the cultivation. Now, however, agricultural roads are being constructed in most of the provinces, and 1268 miles are open, 324 miles having been constructed in Upper Egypt, and 944 in Lower Egypt, up to the end of 1899.

*Railways.*—On 1st January 1901 there were in Egypt 1393 miles of railways belonging to and worked by the State, and 670 miles of light agricultural railways belonging to private companies (see below): in all, 2063 miles; 1403 miles being in the Delta, and 660 miles in Upper Egypt, exclusive of the military railway in the Sudan.

The following table shows since 1880 the length of line of the State railways, the number of passengers and the weight of goods carried, and the net receipts :—

| Year. | Line. | Number of Passengers. | Goods carried. | Net Receipts. |
|---|---|---|---|---|
| | Miles. | | Tons. | £E. |
| 1880 | 944 | 3,086,478 | 1,143,312 | 750,134 |
| 1890 | 961 | 4,696,286 | 1,721,492 | 798,418 |
| 1895 | 1098 | 9,518,000 | 2,398,000 | 994,000 |
| 1896 | 1143 | 9,854,000 | 2,498,000 | 1,033,000 |
| 1897 | 1166 | 10,742,546 | 2,796,096 | 1,123,360 |
| 1898 | 1214 | 11,312,400 | 2,786,780 | 1,114,033 |
| 1899 | 1393 | 11,284,284 | 3,055,897 | 1,161,636 |

Of late years lines of light agricultural railways have been opened by private companies in the Delta and in the Fayum. In connexion with these lines there are 164 miles of telegraphs and 310 miles of telephones.

*Telegraphs and Posts.*—The telegraphs belonging to the Egyptian Government were, at the end of 1900, of a total length of 2106 miles, the length of the wire being 9440 miles. The Government have given concessions to a telephone company for urban telephone lines. The Eastern Telegraph Company, also by concessions, have telegraph lines across Egypt from Alexandria *viâ* Cairo to Suez, and from Port Said to Suez, connecting their cables to England and India. Number of telegrams, 2,994,332 in 1899, not including telegrams sent by the Eastern Telegraph Company. Receipts, £E.54,448 ; expenditure, £E.44,000. In 1900 the number of telegrams was 3,288,662.

There are 313 post offices in the towns of Egypt, 160 travelling offices, and 414 localities where the rural post has been established. The Egyptian Post Office now transacts all the services which exist in the post offices of other countries forming the Postal Union.

The following table gives the number of letters, post-cards, newspapers, &c., despatched through the Egyptian Post Office in the year 1898 :—

| | Inland. | Abroad. | Total. |
|---|---|---|---|
| Letters and post-cards | 12,260,000 | 2,473,000 | 14,733,000 |
| Newspapers | 7,100,000 | 940,000 | 8,040,000 |
| Parcels | 274,000 | 289,800 | 563,800 |
| Total | 19,634,000 | 3,702,800 | 23,336,800 |

In 1899 these totals had arisen to: inland, 20,758,000 ; abroad, 3,903,700 ; total, 24,661,700. Receipts (1899), £E.129,874 ; expenditure, £E.108,198.

Post-office orders and remittances through the post office (1898) numbered 563,800, and amounted to the value of £E.16,437,000 ; in 1899, post-office orders and remittances numbered 598,500, and amounted to a value of £E.17,437,000.

Thirty per cent. of the total foreign correspondence was with Great Britain.

*Money.*—Egyptian money is minted at the Berlin Mint. The nominal value of the coinage (including re-coinage) from 1887 to 1900 was :—

| Years. | Gold. | Silver. | Nickel. | Bronze. | Total. |
|---|---|---|---|---|---|
| | Piastres. | Piastres. | Piastres. | Piastres. | Piastres |
| 1887–1900 | 5,202,400 | 190,584,769 | 22,080,289 | 611,779 | 218,479,237 |

See also SUDAN.

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## FINANCE.

The history of Egyptian finance is the story of Egypt since 1863, the date of the accession of the Khedive Ismaïl.

***History, 1863-1876.*** The notorious and unparalleled extravagance of that ruler necessitated continual recourse on increasingly onerous terms to the capitalists of Europe, and finally plunged his country into a sea of political and financial embarrassment from which it is only now emerging. When Ismaïl came to the throne the Egyptian debt amounted to a little over three millions. By the end of 1876 it was already estimated at ninety-one millions, and in reality considerably exceeded this figure. During the same period the taxation of the land, the principal source of revenue, had been increased about 50 per cent. Under the improvident system of borrowing pursued by Ismaïl, the amount of debt contracted very considerably exceeded the money actually realized, and even of the latter very little was expended on developing the resources of the country. It is stated in Mr Cave's report of March 1876, that "for the present large amount of indebtedness there is absolutely nothing to show but the Suez Canal, the whole proceeds of the loans and floating debt having been absorbed in payment of interest and sinking funds, with the exception of the sum debited to that great work." The Suez Canal, from which, owing to the forced sale of the country's interests therein, Egypt derives no direct benefit to-day, cost the Egyptian Government sixteen millions.

***1876-1882.*** By the end of 1875 this wild career of prodigality had begun to produce its natural result of serious financial embarrassment. In May of that year, in order to allay the apprehensions of the foreign creditors of Egypt, and to put a curb on the extravagant borrowing of Ismaïl, the Caisse de la Dette was instituted. The Caisse was at first composed of only three members, a Frenchman, an Austrian, and an Italian, but in the following year an Englishman was added. The original functions of the members were to act as the receivers of certain revenues that had been assigned to the service of the debt. In order to render their powers effective, they were given the right to sue the Government in the Mixed Courts for any breach of engagement towards the bondholders. The effects of this measure were far more momentous than was apparent at the time or than was intended by its authors. It was, in fact, the beginning of international interference in the financial administration of Egypt. From this moment the period of financial reform may be said to have commenced. Shortly afterwards, in November of the same year, a general settlement of the liabilities of the country was effected on the proposals of Mr Goschen and M. Joubert. It was recognized that no mere rearrangement of existing liabilities could be expected to produce satisfactory results unless some guarantees were given against future maladministration. For this purpose the Dual Control was instituted. In its first form it consisted of two controllers, an Englishman and a Frenchman, the former superintending the revenue and the latter the expenditure of the country. This arrangement was of short duration. It was based upon erroneous information supplied by the Khedive and his ministers as to the real resources of the country. It was only with the greatest possible difficulty, and by the application of the most rigorous and most arbitrary measures to the unfortunate Egyptian taxpayer, that the payment of the coupon could be continued. Finally, in the hope of obtaining a reduction of the rate of interest on the debt, Ismaïl consented, in January 1878, to the appointment of a commission armed with full powers to inquire into the whole state of the country. The first report of this commission insisted on the necessity of a proper system of government through responsible ministers before any real reform could be effected. This was at first accepted by the Khedive, and in the new cabinet the two European controllers were changed into responsible ministers entrusted respectively with the portfolios of the ministries of Public Works and Finance. The new order soon became irksome to the autocratic spirit of Ismaïl. The dismissal of the ministry, followed by the opposition of the Khedive to the later measures recommended by the commission of inquiry, culminated in his deposition in June 1879. Through the joint action of the British and French Governments, the Dual Control was re-established in a different form, with increased powers. The two controllers took part in the deliberations of the council of ministers, and worked together in their supervision of the financial administration, the principle of dividing their functions being abandoned.

These changes enabled the financial proposals of the commission of inquiry to be put into execution, and shortly after the accession of Tewfik they were embodied in the law of liquidation of July 1880, the next general settlement of the liabilities of Egypt. By this law the floating debt was paid off and the debt consolidated into a few large loans, the rate of interest being reduced to what it was at the time considered just possible for the country to pay. Under this settlement the Egyptian debt was composed as follows:—

| | |
|---|---|
| Privileged debt | £22,609,000 [1] |
| Unified debt | 58,018,000 |
| Daïra loan | 9,513,000 |
| Domains loan | 8,500,000 |
| | £98,640,000 |

The rate of interest was fixed at 5 per cent. on the privileged and Domains loans, and 4 per cent. on the unified and Daïra loans, the latter being entitled to an additional 1 per cent. contingent on certain circumstances that have never arisen. The total annual encumbrances of the country, including the tribute due to Turkey and the interest on the Suez Canal shares bought by Great Britain, but excluding the interest on the Daïra and Domains loans—which were expected to be defrayed by the revenues of the respective estates on which these loans were secured—amounted to four and a half million pounds, about half the then annual revenue of Egypt. Further, the revenue was divided between the Government and the bondholders, any surplus in the latter's share after full

[1] The figures of the Egyptian debt are always given in pounds sterling.

payment of the interest being devoted to redemption of the capital. A brief period of prosperity followed the passing of the law of liquidation, but the Arabist rebellion and the events which culminated in the British occupation of Egypt in September 1882, immediately followed by the disastrous reverses in the Sudan, again plunged the country into financial embarrassment. A new loan was absolutely necessary to settle the Alexandria indemnities and to pay off the liabilities arising out of the rebellion and the Sudan war. Moreover, the proportion of the revenue assigned to the Government by the law of liquidation was altogether insufficient for the expenses of administration, so that while the sinking fund was in full operation, the Treasury was compelled to borrow on short loans at high rates of interest in order to meet its ordinary expenditure. At the initiative of the British Government, negotiations were begun with the Great Powers and Turkey, which, after prolonged discussions, resulted in the London convention of March 1885. That convention was the last settlement of the liabilities of Egypt, and, with a few subsequent modifications of detail, its dispositions form the organic law under which Egyptian finance is administered at the present day.

*British control.*

It will be convenient here to state, as briefly as possible, the exact position of the Egyptian Government in respect of its financial autonomy, as established by the various treaties, conventions, and agreements in force. By the Imperial firman of June 1873, the Khedive of Egypt obtained, subject to the payment of an annual tribute to Turkey of £696,000, complete fiscal autonomy, including the right to conclude commercial conventions and to raise loans. The latter privilege was taken away by the firman appointing Tewfik Pasha, and since that time Egypt cannot raise a loan without the previous consent of the Sultan. The international obligations of Turkey remained, of course, binding upon Egypt, and amongst them the capitulations, by which certain privileges are conferred upon foreigners resident in the Ottoman dominions. From a financial point of view the most important of these privileges—based to a certain extent on the text of the original treaties, but still more on an abusive extension in practice which had grown up in Egypt—is immunity from all direct taxation without the assent of their respective governments. The only exception, resulting from the Ottoman law under which foreigners are allowed to acquire and hold real property, is in the case of the land-tax. At the present time all taxes that were formerly paid by natives and not by foreigners have been abolished in Egypt, but the immunity described above constitutes a most serious obstacle to all schemes for redistributing the burden of taxation in a more equitable manner. The supervision exercised over the finances of Egypt by the French and British controllers prior to the British occupation was abolished in 1883, and replaced by that of a British official called the Financial Adviser. This functionary is appointed by the Khedive on the recommendation of the British Government, and has a seat on the council of ministers, but without a vote. It has been laid down by the British Government that "no financial decision should be taken without his consent," an interpretation which has never been questioned by the Egyptian Government. In addition to the control of the Financial Adviser, there exist in Egypt certain commissions or boards, known as "Mixed Administrations," appointed in virtue of international agreements, and having relations of a more or less ill-defined, but quasi-independent character with the Egyptian ministry of finance. First and foremost is the Caisse de la Dette, on which, since 1885, the six Great Powers—France, Austria, Italy, Great Britain, Germany, and Russia—are represented. The functions of the Caisse, originally limited to receiving certain assigned revenues on behalf of the bondholders, have since that date become much more important. The exact extent of their powers is not capable of accurate definition, nor would it be possible to lay down limits which would meet with general acceptance from all parties. The widest interpretation of their functions that has been put forward would give them the right to control, on behalf of the Powers of Europe, the due execution by the Egyptian Government of almost all the complicated international agreements regarding the finances of the country. In virtue of the law of liquidation, their assent, as well as that of the Sultan, is necessary before any new loan can be issued. No portion of the general reserve fund can be used without their sanction. All questions are decided by the vote of the majority of the members, with the exception of grants for extraordinary military expenditure, which, by an arrangement concluded with the Powers in November 1899, require unanimity. All assigned revenues are paid directly to the Caisse de la Dette by the collecting departments without passing through the Ministry of Finance. After the Caisse de la Dette come the Railway Board and the Commissions of the Daïra and Domains, each consisting of three members—an Englishman, a Frenchman, and an Egyptian. The former administers the railways, telegraphs, and port of Alexandria, paying the net receipts, after deduction of the expenses, fixed for the railways at 45 per cent. of the gross receipts, into the Caisse. The Daïra and Domains Commissions administer the large estates that are mortgaged to the holders of those loans. Out of the net profits they pay the annual interest charge, and any surplus and the produce of the sales of land are employed in paying off the capital. Should the net profits in any year be insufficient to meet the coupon, the Egyptian Government is bound to make good the difference. Since their creation both these administrations showed an annual deficit up to 1890. From that date, with the exception of the year 1895, the Daïra has yielded a surplus; but the Domains continued to be administered at a considerable loss, which formerly varied between £50,000 and £200,000 a year, down to 1900, in which year there was a surplus for the first time.

*Financial status.*

It is now possible to explain the working of the financial system prescribed by the London convention. The principle of dividing the revenues of the country between the Ministry of Finance and the Caisse de la Dette was maintained. The revenue assigned to the service of the debt remained as before, so that the security of the bondholders was in no way diminished. At the same time it was recognized that the non-assigned revenue was insufficient to meet the expenses of administration. A certain scale of administrative expenditure was, therefore, authorized, and the Caisse, after paying in full the interest on the debt, had to make good out of the balance of the assigned revenue any deficit between the authorized expenditure and the non-assigned revenue. If, after making good any such deficit, a surplus still remained, this surplus was divided equally between the Caisse and the Government, the share of the former being applied to the reduction of the debt, while the Government was free to dispose of its share as it thought best. By an arrangement with the Powers, concluded in 1888, the Caisse's half-share in the surplus is now paid into a reserve fund, and the sinking fund is suspended until that fund amounts to two millions. The authorized expenditure for administrative purposes was originally fixed at £E.5,237,000,[1] but by subsequent agreement with the Powers certain other items have been added, so that in

*Working.*

[1] The Egyptian pound = £1, 0s. 6d.

1900 it amounted to £E.6,195,000. The effective administrative expenditure has always exceeded the amount fixed by the London convention, and of late years the growing wants of a country in process of development have naturally had a tendency to increase this excess. Any excess can, however, only be met out of the half-share of the eventual surplus which is at the free disposal of the Government. Consequently, in order to meet new expenditure necessitated by the new requirements of the country, just double the amount of revenue must be raised. One-half of the new revenue increases the Government share of the surplus, and thereby pays for the new expenditure. The other half goes for the moment into the general reserve fund, and would ultimately, when that fund has attained its maximum, be employed in reducing the debt. This limitation of administrative expenditure is the great blot in the system designed by the authors of the London convention, and now that the resources of the state are greatly on the increase, it has become a serious obstacle to the development of the national prosperity. The London convention left the permanent rate of interest on the debt, as fixed by the law of liquidation, unchanged, but in order to afford temporary relief to the Egyptian exchequer, a reduction of 5 per cent. on the interest of the debt was granted for two years, on the condition that if at the end of that period payment, including the arrears of the two years, was not resumed in full, another international commission was to be appointed to examine into the whole financial situation. Lastly, the London convention empowered Egypt to raise a loan of nine millions, guaranteed by all the Powers, at a rate of interest of 3 per cent. For the service of this loan an annuity of £315,000 is provided in the Egyptian budget for interest and sinking fund. This sum was sufficient to pay the Alexandria indemnities, to wipe out the deficits of the preceding years, to give the Egyptian treasury a working balance of £E.500,000 and thereby avoid the creation of a fresh floating debt, and to provide a million for new irrigation works. To the wise foresight which, at a moment when the country was sinking beneath a weight of debt, did not hesitate to add this million for expenditure on productive works, the present prosperity of Egypt is largely due.

*1885-1899.*

During the two years that followed the London convention, the financial policy of the Egyptian Government was directed to placing the country in a position to resume full payment of the interest on the debt in 1887, and thereby to avoid the appointment of an international commission. By the exercise of the most rigid economy in all branches this end was attained, though budgetary equilibrium was only secured by a variety of financial expedients, justified by the vital importance of saving Egypt from further international interference. By such means this additional complication was averted, but the struggle to put Egypt in a genuinely solvent position was by no means over. It was not until his report on the financial results of 1888 that Sir Evelyn Baring (afterwards Lord Cromer) was able to inform the British Government that the situation was such that "it would take a series of untoward events seriously to endanger the stability of Egyptian finance and the solvency of the Egyptian Government." From this moment the corner was turned, and the era of financial prosperity commenced. The results of the labours of the preceding six years began to manifest themselves with a rapidity which surprised the most sanguine observers. The principal feature of the successive Egyptian budgets from 1890 was the fiscal relief afforded to the population. This period may be said to have been brought to a close in 1894, though a subsequent reduction of the land-tax by £E.216,000 a year was effected in 1898. From 1894 onwards it was thought desirable to pay more attention than heretofore to the legitimate demands of the spending departments. Accordingly, money was devoted to remunerative objects, such as irrigation works, railway extension, and also to others, such as the construction of hospitals, prisons, and other public buildings, the improvement of education, &c., which, although not directly remunerative, are equally necessary to the well-being of the country. In 1896 the decision of the British Government to undertake the expedition to Dongola, leading by the natural progress of events to the reconquest of the Sudan, subjected the finances of Egypt to a severer strain than had been experienced since they had been placed on a sound footing. The endeavour to obtain assistance towards the cost of the military operations from the general reserve fund, with the co-operation of the Caisse de la Dette, failed, owing to an adverse decision of the Mixed Tribunals as to the legality of such a course. Nevertheless, with a certain amount of financial aid from the British Government, the Egyptian treasury was able to meet the expenditure of the campaign without recourse to extraordinary expedients. The conduct of the war was quite as remarkable from a financial as from a military point of view, and there have been few instances in history of such great results being obtained at such comparatively small cost. The total amount expended for the whole campaign, from the commencement of the Dongola expedition to the capture of Omdurman, was in round figures two millions. Of this about £E.900,000 was spent on railway and telegraph construction, works of permanent utility, the balance of £E.1,100,000 representing the purely military expenditure. After the conclusion of the campaign a further sum of £E.300,000 was granted for the extension of the railway to Khartum. The British Government gave a grant-in-aid of £800,000, and the balance was borne by the Egyptian treasury out of its half-share in the annual surpluses. So far, then, the finances of the country triumphantly stood the test to which they were subjected. But a graver problem preoccupied the minds of those who were responsible for the financial administration of Egypt, and that was whether the resources of the country could support the annual burden of the occupation and government of so large an area without detriment to the normal development of Egypt itself. It was wisely decided to leave no room for doubt on this point, by at once taking steps to increase those resources on a large scale in the immediate future. A vast scheme for the construction of a reservoir at Assuan for the storage of the waters of the Nile had long been under consideration. In 1898 a financial arrangement was concluded whereby the execution of this project, which will enormously increase the productive powers of the country, was at once put in hand. The original estimate of the cost of the works was two millions, and the Egyptian Government arranged to meet the expenditure by the payment of an annuity of £160,000 a year for thirty years, beginning from the 1st July 1903. This important undertaking was brought to a successful termination in 1902, and the actual expenditure incurred amounted to about £E.3,250,000. The difference between the sum originally provided and the ultimate cost was granted by the Caisse de la Dette out of the general reserve fund. In the course of 1899 a great financial reform, the desirability of which had long made itself felt, was seriously taken in hand, namely, the reassessment of the land-tax. The existing assessment, which was made before the British occupation, had long been condemned by all competent authorities, but the inherent intricacies and difficulties of the problem had hitherto postponed a solution. After careful study and a preliminary examination

of the land, a scheme was passed which has given satisfaction to the land-owning community, and which will, when completed, distribute the tax equitably in proportion to the fertility of the soil.

***Results: 1883-1900.*** This brief sketch of the history of Egyptian finance would not be complete without a few statistics showing more definitely the remarkable progress made since 1883. The following particulars, giving the general financial results obtained since the commencement of the British occupation, are taken from Lord Cromer's reports and other official publications. The difference between the real ordinary revenue and expenditure of the Egyptian Government during these years is shown in the following table:—

| Year. | Surplus. | Deficit. |
|---|---|---|
| | £E | £E. |
| 1883 | ... | 921,000 |
| 1884 | ... | 460,000 |
| 1885 | ... | 733,000 |
| 1886 | ... | 492,000 |
| 1887[1] | 348,000 | ... |
| 1888 | ... | 53,000 |
| 1889 | 218,000 | .. |
| 1890 | 647,000 | . |
| 1891 | 933,000 | .. |
| 1892 | 746,000 | ... |
| 1893 | 687,000 | ... |
| 1894 | 692,000 | .. |
| 1895 | 1,003,000 | ... |
| 1896 | 1,089,000 | ... |
| 1897 | 1,383,000 | ... |
| 1898 | 1,332,000 | ... |
| 1899 | 1,270,000 | ... |
| 1900 | 1,552,000 | ... |

This table shows very clearly the cleavage line between the period of semi-insolvency and that of prosperity through which Egypt has passed. During the four years 1883–86, both inclusive, the aggregate deficit amounted to £E.2,606,000. By 1886 the Sudan expenditure had greatly diminished. The efforts of the reformers, notably those of the irrigation officers, had begun to bear fruit. The aggregate surplus of the fourteen years from 1887 to 1900, both inclusive, was £E.11,847,000. During the same period direct taxation was reduced to the extent of about £E.1,275,000 a year. Arrears of land-tax to the extent of £E.1,245,000 were remitted. In the domain of indirect taxes the salt-tax was reduced by 40 per cent., the postal and telegraph rates were reduced by 50 per cent., and the octroi duties were abolished in all the provincial towns. Large reductions were made in the railway rates. The only increase of taxation was in the tobacco duty, which has been raised from P.T. 14 to P.T. 20 per kilogramme. The house-tax was also imposed on European residents in Egypt. In spite of the great relief thus afforded to the taxpayers of Egypt, the revenue increased by £E.2,512,000. In 1883 a revenue of £E.8,935,000 was wrung with difficulty from the country. In 1900 £E.11,447,000 was collected with ease. On the other hand, a stringent control has been exercised over the expenditure. In 1883 the "ordinary" expenditure amounted to £E.9,856,000. In 1900 it amounted to £E.9,895,000, an increase of only £E.39,000.

***Fall in prices: 1885-1898.*** In connexion with this subject it must be borne in mind that, during the period under review, Egypt has suffered very severely from the general fall in prices. Had it not been for the great increase of production, the result of improvements in the system of irrigation, and the fiscal relief afforded to the landowners, the agricultural depression would, without doubt, have seriously impaired the financial situation. Cotton and sugar are the two principal products of the country, forming together about 90 per cent. of the total value of the exports. The following tables show the amount and value of the cotton and sugar crops from 1885 to 1898:—

*Cotton.*

| Season. | Cantars of 50 Kilos. | Price per Cantar. | Value. |
|---|---|---|---|
| | | P.T.[1] | £E. |
| 1885–86 | 2,905,000 | 228 | 6,625,000 |
| 1886–87 | 3,026,000 | 240 | 7,262,000 |
| 1887–88 | 2,963,000 | 249 | 7,382,000 |
| 1888–89 | 2,766,000 | 264 | 7,310,000 |
| 1889–90 | 2,872,000 | 294 | 8,455,000 |
| 1890–91 | 3,638,000 | 255 | 9,281,000 |
| 1891–92 | 4,195,000 | 205 | 8,594,000 |
| 1892–93 | 4,610,000 | 206 | 9,510,000 |
| 1893–94 | 4,548,000 | 191 | 8,707,000 |
| 1894–95 | 4,347,000 | 168 | 7,326,000 |
| 1895–96 | 4,695,000 | 220 | 10,342,000 |
| 1896–97 | 5,177,000 | 195 | 10,089,000 |
| 1897–98 | 5,765,000 | 157 | 9,040,000 |
| 1898–99 | 5,056,000 | 175 | 8,832,000 |

*Cotton Seed.*

| Season. | Ardebs.[2] | Price per Ardeb. | Value. |
|---|---|---|---|
| | | P.T. | £E. |
| 1885–86 | 1,967,000 | 62 | 1,229,000 |
| 1886–87 | 2,307,000 | 55 | 1,264,000 |
| 1887–88 | 2,182,000 | 58 | 1,277,000 |
| 1888–89 | 2,080,000 | 68 | 1,412,000 |
| 1889–90 | 2,211,000 | 61 | 1,344,000 |
| 1890–91 | 2,828,000 | 52 | 1,486,000 |
| 1891–92 | 3,128,000 | 58 | 1,828,000 |
| 1892–93 | 3,157,000 | 60 | 1,898,000 |
| 1893–94 | 3,032,000 | 58 | 1,756,000 |
| 1894–95 | 2,708,000 | 43 | 1,159,000 |
| 1895–96 | 2,982,000 | 41 | 1,213,000 |
| 1896–97 | 3,526,000 | 39 | 1,393,000 |
| 1897–98 | 3,736,000 | 41 | 1,542,000 |
| 1898–99 | 3,163,000 | 46 | 1,446,000 |

*Sugar.*

| Year. | Tons of 1000 Kilos. | Price per 100 Kilos. | Value. |
|---|---|---|---|
| | | P.T. | £E. |
| 1885 | 50,000 | 116 | 579,000 |
| 1886 | 43,000 | 106 | 453,000 |
| 1887 | 50,000 | 99 | 490,000 |
| 1888 | 47,000 | 115 | 541,000 |
| 1889 | 37,000 | 135 | 497,000 |
| 1890 | 30,000 | 113 | 339,000 |
| 1891 | 52,000 | 110 | 573,000 |
| 1892 | 55,000 | 127 | 705,000 |
| 1893 | 55,000 | 138 | 761,000 |
| 1894 | 56,000 | 111 | 629,000 |
| 1895 | 55,000 | 86 | 473,000 |
| 1896 | 74,000 | 104 | 765,000 |
| 1897 | 73,000 | 87 | 635,000 |
| 1898 | 58,000 | 94 | 544,000 |

*Trade and Commerce, 1884–98.*—The following table shows the average annual value of the total imports and exports, excluding bullion, for the three quinquennial periods between 1884 and 1898:—

| Period. | Imports. | Exports. | Total Trade. |
|---|---|---|---|
| | £E. | £E. | £E. |
| 1884–88 | 8,257,000 | 11,106,000 | 19,363,000 |
| 1889–93 | 8,423,000 | 12,887,000 | 21,310,000 |
| 1894–98 | 9,822,000 | 12,592,000 | 22,414,000 |

Owing to the great perturbation of prices that has characterized the period under review, the above figures give a very imperfect impression of the real growth of the trade of the country. A clearer view is obtained by comparing the quantities of some of the

[1] Owing to a change in the way of making up the accounts, normal expenditure of £E.340,000 was not included in the accounts of 1887, so that there was practically financial equilibrium in that year.

[1] 100 P.T. = £E.1 = £1, 0s. 6d.

[2] An ardeb of cotton seed weighs 267 lb.

more important categories of imports and exports. In the following tables those articles have been selected which have an intimate connexion with the national prosperity :—

*Average Annual Imports.*

| Period | Cotton Goods. | Steel and Iron Goods. | Building Wood | Coal. |
|---|---|---|---|---|
| | Kilos. | Tons. | £E. | Tons. |
| 1884–88 | 13,452,000 | 12,000 | 308,000 | 449,000 |
| 1889–93 | 13,665,000 | 25,000 | 388,000 | 513,000 |
| 1894–98 | 16,984,000 | 34,000 | 513,000 | 701,000 |

*Average Annual Exports.*

| Period. | Cotton. | Cotton Seed. | Sugar. | Onions. |
|---|---|---|---|---|
| | Kantars. | Hectolitres. | Kilos. | Kantars. |
| 1884–88 | 2,707,000 | 4,240,000 | 38,919,000 | 226,000 |
| 1889–93 | 3,659,000 | 5,425,000 | 43,375,000 | 656,000 |
| 1894–98 | 4,951,000 | 6,458,000 | 63,147,000 | 1,083,000 |

**Debt.** On the 31st December 1900 the total amount of the Egyptian debt was £102,714,000, of which £7,273,000 was held by the commissioners of the debt on account of the general reserve fund and the fund of the economies of the conversion, as will be explained hereafter, thus leaving £95,441,000 in the hands of the public. The particulars of the different loans are shown in the accompanying table :—

| | On the Market. | Held by the Caisse de la Dette. | Total. |
|---|---|---|---|
| | £ | £ | £ |
| Guaranteed loan 3 per cent. | 8,333,000 | 392,000 | 7,941,000 |
| Preference debt 3½ per cent. | 29,393,000 | 1,055,000 | 28,338,000 |
| Unified debt 4 per cent. | 55,972,000 | 5,493,000 | 50,479,000 |
| Domains loan 4¼ per cent. | 2,899,000 | 2,000 | 2,897,000 |
| Daïra Sanieh loan 4 per cent. | 6,117,000 | 331,000 | 5,786,000 |
| Total | 102,714,000 | 7,273,000 | 95,441,000 |

In June 1890 the assent of the Powers was obtained to the conversion of the preference, Domains, and Daïra loans on the following conditions, imposed at the initiative of the French Government :—

1. The employment of the economies resulting from the conversion was to be the subject of future agreement with the Powers.
2. The Daïra loan was to be reimbursed at 85 per cent., instead of 80 per cent., as provided by the law of liquidation.
3. The sales of Domains and Daïra lands were to be restricted to £E.300,000 a year each, thus prolonging the period of liquidation of those estates.

The interest on the preference stock was reduced from 5 to 3½ per cent., and on the Domains from 5 to 4¼ per cent. As regards the Daïra loan, there was no apparent reduction in the rate of interest, which remained at 4 per cent., but the bondholders received £85 of the new stock for every £100 of the old. The annual economy to the Egyptian Government amounted at the time of the conversion to £E.348,000. Further, an engagement was entered into that there should be no reimbursement of the loans till 1905 for the preference and Daïra, and 1908 for the Domains. By an arrangement concluded in June 1898, between the Egyptian Government and a syndicate, the unsold balance of the Daïra estates will be taken over by the syndicate in October 1905, for the amount of the debt remaining. The Daïra loan will then cease to exist.

The total amount of Egyptian bonds on the market on the 1st January 1883 and 1st January 1901 respectively was as follows :—

| | |
|---|---|
| 1st January 1883 | £96,457,000 |
| 1st January 1901 | 95,441,000 |
| Showing a reduction of | £1,016,000 |

During this period fresh debt was incurred for the following purposes :—

| | |
|---|---|
| Alexandria indemnities | £4,250,000 |
| Deficits of years prior to 1886, including Sudan | 4,030,000 |
| Commutations of pensions and allowances of the Khedivial family | 2,769,000 |
| Treasury working balance | 513,000 |
| Irrigation works | 1,959,000 |
| Expenses of loans (commissions, &c.) | 1,169,000 |
| | £14,690,000 |
| *Less*—Paid out of special receipts (sales of land, &c.) | 1,305,000 |
| Leaving a net increase on this account of | £13,385,000 |
| To this sum must be added the amount by which the debt was increased in consequence of the conversion of the preference and Daïra stocks | 1,945,000 |
| Making a total increase of | £15,330,000 |

On the other hand, the amount of bonds on the market has been diminished by the following amounts :—

| | | |
|---|---|---|
| By sales of property (mostly Daïra and Domains) | £6,304,000 | |
| By surplus revenue, of which £7,273,000 is now held by the commissioners of the debt | 10,042,000 | |
| | | £16,346,000 |
| Making a net reduction of | | £1,016,000 |

These figures are remarkable. They show that in spite of about £13,000,000 having been borrowed for various objects, and in spite of conversion operations, which added nearly £2,000,000 to the capital of the debt, the total amount of Egyptian bonds on the market in 1901 was one million less than in 1883. This result was mainly, although not entirely, due to the system under which large sums of money remained at the close of each year in the hands of the commissioners of the debt, and were by them invested in Egyptian stocks. Whatever objections may on other grounds be urged against this system, it cannot be doubted that its result is to accumulate what is practically a large and ever-increasing sinking fund. During the five years 1896–1900 debt was either paid off or withdrawn from the market by Government purchase at an average rate of no less than £1,262,000 a year. It should be added that the interest charge on the bonds on the market, which on the 1st January 1883 stood at £4,166,000, was in 1901 £3,604,000, a diminution of £562,000.

**Reserve Funds.** In order to give a complete account of the financial position of the Egyptian Government, some explanation must be supplied of the various reserve funds which are in operation. The general reserve fund was created with the assent of the Powers by the decree of the 12th July 1888. Beginning with a sum of £E.340,000, being the amount saved by a change in the system of accounts introduced in 1887, this fund is increased annually by the share of the Caisse in the surplus, by the interest on the invested accumulations, and by the produce of the sale of certain Government lands. When the unpledged portion of the fund reaches the sum of £E.2,000,000, no further accumulation is allowed under the provisions of the above-mentioned decree, and the excess has to be applied to sinking fund. Up to the end of 1901 this contingency had never occurred. The fund is primarily intended to be used in making good any deficiency in the payment of the interest on the debt or of the administrative expenditure authorized by the London convention and subsequent agreements. It may also be drawn upon for extraordinary expenditure with the previous consent of the commissioners of the Caisse. The total amount paid into the general reserve fund, from its constitution in 1888 down to the end of 1900, was £E.8,106,000, of which £E.4,577,000 was actually spent on extraordinary expenditure, and a further sum of

£E.2,342,000 was pledged for the execution of various works in course of progress, leaving an unpledged balance of £E.1,187,000. Out of the total amount advanced, £E.2,305,000 was granted for drainage and irrigation works, £E.2,669,000 for improving the state railways, £E.1,113,000 for the construction of public buildings, &c., and £E.647,000 for the relief of taxation. The unemployed balance of the fund, including the portion that is pledged but has not yet been actually advanced, is invested in Egyptian stocks. The special reserve fund was constituted in 1886, and is chiefly made up out of the net savings of the Government on its share of the annual surpluses. This fund is at the absolute disposal of the Egyptian Government. Since its creation the total receipts have amounted to £E.4,815,000. At the end of 1900 extraordinary expenditure to the amount of £E.4,006,000 had been charged to this fund, leaving an apparent balance of £E.809,000. As, however, further expenditure amounting to £E.50,000 had been authorized, although not actually incurred, when the accounts of 1900 were closed, the real state of the fund was a surplus of £E.759,000. The whole of the extraordinary expenditure of the Sudan campaign, with the exception of the amount granted on this account by the British Government, was charged to the special reserve fund, amounting, in round figures, to £E.1,500,000. The principal remaining items that have been debited to this fund are £E.758,000 for commutation of pensions and £E.350,000 for reproductive works.

*Conversion economies.*

A third fund is formed by the accumulation of the economies resulting from the conversion of the privileged, Domains, and Daira loans in 1890. As already explained, this fund cannot be employed without the assent of the Powers. Up to the end of 1899 none of the numerous proposals submitted by Egypt had proved acceptable to the French Government. In the meantime, the annual economies, amounting, in 1900, to £E.307,000, together with the interest on the accumulations of the past, were invested in Egyptian stocks by the Caisse de la Dette, and on the 31st December 1900 the value of the fund amounted to £E.4,002,000. This system virtually acts as a sinking fund, but one of a very expensive nature for the Egyptian Government, inasmuch as bonds which the Government have the legal right to pay off at par are purchased at the market price, which is, and appears likely to remain, considerably above par. While on this branch of the subject it may be of interest to refer to a passage in Lord Cromer's annual report for 1898, in which, after giving an approximate estimate of the annual charges unnecessarily borne by Egypt, he concludes by stating that, "broadly speaking, it is no exaggeration to say that internationalism imposes an extra charge of about £1,750,000 a year on the Egyptian treasury."

*Egyptian Budget.*

In conclusion, it may be useful to give a brief analysis of the latest published accounts, namely, those for 1900. The total revenue amounts to £E.11,663,000, in which figure is included an annual contribution of £E.216,000 from the general reserve fund, the result of an arrangement with the Powers to make good to the Government a reduction of the land-tax to that amount. This item is therefore not real revenue, but a mere transfer. Of the above revenue £E.7,339,000 was assigned to the service of the debt and was paid into the Caisse de la Dette, and the balance, £E.4,324,000, was received directly by the Government treasury. The service of the debt, including the economies of the conversion of the preference stock, amounted to £E.3,614,000, which figure is exclusive of a sum of £E.181,000 charged to the administrative budget on account of the debt, and the administrative expenditure, as authorized by the London convention and subsequent arrangements, to £E.6,195,000. There remained, therefore, a sum of £E.1,854,000 to be divided between the Government and the general reserve fund. In virtue of certain agreements made with the Powers, the share of the Government, originally fixed at one-half by the London convention, is increased by £E.45,000, and therefore amounted to £E.972,000. From this must be deducted the difference between the real and the authorized expenditure, namely, £E.413,000, so that the real surplus at the disposal of the Egyptian Government was £E.559,000. On the other hand, the amount received by the general reserve fund must be reduced by the contribution of £E.216,000 to the ordinary revenue to which allusion has already been made. The actual amount paid into the general reserve fund was, therefore, £E.666,000 (the half-share £E.927,000 – £E.45,000 – £E.216,000). To sum up in an intelligible manner the results of this complicated system, the real surplus revenue of the country amounted to £E.1,552,000, of which £E.559,000 belongs to the Egyptian Government, £E.666,000 increases the general reserve fund, £E.265,000, representing the economies of the conversion of the preference stock, is paid into the economies fund, and £E.62,000 is devoted to sinking fund.

The chief item of revenue is the land-tax, which brought in £E.4,367,000. The cultivated area paying taxes amounts to 5,541,000 feddans,[1] so that the average tax per feddan is 788 milliemes (= 15s. 4d.). The customs (including the duty on tobacco) produced £E.2,418,000, and the railways £E.2,159,000. These three heads of revenue account for £E.8,944,000, equal to 77 per cent. of the total receipts. The actual revenue collected amounted to £E.11,447,000, of which a certain proportion consists of receipts from administrations rendering direct service to the public, such as the railways, telegraphs, post office, &c. The net receipts from these latter services do not yield more than a normal return on the capital that has been expended on them. Deducting these and certain other items of revenue, which are also not taxation properly so called, such as rents from state property, the total amount paid by the Egyptian taxpayer works out to £E.8,502,000, or 813 milliemes (= 15s. 10d.) per head of the population, as compared with £E.1·014 (= £1, 0s. 9d.) in 1883.

The total expenditure in 1900 was £E.11,104,000. Under the existing system of accounts, first introduced in 1896, this figure includes (1) a sum of £E.265,000, being the annual economy resulting from the conversion of the preference debt; (2) a sum of £E.62,000 paid into sinking fund; and (3) a sum of £E.882,000, being the amount paid to the general reserve fund. As already explained, £E.216,000 of the latter sum is repaid to the Government on account of the reduction of the land-tax. The balance of £E.9,895,000 represents the effective expenditure of the year. The details of this expenditure may be summarized as follows:—

| | |
|---|---|
| 1. Charges on account of the tribute and the debt | £E.4,340,000 |
| 2. Expenditure on railways, telegraphs, post office, and other revenue-paying departments | 1,295,000 |
| 3. Khedivial civil list and allowances to the Khedivial family | 258,000 |
| 4. Administration | 2,228,000 |
| 5. Army (including the expenses of the army of occupation) | 807,000 |
| 6. Pensions | 433,000 |
| 7. Suppression of the corvée | 400,000 |
| 8. Sudan deficit | 134,000 |
| Total | 9,895,000 |

[1] The feddan is practically equivalent to the English acre.

As regards the last item, it should be observed that the total cost of the civil administration of the Sudan in 1900 was £E.332,000. The revenue amounted to £E.157,000, leaving a deficit of £E.175,000, which was borne by the Egyptian Treasury. Of this sum £E.134,000 (representing the amount provided in the budget on this account) was included in the ordinary expenditure of the Egyptian Government for 1900, and the balance of £E.41,000 was advanced out of the special reserve fund. The Sudan budget is also charged with a certain proportion of the army expenditure, amounting in 1900 to £E.283,000. This represents the additional expenditure due to the reoccupation of the Sudan. The real cost of the Sudan to Egypt in 1900 was therefore £E.458,000.

*Currency.*

The monetary system in force in Egypt dates from 1885, when through the efforts of Sir Edgar Vincent the currency was placed on a sound footing. Before that time the multiplicity of foreign silver coinage that circulated throughout the country caused grave inconvenience in all commercial transactions. The present system is based on the single gold standard, silver, nickel, and bronze being used for the subsidiary coinage. The unit is the Egyptian pound, which is divided into 100 piastres, the piastre being again divided into 10 milliemes. The Egyptian pound weighs 8·500 grammes, and contains 875 parts out of 1000 of fine gold. Its approximate value in English currency is £1, 0s. 6d. The subsidiary coinage consists of pieces of 20, 10, 5, 2, and 1 piastres in silver; 5, 2, and 1 milliemes in nickel; and ½ and ¼ millieme in bronze. These coins are token coins, their intrinsic value being considerably less than their nominal value. The amount in circulation is controlled by the Ministry of Finance, and the coins are changed into gold on demand at the Government treasury. They are only legal tender up to 200 piastres. The history of the currency reform in Egypt is interesting as affording a practical example of a system which has been much discussed in connexion with the currency question in India, namely, a gold standard without a gold coinage. The Egyptian pound is practically non-existent, nearly all that were coined having been withdrawn from circulation. Their place has been taken by foreign gold, principally the English sovereign, which circulates at a value of 97½ piastres. In practice the system works perfectly smooth, the gold flowing in and out of the country through the agency of private banking establishments in proportion to the requirements of the circulation. It is, moreover, very economical for the Government. As in most agricultural countries, there is a great expansion of the circulation in the autumn and winter months in order to move the crops, followed by a long period of contracted circulation throughout the rest of the year. Under the above system, the fluctuating requirements of the currency are met without the expense of alternately minting and melting down. Recently paper money has been introduced into the country, this privilege having been conceded by the Government to the National Bank. The notes are of the following values:—£E.100, £E.50, £E.10, £E.5, £E.1, and 50 piastres—and are payable in gold on demand. The issue department is kept wholly distinct from the general business of the Bank. An amount not exceeding one-half of the value of the notes in circulation may be invested in Egyptian stocks, and the balance of the reserve must always be held in gold. The notes are not legal tender, but are accepted by the Government in payment of taxes. Sufficient time has not yet elapsed to state whether this form of currency will become popular among the native population.

(J. L. G.)

## ARMY.

The fellah soldier may be aptly likened to a bicycle, which although incapable of standing up alone, is very useful while under the control of a skilful master. As is the soldier, so is the army. It is generally believed that the successes gained in the time of the Pharaohs were due to foreign legions; and from Cambyses to Alexander, from the Ptolemies to Antony (Cleopatra), from Augustus in the 7th century throughout the Arab period, and from Saladin's dynasty down to the middle of the 13th century, the military power of Egypt was dependent on mercenaries. The Mamelukes (slaves), imported from the eastern borders of the Black Sea and then trained as soldiers, usurped the government of Egypt, and held it till 1507, when the Ottomans began to rule. This form of government, speaking generally, endured till the French invasion at the end of the 18th century. British and Turkish troops drove the French out after an occupation of two years, the British troops remaining till 1803. Then Mehemet Ali, a small tobacconist of Kavala, Macedonia, coming with Albanian mercenaries, made himself governor, and later (1811), by massacring the Mamelukes, became the actual master of the country, and after seven years' war brought Arabia under Egypt's rule. He subdued Nubia and Sennar in 1820–22; and then, requiring a larger army, he obtained instructors from France. To them were handed over 1000 Turks and Circassians to be trained as officers, who later took command of 30,000 Sudanese. These died so rapidly in Egypt from pneumonia[1] that Mehemet Ali conscripted over 250,000 fellaheen, and in so arbitrary a fashion that many peasants mutilated themselves to avoid the much-dreaded service. The common practice was to place a small piece of nitrate of silver into the eye, which was then kept tightly bandaged till the sight was destroyed. Battalions were then formed of one-eyed men, and of soldiers who, having cut off their right-hand fingers, were made to shoot from the left shoulder. Every man who could not purchase exemption, with the exception of those living in Cairo, Alexandria, and Suez, on becoming 19 years old was liable nominally to 12 years' service; but many men were kept for 30 or 40 years, in spite of constant appeals. Nevertheless the experiment succeeded. The docile, yet robust and hardy peasants, under their foreign leaders, gained an unbroken series of successes in the first Syrian War; and after the bloody battle of Konia (1832), where the raw Turkish army was routed and the Grand Vizier taken prisoner, it was only European intervention which prevented the Egyptian General, Ibrahim Pasha, from marching unopposed to the Bosphorus. The defeat of the Turkish army at Nezib, in the second Syrian War (1839), showed that it was possible to obtain favourable military results with Egyptians when stiffened by foreigners and well commanded. Ibrahim, the hero of Konia, declared, however, that no native Egyptian ought to rise higher than the rank of sergeant; and in the Syrian campaigns nearly all the officers were Turks or Circassians, as were many of the non-commissioned officers. In the cavalry and artillery many of the privates were foreigners, numbers of the Janissaries who escaped the massacre at Stambul (1832) having joined Mehemet Ali's army.

*Early history.*

In the reign of Abbas, who succeeded Mehemet Ali, the Egyptian troops were driven from Nejd, and the Wahabi State recovered its independence. The next Khedive, Said,

[1] Similar mortality, though on a smaller scale, recurred in 1889, when Sudanese battalions coming from Suakin were detained temporarily in Cairo.

began as an ardent soldier, but took to agriculture, and at his death (1863) 3000 men only were retained under arms. Ismail, the next Khedive, immediately added 27,000 men, and in seven years was able to put 100,000 men, well equipped, in the field. He sent 10,000 men to help suppress a rebellion in Crete, and conquered the greater part of the (Nile) Sudan; but an expedition of 11,000 men, sent to Abyssinia under Prince Hassan and Rateb Pasha, well equipped with guns and all essentials, was, in two successive disasters (1875 and 1876), practically destroyed. The education of Egyptians in Continental cities had not produced the class of leaders who led the fellaheen to victory at Konia.

Ismail's exactions from the peasantry in 1880–81 reacted on the army, causing discontent; and when he was tottering on the throne he instigated military demonstrations against his own Government, and, by thus sapping the foundations of discipline, assisted Arabi's revolution; the result was the battle of Tel-el-Kebir, the British occupation, and the disbandment of the army, which at that time in Egypt Proper consisted of 18,000 men. Ismail had 500 field-guns, 200 Armstrong cannon, and factories of warlike and other stores. These latter were conducted extravagantly and badly administered.

In January 1883, Major-General Sir Evelyn Wood, V.C., was given £200,000, and directed to spend it in raising a fellaheen force of 6000 men for the defence of Egypt. He was assisted at first by 26 officers, amongst whom were two who later became successively Sirdars—Colonel F. Grenfell, commanding a brigade, and Lieutenant H. Kitchener, R.E., second in command of the cavalry regiment. There were four batteries, eight battalions, and a camel company. Each battalion of the 1st Infantry Brigade had three British mounted officers, Turks and Egyptians holding the corresponding positions in the battalions of the 2nd Brigade. The Sirdar selected these native officers from those of Arabi's followers who had been the least prominent in the recent mutiny; non-commissioned officers who had been drill-instructors in the old army were recalled temporarily, but all the privates were conscripted from their villages. The earlier merciless practice had been in theory abolished by a decree based on the German system, published in 1880; but owing to defective organization, and internal disturbances induced by Khedive Ismail's follies, the law had not been applied, and the 6000 recruits collected at Cairo in January 1883 represented the biggest and strongest peasants who could not purchase exemption by bribing the officials concerned. The difficulties experienced in applying the 1880 decree were great, but the perseverance of British officers gave the oppressed peasants, in 1885, an equitable law, since improved and altered by the Decree of 1900. Financial requirements have in more recent years caused the Sirdar to allow exemption by paying (Badalia) £20 before ballot. The Recruiting Superintending Committee, travelling through districts, supervise every ballot, and work under stringent rules which render systematic bribery difficult. The recruits who draw unlucky numbers at 19 years of age are seldom called up till they are 23, when they are summoned by name and escorted by a policeman to Cairo. To prevent substitution on the journey each recruit wears a string girdle sealed in lead. The periods of service are: with the colours, 5 years; in the reserve, 5 years, during which time they may be called up for police service, manœuvres, &c. The pay is 30 piastres (one piastre being worth 2½d.) per month for all services, and the liberal scale of rations of meat, bread, and rice remained as before in theory, but in practice the value of pay and food received was greatly enhanced. So also with the pension and promotion regulations. They were sufficiently liberal on paper, but had never been carried into effect.

*Reorganization.*

The efforts of 48 American officers, who under General Stone zealously served Ismail, had entirely failed to overcome Egyptian venality and intrigue; and in spite of the military schools, with a comprehensive syllabus, the only perceptible difference between the Egyptian officer and private in 1879 consisted, according to one of the Americans, in the fact that the first was the product of the harem, and the second of the field. Marshal Marmont, writing in 1839, mentions the capacity of the Egyptians for endurance; and it was tested in 1883, especially in the 2nd Brigade, since its officers (Turks and Egyptians), anxious to excel as drill-masters, worked their men not only from morn till eve, but also by lamplight in the corridors of the barracks. On the 31st March 1883, ten weeks after the arrival of the first draft of recruits, about 5600 men went through the ceremonial parade movements as practised by the British Guards in Hyde Park, with unusual precision. The British officers had acquired the words of command in Turkish, as used in the old army, an attempt to substitute Egyptian words having failed owing to lack of crisp, sharp-sounding words. As the Egyptian brigadier, who had spent some years in Berlin, spoke German fluently, and it was also understood by the senior British officers, that language was used for all commands given by the Sirdar on that special parade. The British drill-book, minus about one-third of the least serviceable movements, was translated by an English officer, and by 1900 every necessary British official book had been published in English and Arabic, except the new Recruiting Law (1885) and a manufacturing manual, for which French and Arabic editions are in use. The discipline of the old army had been regulated by a translation of part of the Code Napoleon, which was inadequate for an Eastern army, and the Sirdar replaced it by the Army Act of 1881, slightly modified and printed in Arabic.

The task undertaken by the small body of British officers was difficult. There was not one point in the former administration of the army acceptable to English gentlemen. That there had been no adequate auxiliary departments, without which an army cannot move or be efficient, was comparatively a minor difficulty. To succeed, it was essential that the fellah should be taught that discipline might be strict without being oppressive, that pay and rations would be fairly distributed, that brutal usage by superiors would be checked, that complaints would be thoroughly investigated, and impartial justice meted out to soldiers of all ranks. An epidemic of cholera in the summer of 1883 gave the British officers their first chance of acquiring the esteem and confidence of their men, and the opportunity was nobly utilized. While the patient fellah, resigned to the decrees of the Almighty, saw the ruling Egyptian class hurry away from Cairo, he saw also those of his comrades who were stricken tenderly nursed, soothed in death's struggles, and in many cases actually washed, laid out, and interred by their new self-sacrificing and determined masters. The regeneration of the fellaheen army dates from that epidemic.

When the Egyptian Army of the Delta was dispersed at Tel-el-Kebir, the Khedive had 40,000 troops in the Sudan, scattered from Massawa on the Red Sea to 1200 miles towards the west, and from Wadi Halfa, 1500 miles southward to Wadelai, near Albert Nyanza. These were composed of Turks, Albanians, Circassians, and some Sudanese. Ten thousand fellaheen, collected in March 1883, mainly from Arabi's former forces, set out from Duem, 100 miles south of Khartum, in September 1883, under Hicks Pasha, a dauntless retired Indian Army officer, to vanquish the Mahdi. They disappeared in the deserts

of Kordofan, where they were destroyed by the Mahdists about 50 miles south of El Obeid. In the wave of successful rebellion, except at Khartum, few of the Egyptian garrisons were killed when the posts fell, long residence and local family ties rendering easy their assimilation in the ranks of the Mahdists.

Baker Pasha, with about 4000 constabulary, who were old soldiers, attempted to relieve Tokar in February 1884. He was attacked by 1200 tribesmen and utterly routed, losing 4 Krupp guns, 2 machine guns, and 3000 rifles. Only 1400 Egyptians escaped the slaughter.

The Sirdar made an attempt to raise a battalion of Albanians, but the few men obtained mutinied when ordered to proceed to the Sudan, and it was deemed advisable, after the ringleaders had been executed, to abandon the idea, and rely on blacks to stiffen the fellaheen. Then the 9th (Sudanese) Battalion was created for service at Suakin, and four others having been successively added, these (with one exception—at Gedaref) have since borne the brunt of all the fighting which has been done by the Khedivial troops. The Egyptian troops in the operations near Suakin behaved well, however; and there were many instances of personal gallantry by individual soldiers. In the autumn of 1884, when a British expedition went up the Nile to endeavour to relieve the heroic Gordon, besieged in Khartum, the Egyptians did remarkably good work on the line of communication from Assiut to Korti, a distance of 800 miles, and the training and experience thus gained were of great value in all subsequent operations. The honesty and discipline of the fellah were undoubtedly of a high order. When the crews of the whale-boats were conveying stores, the forwarding officers tried to keep brandy and such like medical comforts from the European crews, coffee and tea from Canadian voyageurs, and sugar from Kroo boys. The only immaculate carrier was the Egyptian. A large sum of specie having failed under British escort to reach Dongola, an equivalent sum was handed to an Egyptian lieutenant of six months' service, with 10 men, and duly reached its destination.

Twelve years later the standard of honesty was unimpaired, and the British officers had imparted energy and activity into Egyptians of all ranks. The intelligent professional knowledge of the native officers, taught under British gentlemen, and the constant hard work cheerfully rendered by the fellah soldiers, were the main factors of the success achieved at Omdurman on the 2nd September 1898. The large depôts of stores at Assuan, Halfa, and Dongola could only be cursorily supervised by British officers, and yet when the stores were received at the advance depôt the losses were infinitesimal.

***Character of Egyptian soldier.***

By nature the fellah is unwarlike. Born in the valley of a great river, he resembles in many respects the Bengali, who exists under similar conditions; but the Egyptian has proved capable of greater improvement. He is stronger in frame, and can undergo greater exertion. Singularly unemotional, he stood up at Tel-el-Kebir after Arabi Pasha and all his officers, from general to subaltern, had fled, until he was mown down by case-shot poured in at close ranges. Near Trinkitat in 1883 he allowed himself to be slaughtered by tribesmen formerly despised, and about one-fourth of his comrades escaped. Baker Pasha's force was termed constabulary, yet his men were all old soldiers, though new to their gallant leader and to the small band of their brave but strange British officers. Since that fatal day, however, many of the fellaheen have shown they are capable of devoted conduct, and much has been done to raise in the soldiers a sense of self-respect, and, in spite of centuries of oppression, of veracity. The barrack square drill was smart under the old system, but there was no fire discipline, and all individuality was crushed. Now both are encouraged, and the men, receiving their full rations, are unsurpassable in endurance at work and in marching. All the troops present in the surprise fight at Firket in June 1896 had covered long distances, and one battalion (the 10th Sudanese) accomplished 90 miles within 72 hours, including the march back to railhead immediately after the action. The troops under Colonel Parsons, Royal Artillery, who beat the Dervishes at Gedaref, were so short of British officers that all orders were necessarily given in Arabic and carried to commanders of units by Arabs. While an Egyptian battalion was attacking in line, it was halted to repel a rush from the rear, and front and rear ranks were simultaneously engaged, firing in opposite directions—yet the fellaheen were absolutely steady; they shot well and showed no signs of trepidation. On the other hand, neither was there any exultation after their victory. It has been said by one who has perhaps more knowledge of them than any other commander, that "the fellah would make an admirable soldier if he only wished to kill some one!"

The well-educated Egyptian officer, with his natural aptitude for figures, does subordinate regimental routine carefully, and works well when supervised by men of stronger character. The ordinary Egyptian is not self-reliant or energetic by nature, and, like most Eastern people, finds it difficult to be impartial where duty and family or other personal relations are in the balance. The black soldier has, on the other hand, many of the finest fighting qualities. This was observed by British officers, from the time of the preliminary operations about Kosheh, and at the action near Ginniss in December 1885, down to the brilliant operations in the pursuit of the Mahdists on the Blue Nile after the action of Gedaref (subsequent to the battle of Omdurman), and the fighting in Kordofan in 1899, which resulted in the death of the Khalifa and his Emirs.

Black soldiers served in Mehemet Ali's army, but their value was not then duly appreciated. At the present day (1902) they are nearly all deserters from the Mahdist forces, or prisoners who have been captured in action. The greater number are Shilluks and Dinkas, coming from the country between Fashoda and the Equatorial Provinces, but a proportion come from the far west of Kordofan, some even from Bornu and Wadai. Many are absolute savages, difficult to control, wayward, and thoughtless like children. They are very excitable and apt to get out of hand; unlike the fellahs, they are not fond of drill, and are slow to acquire it, but their dash, their pugnacious instinct, and their desire to close with an enemy are of immense value. The Sudani, moreover, shoots better than the fellah, whose eyesight is often defective. The Sudanese captain can seldom read or write, and is therefore in the hands of the Egyptian-born company quartermaster-sergeant as regards pay and clothing accounts. He is slow, and as a rule has little knowledge of drill. Nevertheless he is self-reliant, much respected by his men, and can be trusted in the field to carry out any orders received from his British officer. The younger Sudanese officers who have been through the Military School are well instructed, but it is said that the Sudanese brought up in Cairo have lost, in some respects, the robust martial qualities inherent in the Sudan people. The most efficient companies in the Sudanese battalions are apparently those in which the captain is a black and the lieutenants are Egyptians.

The army raised by the first Sirdar in January 1883 was highly commended for its work on the line of communication in 1884–85, and its artillery and camelry distinguished themselves in the action at Kirbekan in

February 1885. Colonel Sir Francis Grenfell succeeded General Sir Evelyn Wood in March 1885, and while under his command the army continued to improve, and fought successful actions at Gemazah, Arguin, Toski, and Tokar. At Toski the Dervish force was nearly annihilated. In March 1892 Colonel Kitchener succeeded General Sir Francis Grenfell, and four years later began his successful reconquest of the Sudan. In June 1896, owing to the indefatigable exertions of Major Wingate, a perfected system of secret intelligence enabled the Sirdar to bring an overwhelming force of 6 to 1 against the Dervish outpost at Firket and destroy it. In September 1896 a skirmish at Hafir, with similarly successful tactics, gave the British commander the possession of Dongola. On the 7th August 1897 Colonel Hunter surprised and annihilated a weak Dervish garrison at Abu Hamed, to which place, by the 31st October 1897, a railway had been laid across the Nubian desert from Wadi Halfa, a distance of 230 miles, the "record" construction of 5300 yards surveyed, embanked, and laid in one day having been attained. On the 26th December 1897 the Italian troops handed over Kassala to Colonel Parsons, R.A. On the 8th April 1898 a British division, with the Egyptian army, destroyed the Dervish force under the Emir Mahmud Ahmed, on the Atbara river. On the 2nd September the Khalifa attacked the British-Egyptian troops at Kerreri, and being routed, his men dispersed; Omdurman was occupied, and on the 19th September the Egyptian flag was rehoisted at Fashoda. On the 22nd September 1898 Gedaref was taken from the Emir Ahmed Fedil by Colonel Parsons, and on the 26th December the army of Ahmed Fedil was finally defeated and dispersed near Roseires. The Khalifa's army, reduced to an insignificant number, after several unsuccessful engagements withdrew to the west of the Nile, where it was attacked, on the 24th November 1899, after a forced march by Colonel Wingate, and annihilated. The Khalifa himself was killed; while the victor, who had joined the Egyptian army in 1883 as aide-de-camp to the first Sirdar, in December 1899 became the fourth Sirdar, as Major-General Sir F. R. Wingate, K.C.B., K.C.M.G., &c.

The single Camel Company of 1883 grew by 1901 into six companies. A raid from Dongola into the Oasis of Beris caused the Sirdar to raise three companies of Sudanese drafted from the battalions, to which two more companies were added in 1896, one of fellaheen and one composed of Dervishes taken at Dongola. Six days' food for men and camels, 300 rounds for each rifle, and three days' water for men are carried in marching order.

In 1899 the infantry of the Egyptian army consisted of 20,000 men, of whom 12,000 were fellaheen and 8000 blacks, divided into battalions of 1000 and 800 men respectively. They are armed with Martini-Henry rifles, and carry into action 130 rounds per man, 80 being in the pouches and 50 in the bandoliers. In 1901 the infantry, reduced by 2 battalions since the war, numbered 9 Egyptian and 7 Sudanese battalions.

The artillery consists of 4 field batteries and 1 Maxim battery, each battery having one British officer and 5 Egyptian, the total comprising 34 officers and 900 men. There is a battalion of 3 companies of garrison artillery, consisting of 12 officers and 370 men.

There are 10 gunboats on the Nile, and a number of unarmed vessels.

The cavalry are mounted on hardy Syrian horses; there are 5 squadrons, one being composed of Sudanese raised after the battle of Omdurman, and the remainder of Egyptians. Three squadrons are commanded by British officers, and two by native officers, each squadron having an average strength of 150. The front ranks carry lance and carbine, and the rear ranks carbine and sword.

The Egyptian soldier, when unfit for duty, had, under the pre-British command, been treated in civil hospitals, but there was a civilian doctor paid on Army Estimates, who was supposed to supervise the conscription, to avoid which large sums were given as bribes. An outbreak of cholera in the summer of 1883 emphasized the necessity of British doctors, and Surgeon-Major Rogers organized a singularly efficient department, which now consists of 14 British officers, 39 Egyptian officers, and 284 non-commissioned officers and men.

The Veterinary Department, represented originally by a single British veterinary officer, who joined in 1883, now consists of two British officers and five Egyptian officers, with 30 non-commissioned officers and men, who are selected for intelligence and education after one year's service in the ranks.

The ambitious Military School system of the Khedive Ismail Pasha was replaced, in consequence of financial pressure, by a smaller establishment in 1879, but, partly out of consideration for the capable French officer then at its head, no drastic changes were enforced in 1883, nor until 1887, when the notoriously bad state of the school necessitated its reorganization, which was effected by a British officer. A simpler programme was adopted: elementary subjects were more thoroughly taught, and a knowledge of arithmetic, geometry, algebra, fortification, military history, topography, drawing, geography, English, French, and Arabic was imparted. The 200 students remain for two years; the course is calculated to last for three years, but at present the demand for officers exceeds the output.

The Supply Department is supervised by a British officer as director, who has under him the Tura Mills, where biscuits and soap are produced much more cheaply than was possible under the contract system. A British officer supervises the stores, clothing, and equipment for both man and horse. The clothing for all arms of the service costs between £3 and £4 per head, and the rations from 4d. to 5d. daily for each soldier. Guns and equipment of all kinds are, as a rule, purchased in the United Kingdom. The total annual expenditure is £500,000.

On the assumption of command by the third Sirdar, then Colonel Kitchener, the Surveyor-General's Department was abolished; the Engineer, Ordnance, and Supply services were administered as separate branches, while to a Financial Secretary was given the duty of preparing the Budget and making contracts, issuing pay, and carrying out a financial audit.

The army has been gradually reduced since the Dervish wars, and large numbers of officers and men are now employed in the civil administration of the Sudan. (E. WO.)

## Political History.

In the ninth edition of this Encyclopædia (vol. v. p. 767) an account is given of the reforms instituted during the Khediviate of Ismail Pasha, but it is justly pointed out that "the funds required for these public works, as well as the actual labour, have been remorselessly extorted from a poverty-stricken population, and there is probably no peasant now existing whose condition is worse than that of the long-suffering Egyptian fellah." The writer ventured however, to predict that "future generations will gain at the fearful expense of the present," and that "a better time is beginning for Egypt." This prediction, made in 1877, has since been fulfilled; but the better time has come in a way and to an extent which no one could have then foreseen.

***Steps leading to the deposition of Ismail.***

The impoverishment of the fellah had reached in 1875 such a point that the ordinary resources of the country no longer sufficed for the most urgent necessities of administration; and the Khedive Ismail, having repeatedly broken faith with his creditors, could not raise any more loans on the European market. The taxes were habitually collected many months in advance, and the colossal floating debt was increasing rapidly. In these circumstances Ismail had to realize his remaining assets, and among them sold 176,602 Suez Canal shares to the British Government for £3,976,582 (see BEACONSFIELD). This comparatively small financial operation brought about the long-delayed crisis and paved the way for the future prosperity of Egypt, for it induced the British Government to inquire more carefully into the financial condition of the country. What is known as the Cave Mission was sent out to Cairo in 1875, and its report showed that under the existing administration national bankruptcy was inevitable. Other commissions of inquiry followed, and each one brought Ismail more under European control. The establishment of the Mixed Tribunals (*Ency. Brit.* vol. v. p. 767) had already made

some of the Courts of Justice international. The Caisse de la Dette, the result of the Cave Mission, established international control over a large portion of the revenue. By the Goschen Mission, the next in order of time, the State railways were internationalized. Then came the Rivers Wilson Mission, in consequence of which the control was extended to the enormous landed property of the Khedive. Driven to desperation, Ismail made a virtue of necessity and accepted, in September 1878, a Constitutional Ministry, under the presidency of Nubar Pasha, with Rivers Wilson as Minister of Finance and De Blignières as Minister of Public Works. Professing to be quite satisfied with this arrangement, he pompously announced that Egypt was no longer in Africa, but a part of Europe; but before seven months had passed he found his Constitutional position intolerable, got rid of his irksome Cabinet by means of a secretly-organized military riot in Cairo, and reverted to his old autocratic methods of government. England and France could hardly sit still under this affront, and decided to administer chastisement by the hand of the Suzerain Power, which was delighted to have an opportunity of asserting its authority. On 26th June 1879 Ismail suddenly received from the Sultan a curt telegram, addressed to him as ex-Khedive of Egypt, informing him that his son Tewfik was appointed his successor. Taken unawares, he made no attempt at resistance, and Tewfik was at once proclaimed Khedive.

*Re-establishment of Dual Control.*

After a short period of inaction, when it seemed as if the change were for the worse, England and France summoned up courage to look the situation boldly in the face, and re-established the Dual Control in the persons of Major Baring and M. de Blignières. For two years the Dual Control governed Egypt, and initiated the work of progress that England was to continue alone. Its essential defect was what might be called insecurity of tenure. Without any efficient means of self-protection and coercion at its disposal, it had to interfere with the power, privileges, and perquisites of a class which had long misgoverned the country. This class, so far as its civilian members were concerned, was not very formidable, because these were not likely to go beyond the bounds of intrigue and passive resistance; but it contained a military element who had more courage, and who had learned their power when Ismail employed them for overturning his Constitutional Ministry. Among the mutinous soldiers on that occasion was a fellah officer calling himself Ahmed Arabi the Egyptian. He was not a man of exceptional intelligence or remarkable powers of organization, but he was a fluent speaker, and could exercise some influence over the masses by a rude kind of native eloquence. Behind him were a group of men, much abler than himself, who put him forward as the figurehead of a party professing to aim at protecting the Egyptians from the grasping tyranny of their Turkish and European oppressors. The movement began among the Arab officers, who complained of the preference shown to the officers of Turkish origin; it then expanded into an attack on the privileged position and predominant influence of foreigners, many of whom, it must be confessed, were of a by no means respectable type; finally it was directed against all Christians, foreign and native. The Government, being too weak to suppress the agitation and disorder, had to make concessions, and each concession produced fresh demands. Arabi was first promoted, then made Under-Secretary for War, and ultimately a member of the Cabinet. The danger of a serious rising brought the British and French fleets in May 1882 to Alexandria, and after a massacre (11th June) had been perpetrated by the Arab mob in that city, the British Admiral bombarded the forts (11th July 1882). The leaders of the National Movement prepared to resist further aggression by force. A conference of Ambassadors was held in Constantinople, and the Sultan was invited to quell the revolt; but he hesitated to employ his troops against Mussulmans who were professing merely to oppose Christian aggression. At last the British Government determined to employ armed force, and invited France to co-operate. The French Government declined, and a similar invitation to Italy met with a similar refusal. England therefore, having to act alone, landed troops at Ismailia under Sir Garnet Wolseley, and suppressed the revolt by the battle of Tel-el-Kebir on 13th September 1882. The Khedive, who had taken refuge in Alexandria, returned to Cairo, and a Ministry was formed under Sherif Pasha, with Riaz Pasha as one of its leading members. On assuming office, the first thing it had to do was to bring to trial the chiefs of the rebellion. Had the Khedive and Riaz been allowed a free hand, Arabi and his colleagues would have found little mercy. Thanks to the intervention of the British Government, their lives were spared. Arabi pleaded guilty, was sentenced to death, the sentence being commuted by the Khedive to banishment; and Riaz resigned in disgust. This solution of the difficulty was brought about by Lord Dufferin, then British Ambassador at Constantinople, who had been sent to Egypt as High Commissioner to adjust affairs and report on the situation. One of his first acts, after preventing the application of capital punishment to the ringleaders of the revolt, was to veto the project of protecting the Khedive and his Government by means of a Prætorian guard recruited from Asia Minor, Epirus, Austria, and Switzerland, and to insist on the principle that Egypt must be governed in a truly liberal spirit. Passing in review all the departments of the administration, he laid down the general lines on which the country was to be restored to order and prosperity, and endowed, if possible, with the elements of self-government for future use.

*Arabi and the revolt of 1882.*

*Single-handed British intervention.*

*Sir Evelyn Baring appointed Consul-General, 1884.*

The laborious task of putting these general indications into a practical shape fell to Sir Evelyn Baring, who arrived as Consul-General and Diplomatic Agent, in succession to Sir Edward Malet, in January 1884. At that moment the situation was singularly like that which had existed on two previous occasions: firstly, when Ismail was deposed, and secondly, when the Dual Control had undermined the existing authority without having any power to enforce its own. For the third time in little more than three years the existing authority had been destroyed and a new one had to be created. But there was one essential difference: the power that had now to reorganize the country possessed in the British army of occupation a support sufficient to command respect. Without that support Sir Evelyn Baring could have done little or nothing; with it he did perhaps more than any other single man could have done. His method may be illustrated by an old story long current in Cairo. Mohammed Ali was said to have appointed as Mudir or governor in a turbulent district a young and inexperienced Turk, who asked, "But how am I to govern these people?" "Listen," replied the Pasha; "buy the biggest and heaviest *kurbash* you can find; hang it up in the centre of the Mudirieh, well within your reach, and you will very seldom require to use it." The British army of occupation was Sir Evelyn's *kurbash;* it was well within his reach, as all the world knew, and its simple presence sufficed to prevent disorder and enforce obedience. He had one other advantage over previous English reformers in Egypt: his position towards France was more independent. The Dual Control had been abolished by a Khedivial decree of 18th January 1883,

and replaced by an English financial adviser. France naturally objected; but having refused to co-operate with England in suppressing the revolt, she could not reasonably complain that her offer of co-operation in the work of reorganization was declined.

*The policy of evacuation.*

At first the intention of the British Government was simply to restore the power of the Khedive, to keep His Highness for some time in the right path by friendly advice, and to withdraw the British troops as soon as possible. As Lord Granville explained in a Circular to the Powers, the position of England in Egypt imposed on her "the duty of giving advice with the object of securing that the order of things to be established shall be of a satisfactory character and possess the elements of stability and progress." But there was to be no embarking on a general scheme of reforms, which would increase unnecessarily the responsibilities of the protecting Power and necessitate the indefinite prolongation of the military occupation. So far, therefore, as the British Government had a definite policy in Egypt, it was a *politique de replâtrage.* Even this policy was not strictly adhered to. Mr Gladstone's Cabinet was as unstable as the public opinion it sought to conciliate. It had its hot fits and its cold fits, and it gave orders now to advance and now to retreat. In the long-run circumstances proved too strong for it, and it had to undertake a great deal more than it originally intended. Each little change in the administration engendered a multitude of others, so that the modest attempts at reform were found to be like the letting out of water. A tiny rill gradually became a boisterous stream, and the boisterous stream grew into a great river, which spread to all sections of the administration and ended by inundating the whole country.

*The Sudan question.*

Of the numerous questions awaiting solution, the first to claim immediate attention was that of the Sudan. The British Government had begun by excluding it from the problem, and by declaring that for events in these outlying territories it must not be held responsible. In that sphere of activity, therefore, the Egyptian Government might do as it thought fit. The principle of limited liability which this attitude assumed was soon found to be utterly untenable. The Sudan was an integral part of the Khedive's dominions and caused, even in ordinary times, a deficit of £200,000 to the Egyptian Treasury. At that moment it was in a state of open rebellion, stirred up by a religious fanatic who proclaimed himself a Mahdi or Messias of Islam. An army of 10,000 men under an English general, Hicks Pasha, had been sent to suppress the revolt, and had been annihilated in a great battle fought on 5th November 1883, near Obeid. The Egyptian Government wished to make a new attempt to recover the lost province, and the idea was certainly very popular among the governing class, but Sir Evelyn Baring vetoed the project on the ground that Egypt had neither soldiers nor money to carry it out. In vain the Khedive and his Prime Minister, Sherif Pasha, threatened to resign, and the latter actually carried out his threat. The British representative remained firm, and it was decided that the Sudan should be, for the moment at least, abandoned to its fate. Nubar, though as strongly opposed to the abandonment policy as Sherif, consented to take his place and accepted somewhat reluctantly the new régime, which he defined as "the administration of Egypt under the government of Baring." By this time the Mahdi was master of the greater part of the Sudan, but Khartum and some other fortified points still held out. The efforts made to extricate the garrisons, including the mission of General Gordon, the fall of Khartum, and the Nile Expedition under Lord Wolseley are described below, in the account given of military operations. The practical result was that the Khedive's authority was limited to the Nile Valley north of Wadi Halfa.

*Internal reorganization.*

With the internal difficulties Sir Evelyn Baring had been struggling bravely ever since his appointment, trying to evolve out of the ever-changing policy and contradictory orders of the British Government some sort of coherent line of action, and to raise the administration to a higher standard. For two or three years it seemed doubtful whether he would succeed. All over Egypt there was a feeling of unrest, and the well-meant but not very successful efforts of the British to improve the state of things were making them very unpopular. The introduction of English officials and English influence into all the administrative departments was resented by the native officials, and the action of the irrigation officers in preventing the customary abuses of the distribution of water was resented by the great landowners, who had been, from time immemorial, in the habit of taking as much as they wanted, to the detriment of the fellaheen. Even these latter, who gained most by the reforms, considered that they had good reason to complain, for the defeat of Arabi and the re-establishment of order had enabled the Christian money-lenders to return and insist on the payment of claims, which were supposed to have been extinguished by the rebellion. Worst of all, the Government was drifting rapidly towards insolvency, being quite unable to fulfil its obligations to the bondholders and meet the expenses of administration. All departments were being starved, and even the salaries of poorly paid officials were in arrear. To free itself from its financial difficulties the Government adopted a heroic remedy which only created fresh troubles. On the advice of Lord Northbrook, who was sent out to Cairo in September 1884 to examine the financial situation, certain revenues which should have been paid into the Caisse for the benefit of the bondholders were paid into the Treasury for the ordinary needs of the administration. Immediately the Powers protested against this infraction of the law of liquidation, and the Caisse applied for a writ to the Mixed Tribunals. In this way the heroic remedy failed, and to the internal difficulties were added international complications.

Fortunately for Egypt, the British Government contrived to solve the international difficulty by timely concessions to the Powers, and succeeded in negotiating the London Convention of March 1885, by which the Egyptian Government was relieved from some of the most onerous stipulations of the Law of Liquidation, and was enabled to raise a loan of £9,000,000 for an annual payment of £135,000. After paying out of the capital the sums required for the indemnities due for the burning of Alexandria and the deficits of the years 1882 and 1883, it still had a million sterling, and boldly invested it in the improvement of irrigation. The investment proved most remunerative, and helped very materially to save the country from bankruptcy and internationalism. The danger of being again subjected to the evils of an international administration was very great, for the London Convention contained a stipulation to the effect that if Egypt could not pay her way at the end of two years, another International Commission would be appointed.

To obviate this catastrophe the British reformers set to work most energetically. Already something in the way of retrenchment and reform had been accomplished. The public accounts had been put in order, and the abuses in the collection of the land tax removed. The constant drain of money and men for the Sudan had been stopped. A beginning had been made for creating a new army to

replace the one that had been disbanded and to allow of a portion of the British garrison being withdrawn. In this work Sir Evelyn Wood had shown much sound judgment as well as great capacity for military organization, and had formed an efficient force out of very unpromising material (see above, under ARMY). His colleague in the Department of Public Works, Sir Colin Scott Moncrieff, had been not less active. By mitigating the hardships of the *corvée*, and improving the irrigation system, on which the prosperity of the country mainly depends, he had conferred enormous benefits on the fellaheen, and had laid the foundation of permanent budgetary equilibrium for the future. Not less active was Sir Edgar Vincent, the Financial Adviser, who kept a firm hold on the purse-strings and ruthlessly cut down expenditure in all departments except that of irrigation.

***Relations between British and native officials.***

The activity of the British officials naturally produced a certain amount of discontent and resistance on the part of their Egyptian colleagues, and Lord Granville was obliged to declare very plainly that such resistance could not be tolerated. Writing (January 1884) to Sir Evelyn Baring, he said: "It should be made clear to the Egyptian Ministers and Governors of Provinces that the responsibility which for the time rests on England obliges H.M. Government to insist on the adoption of the policy which they recommend; and that it will be necessary that those Ministers and Governors who do not follow this course should cease to hold their offices." Nubar Pasha, who continued to be Prime Minister, resisted occasionally. What he chiefly objected to was direct interference in the provincial administration and the native tribunals, and he succeeded for a time in preventing such interference. Sir Benson Maxwell and Mr Clifford Lloyd, who had been sent out to reform the Departments of Justice and the Interior, after coming into conflict with each other were both recalled, and the reforming activity was for a time restricted to the Departments of War, Public Works, and Finance. Gradually the tension between natives and foreigners relaxed, and mutual confidence was established. Experience had evolved the working principle which was officially formulated at a much later period: "Our task is not to rule the Egyptians, but as far as possible to teach the Egyptians to rule themselves. . . . European initiative suggests measures to be executed by Egyptian agency, while European supervision controls the manner in which they are executed." If that principle had been firmly laid down and clearly understood at the beginning, a good deal of needless friction would have been avoided.

***International problems.***

The international difficulty remained. The British position in Egypt was anomalous, and might easily give rise to international complications. The Sultan might well protest against the military occupation of a portion of his Empire by foreign troops. It was no secret that France was ready to give him diplomatic support, and other Powers might adopt a similar attitude. Besides this, the British Government was anxious to terminate the occupation as soon as possible. With a view to regularizing the situation and accelerating the evacuation, Sir Henry Drummond Wolff was sent to Constantinople in August 1885 on a special mission. On 24th October of that year he concluded a preliminary Convention by which an Ottoman and an English High Commissioner, acting in concert with the Khedive, should reorganize the Egyptian army, tranquillize the Sûdan by pacific means, and consider what changes might be necessary in the civil administration. When the two Commissioners were assured of the security of the frontier and the good working and stability of the Egyptian Government, they should present reports to their respective Governments, and these should consult as to the conclusion of a Convention regulating the withdrawal of the English troops. Mukhtar Pasha and Sir Henry Drummond Wolff were appointed Commissioners, and their joint inquiry lasted till the end of 1886, when the former presented his report and the latter went home to report orally. The remaining stipulations of the preliminary Convention were duly carried out. Sir Henry Drummond Wolff proceeded to Constantinople and signed on 22nd May 1887 the definitive Convention, according to which the occupation should come to an end in three years, but England should have a right to prolong or renew it in the event of internal peace or external security being seriously threatened. The Sultan authorized the signature of this Convention, but under pressure of France and Russia he refused to ratify it. Technically, therefore, the preliminary Convention still remains in force, and in reality the Ottoman Commissioner continues to reside in Cairo.

***Progress of reform.***

The steadily increasing prosperity of the country during the years 1886 and 1887 removed the danger of national bankruptcy and international interference, and induced Sir Evelyn Baring to widen the area of administrative reforms. In the provinces the local administration and the methods of dispensing justice were still scandalously unsatisfactory, and this was the field to which the British representative next directed his efforts. Here he met with unexpected opposition on the part of the Prime Minister, Nubar Pasha, and a conflict ensued which ended in Nubar's retirement in June 1888. Riaz Pasha took his place, and remained in office till May 1891. During these three years the work of reform and the prosperity of the country made great progress. The new Egyptian army was so far improved that it gained successes over the forces of the Mahdi; the burden of the national debt was lightened by a successful conversion; the *corvée* was abolished; the land tax was reduced 30 per cent. in the poorest provinces, and in spite of this and other measures for lightening the public burdens, the budgetary surplus constantly increased; the quasi-judicial Special Commissions for Brigandage, which were at once barbarous and inefficient, were abolished; the native tribunals were improved, and Mr (afterwards Sir John) Scott, an Indian judge of great experience and sound judgment, was appointed judicial adviser to the Khedive. This appointment was opposed by Riaz Pasha, and led to his resignation on the plea of ill-health. His successor, Mustafa Pasha Fehmi, continued the work and co-operated cordially with the English officials. The very necessary reform of the native tribunals was then taken seriously in hand. The existing procedure was simplified and accelerated; the working of the Courts was greatly improved by a carefully organized system of inspection and control; the incompetent judges were eliminated and replaced by men of better education and higher moral character; and for the future supply of well-qualified judges, barristers, and law officials, an excellent school of law was established. If the progress made in this direction is maintained, the Native Courts may some day, under proper European control, replace the anomalous Mixed Tribunals, and remove all necessity for the inconvenient consular jurisdictions, which are at present protected by the Capitulations. Meanwhile the reforming activity has been extended to Prisons, Public Health, and Education, and has attained very satisfactory results without ruffling the religious susceptibilities of the people.

Only once since the retirement of Riaz has the policy of teaching the Egyptians to rule themselves led to friction with the native authorities. In January 1892 the Khedive Tewfik, who had always maintained cordial relations with Sir Evelyn Baring, died suddenly, and was

succeeded by his son, Abbas Hilmi, a young man without political experience, who failed at first to understand the peculiar situation in which a Khedive ruling under British protection is necessarily placed. Aspiring to liberate himself at once from foreign control, he summarily dismissed Mustafa Pasha Fehmi, whom he considered too amenable to English influence, and appointed in his place Fakhri Pasha, who was not a *persona grata* at the British Agency. Such an incident, which might have constituted a precedent for more important acts of a similar kind, could hardly be overlooked by the British representative. He had always maintained that what Egypt most required, and would require for many years to come, was an order of things which would render practically impossible any return to that personal system of government which had well-nigh ruined the country. The young Khedive was made, therefore, to understand that he must not make such changes in the administration without a previous agreement with the representative of the protecting Power; and a compromise was effected by which Fakhri Pasha retired, and the post of Premier was confided once more to Riaz. With this compromise the friction between the Khedive and Sir Evelyn Baring, who had now become Lord Cromer, did not end. For some time Abbas Hilmi clung to his idea of liberating himself from all control, and secretly encouraged a nationalist and anti-British agitation in the native press; but he gradually came to perceive the folly, as well as the danger to himself, of such a course, and accordingly refrained from giving any occasion for complaint or protest. In like manner the relations between the British officials and their Egyptian colleagues gradually became more cordial, so that it was found possible at last to reform the local administration in the provinces according to the recommendations of Mr J. L. Gorst, who had been appointed adviser to the Ministry of the Interior. Nubar Pasha, it is true, who succeeded Riaz as Prime Minister in April 1894, objected to some of Mr Gorst's recommendations, and in November 1895 resigned. He was succeeded by Mustafa Fehmi, who had always shown a conciliatory spirit, and who had been on that account, as above stated, summarily dismissed by the Khedive in January 1893. After his reinstatement the Anglo-Egyptian condominium worked without serious friction, and there is reason to believe that it will continue so to work in the future as long as England remains true to her mission and shows no signs of hesitation in carrying it out. In the Report by His Majesty's Agent and Consul-General on the finances, administration, and condition of Egypt presented to Parliament in 1901, Lord Cromer concluded by expressing his belief "that His Highness the Khedive's recent visit to England (in 1900), coupled with the very remarkable and touching sympathy displayed by every class of society in this country (Egypt) on the occasion of the death of Queen Victoria, will serve to cement more closely the bonds of friendship and goodwill which, now perhaps more than at any previous period, unite my own countrymen and the Egyptians."

***Accession of Abbas.***

The success of the Anglo-Egyptian condominium, and the consequent economic and financial prosperity of Egypt Proper, rendered it possible to recover from the Mahdists the Sudanese provinces (see below, *Military Operations in the Sudan*), and to delimit in that part of Africa, in accordance with Anglo-Egyptian interests, the respective spheres of influence of Great Britain and France. The arrangement was not effected without serious danger of a European conflict. Taking advantage of the temporary weakness of Egypt, the French Government formed the project of seizing the Upper Nile Valley and uniting her possessions in West Africa with those at the entrance to the Red Sea. With this object a small force under Major Marchand was sent from the French Congo into the Bahr-el-Ghazal, with orders to occupy Fashoda on the Nile; whilst a Franco-Abyssinian Expedition was despatched from the eastward, to join hands with Major Marchand. The small force from the French Congo reached its destination, and a body of Abyssinian troops, accompanied by French officers, appeared for a short time a little higher up the river; but the grand political scheme was frustrated by the victorious advance of an Anglo-Egyptian force under General Kitchener and the resolute attitude of the British Government. Major Marchand had to retire from Fashoda, and as a concession to French susceptibilities he was allowed to retreat by the Abyssinian route. By an agreement signed by Lord Salisbury and the French Ambassador on 21st March 1899, and appended as Art. IV. to the Anglo-French Convention of 14th June 1898, which dealt with the British and French spheres of influence in the region of the Niger, France was excluded from the basin of the Nile, and a line marking the respective spheres of influence of the two countries was drawn on the map from the northern frontier of the Congo Free State to the southern frontier of the Turkish province of Tripoli (see Africa: *History*).

***Fashoda.***

The administration of the Sudan was organized on the basis of an agreement between the British and Egyptian Governments signed on 19th January 1899. According to that agreement the British and Egyptian flags are used together, and the supreme military and civil command is vested in a Governor-General, who is appointed by the Khedive on the recommendation of the British Government, and who cannot be removed without the British Government's consent. So far the arrangement has worked well. The Governor-General, Sir Reginald Wingate, in his report dated Khartum, 30th January 1901, after giving an account of the progress made, says: "I cannot close this report without recording my appreciation of the manner in which officers, non-commissioned officers, soldiers, and officials—British, Egyptian, and Sudanese, without distinction—have laboured during the past year to push on the work of regenerating the country. Nor can I pass over without mention the loyal and valuable assistance I have received from many of the local Ulemas, Sheikhs, and Notables, who have displayed a most genuine desire to see their country once more advancing in the paths of progress and material and moral improvement." (D. M. W.)

***The Anglo-Egyptian Sudan.***

## British Military Operations of 1882–1885.

In February 1879 a slight outbreak of discharged officers and soldiers occurred at Cairo, which led to the despatch of British and French ships to Alexandria. On 26th June of that year Ismail Pasha was removed from Egypt, and Tewfik assumed the Khediviate, becoming practically the *protégé* of the two Western Powers. On 1st February 1881 a more serious disturbance arose at Cairo from the attempt to try three colonels, Ahmed Arabi, Ali Fehmy, and Abd-el-Al, who had been arrested as the ringleaders of the military party. The prisoners were released by force, and proceeded to dictate terms to the Khedive. Again British and French warships were despatched to Alexandria, and were quickly withdrawn, their presence having produced no apparent impression. It soon became clear that the Khedive was powerless, and that the military party, headed by Arabi, threatened to dominate the country. The "dual note," communicated to the Khedive on 6th January 1881, contained an intimation that Great Britain and France were prepared to afford material support if necessary; but the fall of Gambetta's Ministry produced a reaction, and both Governments

proceeded to minimize the meaning of their language. The Khedive was practically compelled to form a government in which Arabi was Minister of War and Mahmoud Sami Premier, and Arabi took steps to extend his influence throughout his army. The situation now became critically serious: for the third time ships were sent to Alexandria, and on 25th May 1882 the Consuls-General of the two Powers made a strong representation to Mahmoud Sami which produced the resignation of the Egyptian Ministry, and a demand, to which the Khedive yielded, by the military party for the reinstatement of Arabi. The attitude of the troops in Alexandria now became threatening; and on the 29th the British residents pointed out that they were "absolutely defenceless." This warning was amply justified by the massacres of 11th June, during which more than one hundred persons, including an officer and two seamen, were killed in the streets of Alexandria, almost under the guns of the ships in harbour. It was becoming clear that definite action would have to be taken, and on the 15th the Channel Squadron was ordered to Malta. By the end of June twenty-six warships, representing the navies of Great Britain, France, Germany, Italy, Austria, Russia, the United States, Spain, Greece, and Turkey, lay off the port of Alexandria, and large numbers of refugees were embarked. The order received by Admiral Sir Beauchamp Seymour on 3rd July was as follows:—

***Bombardment of Alexandria.***

Prevent any attempt to bar channel into port. If work is resumed on earthworks, or fresh guns mounted, inform Military Commander that you have orders to prevent it; and if not immediately discontinued, destroy earthworks and silence batteries if they open fire, having given sufficient notice to population, shipping, and foreign men-of-war.

On the 9th the Admiral received a report that working parties had been seen in Fort Silsileh "parbuckling two smooth-bore guns—apparently 32-pounders—towards their respective carriages and slides, which were facing in the direction of the harbour." Fort Silsileh was an old work at the extreme east of the defences of Alexandria, and its guns do not bear on the harbour. On the 10th an ultimatum was sent to Toulba Pasha, the Military Commandant, intimating that the bombardment would commence at sunrise on the following morning unless "the batteries on the isthmus of Ras-el-Tin and the southern shore of the harbour of Alexandria" were previously surrendered "for the purpose of disarming." The fleet prepared for action, and the bearer of the reply, signed by the President of the Council, and offering to dismount three guns in the batteries named, only succeeded in finding the flagship late at night. This proposal was rejected, and at 7 a.m. on 11th July the *Alexandra* opened fire and the action became general. The attacking force was disposed in three groups: (1) the *Alexandra*, *Sultan*, and *Superb*, outside the reef, to engage the Ras-el-Tin and the earth works under weigh; (2) the *Monarch*, *Invincible*, and *Penelope*, inside the harbour, to engage the Meks batteries; and (3) the *Inflexible* and *Temeraire*, to take up assigned stations outside the reef and to co-operate with the inshore squadron. The gunboats *Beacon*, *Bittern*, *Condor*, *Cygnet*, and *Decoy* were to keep out of fire at first and seek opportunities of engaging the Meks batteries. Meks fort was silenced by about 12.45 p.m., and a party from the *Invincible* landed and disabled the guns. As the fire delivered under way was not effective, the offshore squadron anchored at about 10.30 a.m., and succeeded in silencing Fort Ras-el-Tin at about 12.30 p.m., and Fort Adda, by the explosion of the main magazine, at 1.35 p.m. The *Inflexible* weighed soon after 8 a.m. and engaged Ras-el-Tin, afterwards attacking Forts Pharos and Adda. The *Condor*, followed by the *Beacon*, *Bittern*, and *Decoy*, engaged Fort Marabout soon after 8 a.m. till 11 a.m., when the gunboats were recalled. After the works were silenced, the ships moved in closer, with a view to dismount the Egyptian guns. The bombardment ceased at 5 p.m.; but a few rounds were fired by the *Inflexible* and *Temeraire* on the morning of the 12th at the right battery in Ras-el-Tin lines.

The bombardment of the forts of Alexandria is interesting as a gauge of the effect to be expected from the fire of ships under specially favourable conditions. The Egyptians at different times during the day brought into action about 33 R.M.L. guns (7-inch to 10-inch), 3 R.B.L. guns (40 prs.), and 120 S.B. guns (6·5-inch and 10-inch), with a few mortars. These guns were disposed over a coast-line of about 10 sea miles, and were in many cases indifferently mounted. The Egyptian gunners had been little trained, and many of them had never once practised with rifled ordnance. Of seventy-five hits on the hulls of the ships only five can with certainty be ascribed to projectiles from rifled guns, and thirty were unquestionably due to the old smoothbores, which were not provided with sights. The total loss inflicted was 6 killed and 27 wounded. The British ships engaged fired 1741 heavy projectiles (7-inch to 16-inch) and 1457 light (7-prs. to 64-prs.), together with 33,493 machine-gun and rifle bullets. The result was comparatively small. About 8 rifled guns and 19 smoothbores were dismounted or disabled and 4 and 1 temporarily put out of action respectively. A considerable portion of this injury was inflicted, after the works had been silenced, by the deliberate fire of the ships. As many as twenty-eight rifled guns and 140 smoothbores would have opened fire on the following day. The Egyptians made quite as good a stand as could be expected, but were driven from their guns, which they were unable to use with adequate effect; and the bombardment of Alexandria confirms previous experience, that the fire of ships cannot really compete with that of well-mounted and well-handled guns on shore.

In the afternoon of the 12th, fires, which were the work of incendiaries, began to break out in the best quarters of Alexandria; and the town was left to murder and pillage till the following day, when a party of bluejackets and marines was landed at about 3 p.m.

Military intervention being now imperatively demanded, a vote of credit for £2,300,000 was passed in the British House of Commons on 27th July. Five days later the French Government failed to secure a similar vote, and Great Britain was left to deal with the Egyptian question alone. An expeditionary force detailed from home stations and from Malta was organized in two divisions, with a cavalry division, corps troops, and a siege train, numbering in all about 25,000 men. An Indian contingent numbering about 7000 combatants, complete in all arms and with its own transport, was prepared for despatch to Suez. General Sir Garnet Wolseley was appointed Commander-in-Chief, with Lieut.-General Sir J. Adye as Chief of the Staff. The plan of operations contemplated the seizure of Ismailia as the base for an advance on Cairo, Alexandria and its suburbs to be held defensively, and the Egyptian forces in the neighbourhood to be occupied by demonstrations. The expeditionary force having rendezvoused at Alexandria, means were taken by Rear-Admiral Hoskins and Sir W. Hewett for the seizure of the Suez Canal. Under orders from the former, Captain Fairfax, R.N., occupied Port Said on the night of 19th August, and Commander Edwards, R.N., proceeded down the Canal, taking possession of the *gares* and dredgers, while Captain Fitzroy, R.N., occupied Ismailia after slight opposition. Before nightfall on 20th August the Canal was wholly in British hands. Meanwhile, leaving Sir E. Hamley in command at Alexandria, Sir G. Wolseley with the bulk of the expeditionary force arrived at Port Said on 20th August, a naval demonstration having been made at Abukir with a view to deceive the enemy as to the object of the great movement in progress. The advance from Ismailia now began. On the 21st Major-General Graham moved from Ismailia with about 800 men and a small naval force, occupying Nefiche, the junction with the Suez line, at 1.30 a.m. without opposition. On the

***British expedition under Sir Garnet Wolseley.***

22nd he made a reconnaissance towards Suez, and on the 23rd another to El-Magfar, 4 miles from Nefiche. It now appeared that the enemy had dammed the sweet-water canal and blocked the railway at Tel-el-Mahuta, where entrenchments had been thrown up and resistance seemed to be contemplated. At 4 a.m. on the 24th Sir Garnet Wolseley advanced with 3 squadrons of cavalry, 2 guns, and about 1000 infantry, placed under the orders of Lieutenant-General Willis. The enemy showed in force, estimated at 7000 with 12 guns, and a somewhat desultory action ensued. Reinforcements from Ismailia were ordered up, and the British cavalry, operating on the right, helped to check the enemy's attack, which showed little vigour. At night the troops, now reinforced by the Guards Brigade, an infantry battalion, 2 cavalry regiments, and 10 guns, bivouacked on the ground. Early on the morning of the 25th the advance was continued to Tel-el-Mahuta, which the enemy evacuated, while the mounted troops and horse artillery pressed on to Mahsameh, capturing the Egyptian camp, with 7 guns and large quantities of ammunition and supplies. On the same evening Major-General Graham, with about 1200 marines (artillery and light infantry), reached Mahsameh, and on the following day he occupied Kassassin without opposition. The advance guard had now outrun its communications and was actually short of food, while a considerable force was distributed at intervals along the line Ismailia–Kassassin. The situation on the 27th tempted attack by an enterprising enemy, and Major-General Graham's force, consisting of a squadron of the 19th Hussars, the York and Lancaster Regiment, the Duke of Cornwall's Light Infantry, the Marine Artillery Battalion and two R.H.A. guns, short of ammunition, was in danger of being overwhelmed by vastly superior numbers from Tel-el-Kebir. On the 28th Major-General Graham's troops were attacked, and after repulsing the enemy, made a general advance about 6.45 p.m. The cavalry, summoned by heliograph from Mahsameh, co-operated, and in a moonlight charge inflicted considerable loss. The British casualties amounted to 14 killed and 83 wounded. During the lull which followed the first action of Kassassin, strenuous efforts were made to bring up supplies and troops and to open up railway communication to the front. On 9th September the Egyptians again attacked Kassassin, but were completely repulsed by 9 a.m., with a loss of 4 guns, and were pursued to within extreme range of the guns of Tel-el-Kebir. The British casualties were 3 killed and 78 wounded. The three following days were occupied in concentrating troops at Kassassin for the attack on Tel-el-Kebir, held by about 38,000 men with 60 guns. The Egyptian defences consisted of a long line of trench ($2\frac{1}{2}$ miles) approximately at right angles to the railway and the sweet-water canal. At 11 p.m. on 12th September the advance of about 15,000 men commenced: the 1st Division, under Lieutenant-General Willis, was on the right, and the 2nd Division, under Lieutenant-General Hamley, was on the left. Seven batteries of artillery, under Brigadier-General Goodenough, were placed in the centre. The cavalry, under Major-General Drury Lowe, was on the right flank, and the Indian contingent, under Major-General Macpherson, starting one hour later, was ordered to move south of the sweet-water canal. The night was moonless, and the distance to be covered about $6\frac{1}{4}$ miles. The ground was perfectly open, slightly undulating, and generally firm gravel. The conditions for a night march were thus ideal; but during the movement the wings closed towards each other, causing great risk of an outbreak of firing. The line was, however, rectified, and after a halt the final advance began. By a fortunate accident the isolated outwork was just missed in the darkness by the left flank of the 2nd Division; otherwise a premature alarm would have been given, which must have changed all the conditions of the operation. At dawn the Highland Brigade of the 2nd Division struck the enemy's trenches, and carried them after a brief struggle. The 1st Division attacked a few minutes later, and the cavalry swept round the left of the line of entrenchments, cutting down any fugitives who attempted resistance and reaching the enemy's camp in rear. The Indian contingent, on the south of the canal, co-operated, intercepting the Egyptians at the canal bridge. The opposition encountered at some points was severe, but by 6 a.m. all resistance was at an end. The British loss amounted to 58 killed, 379 wounded, and 22 missing; nearly 2000 Egyptians were killed, and more than 500 wounded were treated in hospital. An immediate pursuit was ordered, and the Indian contingent, under Major-General Macpherson, reached Zagazig, while the cavalry, under Major-General Drury Lowe, occupied Belbeis and pushed on to Cairo, 65 miles from Tel-el-Kebir, next day. On the evening of the 14th the 10,000 troops occupying Abassiyeh Barracks, and 5000 in the Citadel of Cairo, surrendered. On the 15th General Sir Garnet Wolseley, with the Brigade of Guards under H.R.H. the Duke of Connaught, entered the city.

*Tel-el-Kebir.*

The prompt following up of the victory at Tel-el-Kebir saved Cairo from the fate of Alexandria and brought the rebellion to an end. The Egyptian troops at Kafr Dauar, Abukir, and Rosetta surrendered without opposition, and those at Damietta followed on 23rd September, after being threatened with attack. On the 25th the Khedive entered Cairo, where a review of the British troops was held on the 30th. The expeditionary force was now broken up, leaving about 10,000 men, under Major-General Sir A. Alison, to maintain the authority of the Khedive. In twenty-five days, from the landing at Ismailia to the occupation of Cairo, the rebellion was completely suppressed, and the operations were thus signally successful.

The authority of the Khedive and the maintenance of law and order now depended absolutely on the British forces left in occupation. Lord Dufferin, who had been sent to Cairo to draw up a project of constitutional reforms, advocated the re-establishment of a native army, not to exceed 5000 to 6000 men, with a proportion of British officers, for purely defence purposes within the Delta; and on 13th December 1882 Sir Evelyn Wood left England to undertake the organization of this force, with the title of Sirdar. Lord Dufferin further advised the formation of a gendarmerie, which "should be in a great measure a mounted force and empowered with a semi-military character" (despatch of 1st January 1883). The strength of this military police force was fixed at 4400 men with 2562 horses, and Baker Pasha was entrusted with its formation, with the title of Inspector-General. In a despatch of 6th February 1883 Lord Dufferin dealt with the Sudan, and stated that Egypt "could hardly be expected to acquiesce" in a policy of withdrawal from her Southern territories. At the same time he pointed out that,

*The Sudan question.*

Unhappily, Egyptian administration in the Sudan had been almost uniformly unfortunate. The success of the present Mahdi in raising the tribes and extending his influence over great tracts of country was a sufficient proof of the Government's inability either to reconcile the inhabitants to its rule or to maintain order. The consequences had been most disastrous. Within the last year and a half the Egyptians had lost something like 9000 men, while it was estimated that 40,000 of their opponents had perished.

Moreover, to restore tranquillity in the Sudan,

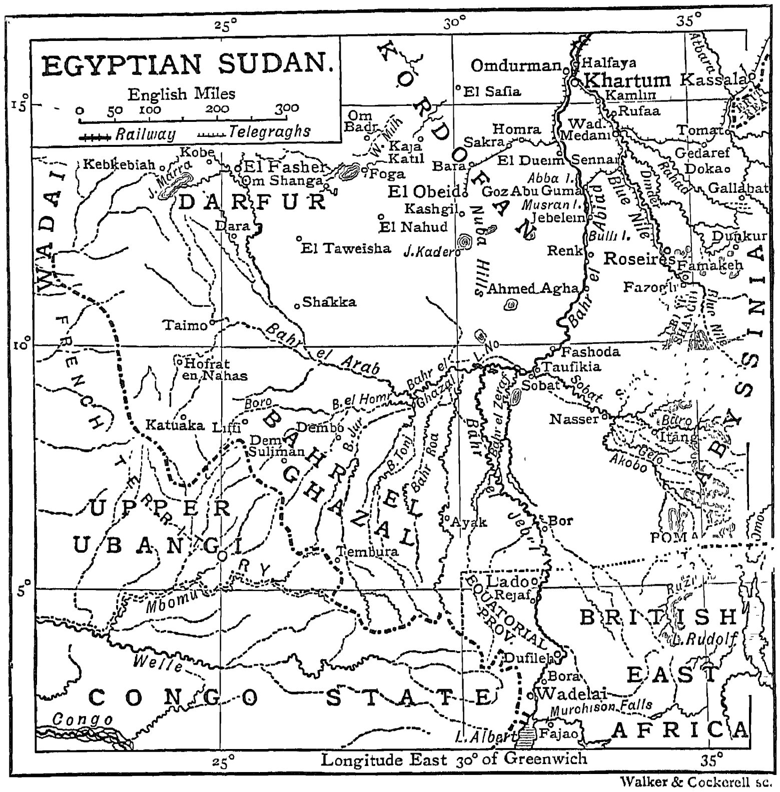
the first step necessary was the construction of a railway from Suakin to Berber, or, what, perhaps, would be more advisable, to

Shendi, on the Nile. The completion of this enterprise would at once change all the elements of the problem.

The immense responsibilities involved were most imperfectly understood by the British Government. Egyptian sovereignty in the Sudan dates from 1819, when Mehemet Ali sent a large force into the country, and ultimately established his authority over Sennar and Kordofan. In 1866 Suakin and Massawa were assigned to Egyptian rule by the Sultan, and in 1870 Sir Samuel Baker proceeded up the Nile to the conquest of the Equatorial Provinces, of which General Gordon was appointed Governor-General in 1874. In 1875 Darfur and Harrar were annexed, and in 1877 Gordon became Governor-General of the Sudan, where, with the valuable assistance of Jessi Pasha, he laboured to destroy the slave trade and to establish just government. In August 1879 he returned to Cairo, and was succeeded by Raouf Pasha. Misrule and oppression in every form now again prevailed throughout the Sudan, while the slave traders, exasperated by Gordon's stern measures, were ready to revolt. The authority of Egypt was represented by scattered garrisons of armed men, badly officered, undisciplined, and largely demoralized. In such conditions a leader only was required to ensure widespread and dangerous rebellion. A leader appeared in the person of Mahommed Ahmed, born in 1848, who had taken up his abode on Abba Island, and, acquiring great reputation for sanctity, had actively fomented insurrection. In August 1881 a small force sent by Raouf Pasha to arrest Mahommed Ahmed was destroyed, and the latter, proclaiming himself the *Mahdi*, stood forth as the champion of revolt. Thus at the time when the Egyptian army was broken up at Tel-el-Kebir, the Sudan was already in flames. On 7th June 1882, 6000 men under Yusef Pasha, advancing from Fashoda, were nearly annihilated by the Mahdists. Payara and Birket in Kordofan quickly fell, and a few days before the battle of Tel-el-Kebir was fought, the Mahdi, with a large force, was besieging El Obeid. By the close of the year almost the whole of the Sudan south of Khartum was in open rebellion, except the Bahr-el-Ghazal and the Equatorial Provinces, where for a time Lupton Bey and Emin Pasha were able to hold their own. Abd-el-Kader, who had succeeded Raouf, telegraphed to Cairo for 10,000 additional troops, and pointed out that if they were not sent at once four times this number would be required to re-establish the authority of the Government in the Sudan. After gaining some small successes, Abd-el-Kader was superseded by Suliman Niagi on 20th February 1883, and on 26th March Ala-ed-din Pasha was appointed Governor-General. Meanwhile 5000 men, who had served in the Egyptian army, were collected and forcibly despatched to Khartum *viâ* Suakin. In March 1883 Major-General Hicks, who in January had been appointed by the Khedive Chief of the Staff of the army of the Sudan, found himself at Khartum with nine European officers and about 10,000 troops of little military value. The reconquest of the Sudan having been determined upon, although Sir E. Malet reported that the Egyptian Government could not supply the necessary funds and that there was great risk of failure, General Hicks, who had resigned his post on 23rd July, and had been appointed Commander-in-Chief, started from Khartum on 9th September, with a total force of about 10,000 men, including non-combatants, for Kordofan. On 22nd May Sir E. Malet had informed Sherif Pasha that,

***Disaster to General Hicks.***

although General Hicks finds it convenient to communicate with Lord Dufferin or with me, it must not be supposed that we endorse in any way the contents of his telegrams. . . . Her Majesty's Government are in no way responsible for his operations in the Sudan, which have been undertaken under the authority of His Highness's Government.




Walker & Cockerell sc.

General Hicks was fully aware of the unfitness of his rabble forces for the contemplated task, and on 5th August he telegraphed: "I am convinced it would be best to keep the two rivers and province of Sennar, and wait for Kordofan to settle itself." Early in November the force from Khartum was caught by the Mahdists short of water at Kashgil, near El Obeid, and was almost totally destroyed, General Hicks, with all his European officers, perishing. Sinister rumours having reached Cairo, Sir E. Baring, who had succeeded Sir E. Malet, telegraphed that "if General Hicks's army is destroyed, the Egyptian Government will lose the whole of the Sudan, unless some assistance from the outside is given," and advised the withdrawal to some post on the Nile. On the following day Lord Granville replied: "We cannot lend English or Indian troops; if consulted, recommend abandonment of the Sudan within certain limits"; and on the 25th he added that "Her Majesty's Government can do nothing in the matter which would throw upon them the responsibilities for operations in the Sudan." In a despatch of 3rd December Sir E. Baring forcibly argued against British intervention in the affairs of the Sudan, and on 13th December Lord Granville telegraphed that "Her Majesty's Government recommend the Ministers of Khedive to come to an early decision to abandon all territory south of Assuan, or, at least, of Wadi Halfa." On 4th January 1884 Sir E. Baring was directed to insist upon the policy

of evacuation, and on the 18th General Gordon left London to assist in its execution.

The year 1883 brought a great accession of power to the Mahdi, who had captured about 20,000 rifles, 19 guns, and large stores of ammunition. On the Red Sea littoral Osman Digna, a slave dealer of Suakin, appointed Emir of the Eastern Sudan, raised the local tribes and invested Sinkat and Tokar. On 16th October and 4th November Egyptian reinforcements intended for the former place were destroyed, and on 2nd December a force of 700 men was annihilated near Tamanieb. On 23rd December General Baker, followed by about 2500 men, gendarmerie, blacks, Sudanese, and Turks, with 10 British officers, arrived at Suakin to prepare for the relief of Sinkat and Tokar. The Khedive appears to have been aware of the risks to be incurred, and in a private letter he informed the general that "I rely upon your prudence and ability not to engage the enemy except under the most favourable circumstances." The tragedy of Kashgil was repeated on 4th February 1884, when General Baker's heterogeneous force, on the march from Trinkitat to Tokar, was routed at El Teb by an inferior body of tribesmen. Of 3715 men, 2375, with 11 European officers, were killed. Suakin was now in danger, and on 6th February British bluejackets and marines were landed for the defence of the town.

***Defeat of General Baker.***

Two expeditions in the Sudan led by British officers having thus ended in disaster, and General Gordon with Lieutenant-Colonel Stewart having reached Khartum on 18th February, the policy of British non-intervention in regard to Sudan affairs could no longer be maintained. Public opinion in England was strongly impressed by the fact that the Egyptian garrisons of Tokar and Sinkat were perishing within striking distance of the Red Sea littoral. A British force about 4400 strong, with 22 guns, made up of troops from Egypt and from units detained on passage from India, was rapidly concentrated at Suakin and placed under the orders of Major-General Sir G. Graham, with Major-Generals Sir R. Buller and J. Davis as Brigadiers. News of the fall of Sinkat, where the starving garrison, under Tewfik Bey, made a gallant sortie and was cut to pieces, reached Suakin on 12th February. On the 24th General Graham's force disembarked at Trinkitat and received information of the surrender of Tokar. At 8 a.m. on the 29th the force advanced towards Tokar in square, and came under fire at 11.20 a.m. from the enemy entrenched at El Teb. The tribesmen made desperate efforts to rush the square, but were repulsed, and the position was taken by 2 p.m. The cavalry, 10th and 19th Hussars, under Brigadier-General H. Stewart, became involved in a charge against an unbroken enemy, and suffered somewhat severely. The total British loss was 34 killed and 155 wounded; that of the tribesmen was estimated at 1500 killed. On the following day Tokar was reached, and on 2nd March the force began its return to Suakin, bringing away about 700 people belonging to the late garrison and the civil population, and destroying 1250 rifles and a quantity of ammunition found in a neighbouring village. On 9th March the whole force was back at Suakin, and on the evening of the 11th an advance to Tamai began, and the force bivouacked and formed a zeriba in the evening. Information was brought by a native that the enemy had assembled in the Khor Ghob, a deep ravine not far from the zeriba. At about 8.30 a.m on the 13th the advance began in echelon of brigade squares from the left. The left and leading square (2nd Brigade) moved towards the Khor, approaching at a point where a little ravine joined it. The enemy showing in front, the leading face of the square was ordered to charge up to the edge of the Khor. This opened the square, and a mass of tribesmen rushed in from the small ravine. The brigade was forced back in disorder, and the naval guns, which had been left behind, were temporarily captured. After a severe hand-to-hand struggle, in which the troops behaved with great gallantry, order was restored and the enemy repulsed, with the aid of the fire from the 1st Brigade square and from dismounted cavalry. The 1st Brigade square, having a sufficient field of fire, easily repelled all attempts to attack, and advancing as soon as the situation had been restored, occupied the village of Tamai. The British loss was 109 killed and 104 wounded; of the enemy nearly 2000 were killed. On the following day the force returned to Suakin.

***British expedition under Sir G. Graham: battles of El Teb and Tamanieb.***

Two heavy blows had now been inflicted on the followers of Osman Digna, and the road to Berber could have been opened, as General Graham and Colonel H. Stewart suggested. General Gordon, questioned on the point, telegraphed from Khartum, on 7th March, that he might be cut off by a rising at Shendi, adding, "I think it, therefore, most important to follow up the success near Suakin by sending a small force to Berber." He had previously, on 29th February, urged that the Suakin–Berber road should be opened up by Indian troops. This, and General Gordon's proposal to send 200 British troops to Wadi Halfa, was opposed by Sir E. Baring, who, realizing soon afterwards the gravity of the situation, telegraphed on 16th March:—

It has now become of the utmost importance not only to open the road between Suakin and Berber, but to come to terms with the tribes between Berber and Khartum.

The Government refused to take this action, and Major-General Graham's force was employed in reconnaissances and small skirmishes, ending in the destruction of the villages in the Tamanieb Valley on 27th March. On the 28th the whole force was reassembled at Suakin, and was then broken up, leaving one battalion to garrison the town.

The abrupt disappearance of the British troops encouraged the tribesmen led by Osman Digna, and effectually prevented the formation of a native movement, which might have been of great value. The first attempt at intervention in the affairs of the Sudan was made too late to save Sinkat and Tokar. It resulted only in heavy slaughter of the tribesmen, which afforded no direct or indirect aid to General Gordon or to the policy of evacuation. The public announcement of the latter was a grave mistake, which increased General Gordon's difficulties, and the situation at Khartum grew steadily worse. On 24th March Sir E. Baring telegraphed:—

***Entanglement of General Gordon at Khartum.***

The question now is, how to get General Gordon and Colonel Stewart away from Khartum. . . . Under present circumstances, I think an effort should be made to help General Gordon from Suakin, if it is at all a possible military operation. . . . We all consider that, however difficult the operations from Suakin may be, they are more practicable than any operations from Korosko and along the Nile.

A telegram from General Gordon, received at Cairo on 19th April, stated that,

We have provisions for five months and are hemmed in. . . . Our position will be much strengthened when the Nile rises. . . . Sennar, Kassala, and Dongola are quite safe for the present.

At the same time he suggested "an appeal to the millionaires of America and England" to subscribe money for the cost of "2000 or 3000 Nizams" (Turkish regulars) to be sent to Berber. A cloud now settled down upon Khartum, and subsequent communications were few and irregular. The Foreign Office and General Gordon appeared to be somewhat at cross purposes. The former

hoped that the garrisons of the Sudan could be extricated without fighting. The latter, judging from the tenor of some of his telegrams, believed that to accomplish this work entailed the suppression of the Mahdi's revolt, the strength of which he at first greatly underestimated. He had pressed strongly for the employment of Zobeir as "an absolute necessity for success" (3rd March); but this was refused, since Sir H. Gordon advised at this time that it would be dangerous. On 9th March General Gordon proposed, "if the immediate evacuation of Khartum is determined upon irrespective of outlying towns," to send down the "Cairo *employés*" and the garrison to Berber with Lieutenant-Colonel Stewart, to resign his commission, and to proceed with the stores and steamers to the Equatorial Provinces, which he would consider as placed under the King of the Belgians. On 13th March Lord Granville gave full power to General Gordon to "evacuate Khartum and save that garrison by conducting it himself to Berber without delay," and expressed a hope that he would not resign his commission.

***Relief expedition: question of route.***

By the end of March 1884 Sir E. Baring and the British officers in Egypt were convinced that force would have to be employed, and the growing danger of General Gordon, with the grave national responsibility involved, began to be realized in Great Britain. Sir Henry Gordon, however, who was in personal communication with Mr Gladstone, considered that his brother was in no peril, and for some time disbelieved in the need for a relief expedition. Meanwhile it was at least necessary to evolve some plan of action, and on 8th April the Adjutant-General addressed a memorandum to the Secretary of State for War detailing the measures required for placing 6500 British troops "in the neighbourhood of Shendi." The battle of the routes began much earlier, and was continued for some months. Practically the choice lay between the Nile and the Suakin–Berber road. The first involved a distance of 1650 miles from Cairo along a river strewn with cataracts, which obstructed navigation to all but small boats, except during the period of high water. So great was this obstruction that the Nile had never been a regular trade route to the Sudan. The second entailed a desert march of about 250 miles, of which one section, Obak–Bir Mahobeh (52 miles), was waterless, and the rest had an indifferent water supply (except at Ariab, about half-way to Berber), capable, however, of considerable development. From Berber the Nile is followed (210 miles) to Khartum. This was an ancient trade route with the Sudan, and had been used without difficulty by the reinforcements sent to Hicks Pasha in 1883, which were accompanied by guns on wheels. The authorities in Egypt, headed by General Stephenson, subsequently supported by the Admiral Lord John Hay, who sent a naval officer to examine the river as far as Dongola, were unanimous in favour of the Suakin–Berber route. From the first Major-General Sir A. Clarke, then Inspector-General of Fortifications, strongly urged this plan, and proposed to begin at once a metre gauge railway from Suakin, to be constructed by Indian labour under officers skilled in laying desert lines. Some preliminary arrangements were made, and on 14th June the Government sanctioned certain measures of preparation at Suakin. On the other side were the Adjutant-General (Lord Wolseley) and a small number of officers who had taken part in the Red River expedition of 1870. The memorandum of the Adjutant-General above referred to was based on the hypothesis that Khartum could not hold out beyond 15th November, and that the expedition should reach Berber by 20th October. Steamers were to be employed in such reaches as proved practicable, but the force was to be conveyed in special whale-boats, by which "the difficulty of transport is reduced to very narrow limits." The mounted force was to consist of 400 men on native horses and 450 men on horses or camels. The question of routes continued to be the subject of animated discussion, and on 29th July a committee of three officers who had served in the Red River expedition reported:—

> We believe that a brigade can easily be conveyed in small boats from Cairo to Dongola in the time stated by Lord Wolseley; and, further, that should it be necessary to send a still larger force by water to Khartum, that operation will present no insuperable difficulties.

***Lord Wolseley sent out; Nile route adopted.***

This most inconclusive report, and the baseless idea that the adoption of the Nile route would involve no chances of bloodshed, which the Government was anxious to avoid, seem to have decided the question. On 8th August the Secretary of State for War informed General Stephenson that "the time had arrived when some further measures for obtaining accurate information as to his (General Gordon's) position, and, if necessary, for rendering him assistance, should be adopted." General Stephenson still urged the Suakin–Berber route, and was informed on 26th August that Lord Wolseley would be appointed to take over the command in Egypt for the purposes of the expedition, for which a vote of credit had been taken in the House of Commons on 5th August. On 9th September Lord Wolseley arrived at Cairo, and the plan of operations was somewhat modified. A camel corps of 1100 men selected from twenty-eight regiments at home was added, and the "fighting force to be placed in line somewhere in the neighbourhood of Shendi" was fixed at 5400. The construction of whale-boats began on 12th August, and the first batch arrived at Wadi Halfa on 14th October, and on the 25th the first boat was hauled through the second cataract. The mounted forces proceeded up the banks, and the first half-battalion embarked at Gemai, 870 miles from Khartum, on 5th November, ten days before the date to which it had been assumed General Gordon could hold out. In a straggling procession the boats worked their way up to Korti, piloted by Canadian *voyageurs*. The labour was very great, and the troops, most of whom were having their first lesson in rowing, bore the privations of their unaccustomed conditions with admirable cheerfulness. By 25th December 2220 men had reached Korti, of whom about 800 only had been conveyed by the whale-boats, the last of which did not arrive till 27th January. Beyond Korti lay the very difficult section of the river to Abu Hamed, which was quite unknown. Meanwhile news of the loss of the *Abbas* and of the murder of Colonel J. D. Stewart and his party on 18th September had been received. A letter from Gordon, dated 4th November and received 17th November, stated that his steamers would await the expedition at Metemmeh, and added, "We can hold out forty days with ease; after that it will be difficult." In his diary, on 13th December, when his difficulties had become extreme, he noted that "if the expeditionary force does not come in ten days, the town may fall."

***Stewart's Desert Column; battle of Abu Klea wells.***

It was clear at Korti that something must be done at once; and on 13th December 1100 men, with 2200 camels, under Colonel Sir H. Stewart, were despatched to occupy Jakdul wells, 96 miles on the desert route to Metemmeh. Stewart returned on 5th January, and started again on the 8th, with orders to establish a fort at Abu Klea and to occupy Metemmeh. The "Desert Column," 1800 men, with 2880 camels in poor condition and 153 horses, found the enemy in possession of Abu Klea wells on the 16th, and was desperately attacked on the 17th. The

want of homogeneity of the force, and the unaccustomed tactics imposed upon the cavalry, somewhat hampered the defence, and the square was broken at the left rear corner. Driven back upon the camels in the centre, the troops fought hand to hand with the greatest gallantry. Order was quickly restored, and the attack was repulsed, with a loss of 74 killed and 94 wounded. At least 1100 of the enemy were killed. The wells being occupied and a zeriba formed, the column started on the evening of the 18th. The wrong road was taken, and great confusion occurred, during the night, but at dawn this was rectified; and after forming a rough fort under fire, by which Sir H. Stewart was fatally wounded, an advance was made at 3 p.m. The square was again heavily attacked, but the Arabs could not get to close quarters, and in the evening a bivouac was formed on the Nile. The British losses on this day were 23 killed and 98 wounded. The Desert Column was now greatly exhausted. On the 20th the village of Gubat was occupied; and on the following day Sir C. Wilson, on whom the command had devolved, advanced against Metemmeh, which was found too strong to assault. On this day General Gordon's four steamers arrived; and on the morning of the 24th Sir C. Wilson, with 20 British soldiers in red coats and about 280 Sudanese, started in the *Bordein* and *Telahawiyeh* for Khartum. The *Bordein* grounded on the following day, and again on the 26th, by which twenty-four hours were lost. At 11 a.m. on the 28th Khartum was sighted, and it soon became clear that the town was in the hands of the enemy. After reconnoitring farther, the steamers turned and proceeded down stream under a heavy fire, the Sudanese crews showing signs of disaffection. The *Telahawiyeh* was wrecked on 29th January and the *Bordein* on the 31st, Sir C. Wilson's party being rescued on 4th February by Lord C. Beresford in the *Safieh*, which had come up from Gubat on receipt of news carried there by Lieutenant Stuart Wortley in a row-boat. Khartum had been taken and General Gordon killed on the morning of 26th January 1885, having thus held out thirty-four days beyond the date when he had expected the end. The garrison had been reduced to starvation; and the arrival of twenty British soldiers, with orders to return at once, could not have affected the situation. The situation of the Desert Column and of its transport was most imperfectly understood at Korti, where impossible plans were formed. Fortunately Major-General Sir R. Buller, who arrived at Gubat on 11th February, decided upon withdrawal, thus averting impending disaster, and by 16th March the Desert Column had returned to Korti.

***Failure of relief expedition.***

The advance from Korti of the "River Column," under Major-General Earle, began on 28th December, and great difficulties of navigation were encountered. On 10th February an action was fought at Kirbekan with about 800 of the enemy, entailing a loss of 10 killed, including Major-General Earle, and 47 wounded. The column, now commanded by Brigadier-General Brackenbury, continued its slow advance, and on the morning of 24th February it was about 26 miles below Abu Hamed, a point where the Korosko desert route strikes the Nile, 350 miles from Khartum. Here it received orders to retire, and it reached Korti on 8th March.

***Suakin operations.***

The verbal message received from General Gordon on 30th December 1884 rendered the extreme danger of the position at Khartum painfully apparent, and the English Minister for War, acting on Sir E. Baring's advice, offered to make an active demonstration from Suakin. To this proposal Lord Wolseley demurred, but asked that ships of war should be sent to Suakin, and that "marines in red coats should be frequently landed and exercised." Lord Hartington replied that the Government did not consider that a demonstration of this kind could be effective, and again suggested stronger measures. On 8th January 1885 Lord Wolseley repeated that "the measures you propose will not assist my operations against Khartum," adding:—

> I have from first endeavoured to impress on Government that I am strong enough to relieve Khartum, and believe in being able to send a force, when returning by way of Berber, to Suakin, to open road and crush Osman Digna.

On this very day the small Desert Column started from Korti on its hazardous mission to the relief of a town fully 270 miles distant, held by a starving garrison, and invested by 30,000 fighting men, mostly armed with good rifles. Before reaching the Nile the Desert Column had lost 300 men and was unable to take Metemmeh, while its transport had completely broken down. On the 8th February Lord Wolseley telegraphed, "The sooner you can now deal with Osman Digna the better," and recommended the despatch of Indian troops to Suakin, to "co-operate with me in keeping road to Berber open." On 11th February, the day on which Sir R. Buller most wisely decided to withdraw the Desert Column from a position of extreme danger, it was determined at Korti that the River Column should proceed to attack Berber, and Lord Wolseley accepted the proposal of the Government to make a railway from Suakin, telegraphing to Lord Hartington:—

> By all means make railway by contract to Berber, or as far as you can, during summer. It will be invaluable as a means of supply, and I recommend it being begun immediately. Contract to be, if possible, for so much per ton military stores and supplies and men carried, per mile.

Every effort was now concentrated upon sending an expeditionary force to Suakin, and before the end of March about 13,000 men, including a brigade from India and a field battery from New South Wales, with nearly 7000 camels and 1000 mules, were there assembled. Lieutenant-General Sir G. Graham was placed in command of this force, with orders to break down the power of Osman Digna and to press the construction of the railway towards Berber. The troops at Suakin, on arrival, were much harassed by small night attacks, which ceased as soon as the scattered camps were drawn together. On 19th March Sir G. Graham, with the cavalry brigade and the infantry of the Indian contingent, reconnoitred as far as Hashin, finding the country difficult on account of the dense mimosa scrub. The enemy occupied the hills and fired upon the cavalry. On the 20th Sir G. Graham, with about 9000 men, again advanced to Hashin, and Dehilbat Hill was taken by the Berkshire Regiment and the Royal Marines. A squadron of the 9th Royal Lancers, which was dismounted in the thick bush, was driven back with the loss of 9 men; but elsewhere the Arabs never succeeded in closing, and the troops returned to Suakin in the afternoon, leaving the East Surrey Regiment in a zeriba covering some low hills near Hashin village. The total British loss was 9 killed and 39 wounded.

***Battle of Hashin.***

On 22nd March a force, consisting of two British and three Indian battalions, with a naval brigade, a squadron of Lancers, two companies of Engineers, and a large convoy of camels carrying water and supplies, under Major-General Sir J. McNeill, started from Suakin for Tamai, with orders to form a half-way zeriba. The advance was much impeded by the dense bush, and the force halted at Tofrik, about 6 miles out, at 10.30 a.m. A native had brought information that the enemy intended to attack while the zeriba was being formed, and

***McNeill's zeriba.***

this actually occurred. The force was caught partly unprepared soon after 2.30 p.m., and some fighting took place. The enemy were repulsed in about twenty minutes, the Naval Brigade, the Berkshire Regiment, the Royal Marines, and the 15th Sikhs showing the greatest gallantry. The casualties, including those among non-combatants, were 150 killed, 148 missing, and 174 wounded. More than 500 camels were killed. The tribesmen lost more than 1000 killed. As soon as firing was heard at Suakin, Sir G. Graham, with two battalions of Guards and a battery of Horse Artillery, started for Tofrik, but returned on being assured that reinforcements were not required. On the 24th and 26th convoys proceeding in square to Tofrik were attacked, the enemy being repulsed without difficulty. On 2nd April a force exceeding 7000 men, with 14 guns and 1600 transport animals, started from Suakin at 4.30 a.m., and bivouacked twelve hours later at Tesela Hill. Next morning an advance was made towards Tamai, and a number of huts in the Khor Ghob were burned. The force then returned to Suakin. The railway was now pushed on without interruption, reaching Otao on the 30th. On the night of 6th May a combined movement was made from Suakin and Otao, which resulted in the surprise and break-up of a force of the enemy under Mahommed Sardun, and the capture of a large number of sheep and goats. The moral effect of this operation was marked, and large numbers of tribesmen placed themselves unconditionally at the disposal of Sir G. Graham. A great native movement could now have been organized, which would have kept the route to Berber and enabled the railway to be rapidly pushed forward.

Meanwhile many communications had passed between the War Office and Lord Wolseley, who at first believed that Berber could be taken before the summer. In a long despatch of 6th March he discussed the general situation, and pointed out that although the force at his disposal "was amply sufficient" for raising the siege of Khartum and defeating the Mahdi, the conditions were changed by the fall of the town. It was now "impossible . . . to undertake any offensive operations until about the end of the summer," when twelve additional British battalions, four strong squadrons of British cavalry, and two R.H.A. batteries, together with a large extension of the Wadi Halfa railway, eleven steamers, and three hundred more whale-boats, would be required. He considered it necessary to hold Dongola, and he reported that he was "distributing this army along the left bank of the Nile, on the open reach of water" between the Hannek cataract and Abu Dom, opposite Merawi. On 30th March Lord Wolseley quitted the army and proceeded to Cairo. A cloud having arisen on the frontiers of Afghanistan, the withdrawal of the troops from the Sudan was ordered on 11th May. On the formation of Lord Salisbury's Cabinet, the new Secretary of State for War, Mr W. H. Smith, inquired whether the retirement could be arrested, but Major-General Sir R. Buller reported that the difficulties of reoccupation would be great, and that if Dongola was to be held, a fresh expedition would be required. On 20th June, before the British rearguard had left Dongola, the Mahdi died. The withdrawal of the Suakin force began on 17th May, and the friendly tribes, deprived of support, were compelled to make terms with Osman Digna, who was soon able to turn his attention to Kassala, which capitulated in August, nearly at the same time as Sennar.

***Political and military situation at end of operations.***

The failure of the operations in the Sudan had been absolute and complete, and the reason is to be sought in a total misconception of the situation, which caused vacillation and delay, and in the choice of a route by which, having regard to the date of the decision, the relief of General Gordon and Khartum was impossible.

(G. S. C.)

## Military Operations in Egypt and the Sudan. 1885 to 1896.

The operations against Mahdism during the eleven years from the end of the Nile expedition and the withdrawal from the Sudan to the commencement of the Dongola campaign will be more easily understood if, instead of narrating them in one chronological sequence, the operations in each province are considered separately. The Mahdi, Mahommed Ahmed, died at Omdurman on 22nd June 1885. He was succeeded by the principal Khalifa, Abdullah el Taaishi, a Baggara Arab, who for the next thirteen years ruled the Sudan with despotic power. Cruel, vicious, unscrupulous, and strong, the country groaned beneath his oppression. He removed all possible rivals, concentrated at Omdurman a strong military force composed of men of his own tribe, and maintained the ascendency of that tribe over all others. As the British troops retired to Upper Egypt, his followers seized the evacuated country, and the Khalifa cherished the idea, already formulated by the Mahdi, of the conquest of Egypt, but for some years he was too much occupied in quelling risings, massacring the Egyptians in the Sudan, and fighting Abyssinia, to move seriously in the matter.

*Upper Egypt.*—Mahommed el Kheir, dervish Emir of Dongola, however, advanced towards the frontier in the autumn, and at the end of November came in touch with the frontier field force, a body of some 3000 men composed in nearly equal parts of British and Egyptian troops. A month of harassing skirmishes ensued, during which the Egyptian troops showed their mettle at Mograkeh, where 200 of them held the fort against a superior number of dervishes, and in combats at Ambigol, Kosheh, and Firket. Sir Frederick Stephenson, commanding the British army of occupation in Egypt, then concentrated the frontier field force at Firket, and attacked the main body of the enemy at Ginnis on the 30th December 1885, completely defeating it and capturing two guns and twenty banners. It was here the new Egyptian army received its baptism of fire and acquitted itself very creditably. Although checked, the dervishes were not discouraged, and continued to press upon the frontier in frequent raids, and thus in many bloody skirmishes the fighting qualities of the Egyptian troops were developed. In April 1886 the frontier was drawn back to Wadi Halfa, a fortified camp at the northern end of the desolate defile, Batn-el-Hagar, through which the Nile tumbles amid black, rocky hills in a succession of rapids, and debouches on a wide plain. The protection of the frontier was now left in the hands of the Egyptian army, a British force remaining at Assuan, 200 miles to the north, as a reserve in case of emergency, and two years later even this precaution was deemed unnecessary.

In October 1886 Wad en Nejumi, the Emir who had defeated Hicks Pasha in Kordofan three years before, and led the assault at Khartum when General Gordon was slain in January 1885, replaced Mahommed el Kheir as "Commander of the Force for the Conquest of Egypt," and brought large reinforcements to Dongola. An advanced column under Nur-el Kanzi occupied Sarras in April 1887, was attacked by the Egyptian force under Colonel H. Chermside on the 28th of that month, and after a stubborn resistance was defeated with great loss. Nur-el-Kanzi was killed and ten standards taken.

The troubles in Darfur and with Abyssinia (*q.v.*) induced the Khalifa to reduce the garrisons of the north; nevertheless the dervishes reoccupied Sarras, continued

active in raids and skirmishes, and destroyed the railway south of Sarras, which during the Nile expedition of 1884 and 1885 had been carried as far as Akasheh. It was not until May 1889 that an invasion of the frontier on a large scale was attempted. At this time the power and prestige of the Khalifa were at their height: the rebellions in Darfur and Kordofan had been stamped out, the Anti-Mahdi was dead, and even the dervish defeat by the Abyssinians had been converted by the death of King John and the capture of his body into a success. It was therefore an opportune time to try to sweep the Turks and the British into the sea. On the 22nd June Nejumi was at Sarras with over 6000 fighting men and 8000 followers. On the 2nd July Colonel J. Woodhouse headed off a part of this force from the river at Argin and, after a sharp action, completely defeated it, killing 900, among whom were many important Emirs, and taking 500 prisoners and 12 banners, with very small loss to his own troops. A British brigade was on its way up stream, but the Sirdar, who had already arrived to take the command in person, decided not to wait for it. The Egyptian troops, with a squadron of the 20th Hussars, concentrated at Toski, and thence, on the 3rd August, General Grenfell, with slight loss, gained a decisive victory. Wad en Nejumi, most of his Emirs, and more than 1200 Arabs were killed; 4000 prisoners and 147 standards were taken, and the dervish army practically destroyed. No further serious attempts were made to disturb the frontier, of which the most southerly outpost was at once advanced to Sarras.

***Battle of Toski.***

The escape from Omdurman of Father Ohrwalder and of two of the captive nuns in December 1891, of Father Rossignoli in October 1894, and of Slatin Bey in February 1895, revealed the condition of the Sudan to the outside world, throw a vivid light on the rule of the Khalifa, and corroborated information already received of the discontent which existed among the tribes with the oppression and despotism under which they lived.

*The Eastern Sudan.*—In 1884 Colonel Chermside, Governor of the Red Sea Littoral, entered into arrangements with King John of Abyssinia for the relief of the beleaguered Egyptian garrisons. Gera, Amadib, Senhit, and Galabat were, in consequence, duly succoured, and their garrisons and Egyptian populations brought away to the coast by the Abyssinians in 1885. Unfortunately famine compelled the garrison of Kassala to capitulate on 30th July of that year, and Osman Digna hurried there from Tamai to raise a force with which to meet the Abyssinian general, Ras Alula, who was preparing for its relief. By the end of August Osman Digna had occupied Kufit, in the Barea country, with 10,000 men and entrenched himself. On the 23rd September Ras Alula attacked him there with an equal number of men and routed him with great slaughter. Over 3000 dervishes with their principal Emirs, except Osman Digna, lay dead on the field, and many more were killed in the pursuit. The Abyssinians lost 40 officers and 1500 men killed, besides many more wounded. Instead of marching on to Kassala, Ras Alula, who at this time was much offended by the transfer of Massawa by the Egyptians to Italy, made a triumphant entry into Asmara, and absolutely refused to make any further efforts to extricate Egyptian garrisons from the grip of the Khalifa. Meanwhile Osman Digna, who had fled from Kufit to Kassala, wreaked his vengeance upon the unhappy captives at Kassala.

In the neighbourhood of Suakin there were many tribes disaffected to the Khalifa's cause, and in the autumn of 1886 Colonel H. Kitchener, who was at the time Governor of the Red Sea Littoral, judiciously arranged a combination of them to overthrow Osman Digna, with the result that his stronghold at Tamai was captured on the 7th October, 200 of his men killed, and 50 prisoners, 17 guns, and a vast store of rifles and ammunition captured. For about a year there was comparative quiet. Then at the end of 1887 Osman Digna again advanced towards Suakin, but his force at Taroi was routed by the "Friendlies," and he fell back on Handoub. Kitchener unsuccessfully endeavoured to capture Osman Digna on the 17th January 1888, but in the attack was himself severely wounded, and was shortly after invalided. Later in the year Osman Digna collected a large force and besieged Suakin. In December the Sirdar arrived with reinforcements from Cairo, and on the 20th sallied out and attacked the dervishes in their trenches at Gemaizeh, clearing the whole line and inflicting considerable loss on the enemy, who retired towards Handoub, and the country was again fairly quiet for a time. During 1889 and 1890 Tokar became the centre of dervish authority, while Handoub continued to be occupied for the Khalifa. In January 1891 Osman Digna showed signs of increased activity, and Colonel Holled Smith, then Governor of the Red Sea Littoral, attacked Handoub successfully on the 27th and occupied it, then seized Trinkitat and Teb, and on the 19th February fought the decisive action of Afafit, occupied Tokar, and drove Osman Digna back to Temrin with a loss of 700 men, including all his chief Emirs. This action proved the final blow to the dervish power in the neighbourhood of Suakin, for although raiding continued on a small scale, the tribes were growing tired of the Khalifa's rule and refused to support Osman Digna.

***Battle of Afafit.***

In the spring of 1891 an agreement was made between England and Italy by which the Italian forces in Eritrea were at liberty, if they were able, to capture and occupy Kassala, which lay close to the western boundary of their new colony, on condition that they restored it to Egypt at a future day when required to do so. Three years passed before they availed themselves of this agreement. In 1893 the dervishes, 12,000 strong, under Ahmed Ali, invaded Eritrea, and were met on the 29th December at Agordat by Colonel Arimondi with 2000 men of a native force. Ahmed Ali's force was completely routed and himself killed, and in the following July Colonel Baratieri, with 2500 men, made a fine forced march from Agordat, surprised and captured Kassala on the 17th of that month, and continued to hold it for three years and a half.

*The Abyssinian Frontier.*—On the Abyssinian frontier Ras Adal was in command of a considerable force of Abyssinians early in 1886, and in June of that year he invaded Galabat and defeated the dervishes on the plain of Madana; the dervish Emir Mahommed Wad Ardal was killed and his camp captured. In the following year Emir Yunis ed Dekeim made two successful raids into Abyssinian territory, upon which Ras Adal collected an enormous army, said to number 200,000 men, for the invasion of the Sudan. The Khalifa sent Emir Hamdan Abu Angar, a very skilful leader, with an army of over 80,000 men against him. Abu Angar entered Abyssinia and, in August 1887, attacked Ras Adal in the plain of Debru Sin and, after a prolonged battle, defeated the Abyssinians, captured their camp, and marched on Gondar, the ancient capital of Abyssinia, which he sacked, and then returned into Galabat. King John, the Negus of Abyssinia, burning to avenge this defeat, marched, in February 1889, with an enormous army into Galabat, where the Emir Ez Zaki Tumal commanded the Khalifa's forces, some 60,000 strong, and had strongly fortified the town of Matamma and the camp. On the 9th March 1889 the Abyssinians made a terrific onslaught, stormed and burnt the town, and took thousands of prisoners. A small party of dervishes still held a zeriba when King John was struck by a stray bullet. The Ayssinians decided to retire, fighting ceased, and they moved off with their prisoners and the wounded Negus. That night the king died, and the greater part of the army having gone ahead with the prisoners, a party of Arabs pursued the rearguard, which consisted of the king's bodyguard, routed them, and captured the king's body, which was sent to Omdurman to confirm the report of a brilliant victory sent by Ez Zaki Tumal to the Khalifa. Internal strife prevented the new

Negus of Abyssinia from prosecuting the war, which thus, in spite of the Abyssinian success, resulted in the increased power and prestige of the Khalifa.

*Darfur and Kordofan.*—On the outbreak of the Mahdi's rebellion Slatin Bey was governor of the province, and when Madibbo, the insurgent Sheikh of Rizighat, attacked and occupied Shakka and was following up his success, Slatin twice severely defeated him and, having concentrated his forces at El Fasher, repulsed the enemy again at Om Shanga. Mahdism, however, spread over Darfur in spite of Slatin's efforts to stay it. He fought no fewer than twenty-seven actions in various parts of his province, but his own troops, in course of time, became infected with the new faith and deserted him. He was obliged to surrender at Dara in December 1883, and was a prisoner, first at Obeid and then at Omdurman, until he escaped in 1895. In January 1884 Zogal, the new dervish Emir of the province, attacked El Fasher, where Said Bey Guma and an Egyptian garrison 1000 strong with 10 guns was still holding out, and captured it. He also reduced the Jebel Marra district, where the loyal hill-people gave him some trouble.

After the death of the Mahdi in 1885, Madibbo revolted against the Khalifa, but was defeated by Karamalla, the dervish Emir of the Bahr-el-Ghazal, and was caught and executed. A war then sprang up between Karamalla and Sultan Yusef, who had succeeded Zogal as Emir of Darfur. Yusef was joined in 1887 by Sultan Zayid, the black ruler of Jebel Marra, and Karamalla's trusted general, Ketenbur, was defeated with great slaughter at El Towaish on 29th June 1887. Osman wad Adam (Ganu), Emir of Kordofan, was sent by the Khalifa to Karamalla's assistance. He forced back the Darfurians near Dara on the 26th December, routed Zayid in a second battle, entered El Fasher, and, in 1888, became complete master of the situation, the two Sultans being killed. The Darfurian chiefs then allied themselves with Abu Gemaizeh, Sheikh of the Masalit Arabs, who had proclaimed himself "Khalifa Osman," and was known as the Anti-Mahdi. The revolt assumed large proportions, and became the more dangerous to Abdullah, the Khalifa, by reason of its religious character, wild rumours spreading over the country and reaching to Egypt and Suakin of the advent to power of an opposition Mahdi. Abu Gemaizeh attacked a portion of Osman Adam's force, under Abd-el-Kader, at Kebkebieh, 30 miles from El Fasher, and almost annihilated it on the 16th October 1888; and a week later another large force of Osman Adam met with the same fate at the same place. Instead of following up his victories, Abu Gemaizeh retired to Dar Tama to augment his army, to which thousands flocked as the news of his achievements spread far and wide. He again advanced to El Fasher in February 1889, but was seized with smallpox. His army, however, under Fiki Adam, fought a fierce battle close to El Fasher on the 22nd, which resulted in its defeat and dispersion, and Abu Gemaizeh himself dying the following day, the movement collapsed.

In 1891 Darfur and Kordofan were again disturbed, and Sultan Abbas succeeded in turning the dervishes out of the Jebel Marra district. Two years later a saint of Sokoto, Abu Naal Muzil el Muhan, collected many followers and for a time threatened the Khalifa's power, but the revolt gradually died out.

*The Bahr-el-Ghazal.*—The first outbreak in favour of Mahdism in the Bahr-el-Ghazal took place at Liffi in August 1882, when the Dinka tribe, under Jango, revolted and was defeated by Lupton Bey with considerable slaughter at Tel Gauna, and again in 1883 near Liffi. In September of that year Lupton's captain, Rufai Aga, was massacred with all his men at Dembo, and Lupton, short of ammunition, was forced to retire to Dem Suliman, where he was completely cut off from Khartum. After gallantly fighting for eighteen months he was compelled by the defection of his troops to surrender on 21st April 1884 to Karamalla, the dervish Emir of the province. He died at Omdurman in 1888.

In 1890 the Shillouks in the neighbourhood of Fashoda rose against the Khalifa, and the dervish Emir of Galabat, Zeki Tumal, was engaged for two years in suppressing the rebellion. He got the upper hand in 1892, and was recalled to oppose an Italian force said to be advancing from Massawa; but on reporting that it was impossible to invade Eritrea, as the Khalifa wished him to do, he was summoned to Omdurman and put to death. The country then relapsed into its original barbarous condition, and dervish influence was nominal only. In 1892 the Congo State Expedition established posts up to the seventh parallel of north latitude. In 1893 the dervish Emir, Abu Mariam, fought with the Dinka tribe and was killed and his force destroyed, the fugitives taking refuge in Shakka. In the following year the Congo Expedition established further posts, and in consequence the Khalifa sent 3000 men, under the Emir Khatem Musa, from Skakka to reoccupy the Bahr-el-Ghazal. The Belgians at Liffi retired before him, and he entered Faroga. Famine and disease broke out in Khatem Musa's camp in 1895, and a retreat was made towards Kordofan.

*Equatoria.*—In the equatorial province, which extended from the Albert Nyanza to Lado, Emin Bey, who had a force of 1300 Egyptian troops and 3000 irregulars, distributed among many stations, held out, hoping for reinforcements. In March 1885, however, Amadi fell to the dervishes, and on the 18th April Karamalla arrived near Lado, the capital, and sent to inform Emin of the fall of Khartum. Emin and Captain Casati, an Italian, moved south to Wadelai, giving up the northern posts, and opened friendly relations with Kabarega, King of Unyoro. On 26th February 1886 Emin received despatches from Cairo *viâ* Zanzibar, from which he learned all that had occurred during the previous three years, and that "he might take any step he liked, should he decide to leave the country." He determined to remain where he was and "hold together, as long as possible, the remnant of the last ten years." His troops were in a mutinous state, wishing to go north rather than south, as Emin had ordered them to do, and unsuccessfully endeavoured to carry him with them by force.

His communications to Europe through Zanzibar led to the Relief Expedition under Mr H. M. Stanley, which went to his rescue by way of the Congo in 1887, and after encountering incredible dangers and experiencing innumerable sufferings, met with Emin and Casati at Nsabé, on the Albert Nyanza, on 29th April 1888. Stanley went back in May to pick up his belated rearguard, leaving Mounteney Jephson and a small escort to accompany Emin round his province. The southern garrisons decided to go with Emin, but the troops at Laboreh mutinied, and a general revolt broke out, headed by Fadl el Maula, governor of Fabbo. On arriving at Dufileh in August 1888, Emin and Jephson were made prisoners by the Egyptian mutineers. In the meantime the arrival of Stanley at Lake Albert had caused rumours, which quickly spread to Omdurman, of a great invading White Pasha, with the result that in July the Khalifa sent up the river three steamers and six barges, containing 4000 troops, to oppose this new-comer. In October Omar-Saleh, the Mahdist commander, took Rejaf and sent messengers to Dufileh to summon Emin to surrender; but on the 15th November the mutineers released both Emin and Jephson, who returned to Lake Albert with some 600 refugees, and joined Stanley in February 1889. The expedition arrived at Zanzibar at the end of the year.

Emin's mutinous troops kept the dervishes at bay between Wadelai and Rejaf, and eventually severely defeated them, driving them back to Rejaf. They did not, however, follow up their victory, and under the leadership of Fadl-el-Maula Bey remained about Wadelai, while the dervishes strengthened their post at Rejaf. In 1893 Fadl-el-Maula Bey and many of his men took service with Baert of the Congo State Expedition. The Bey was killed fighting the dervishes at Wandi in January 1894, and the remnant of his men eventually were found by Captain Thruston from Uganda on the 23rd March 1894 at Mahaji Sghir, on the Albert Nyanza, whither they had drifted from Wadelai in search of supplies. They were enlisted by Thruston and brought back under the British flag to Uganda.

In consequence of the Franco-Congolese Treaty of 1894, Major Cunningham and Lieutenant Vandeleur were sent from Uganda to Dufileh, where they planted the British flag on the 15th January 1895.

### Sudan Operations, 1896–99.

The wonderful progress — political, economical, and social—which Egypt had made during British occupation, so ably set forth in Sir Alfred Milner's *England in Egypt* (published in 1892), together with the revelation in so strong a light of the character of the Khalifa's despotism in the Sudan and the miserable condition of his misgoverned people, as detailed in the accounts of their captivity at Omdurman by Father Ohrwalder and Slatin Bey (published in 1892 and 1896), stirred public opinion in Great Britain, and brought the question of the recovery of the Sudan into prominence. A change of ministry took place in 1895, and Lord Salisbury's Cabinet, which had consistently assailed the Egyptian policy of the old, was not unwilling to consider whether the flourishing condition of Egyptian finance, the prosperity of the country and the settled state of its affairs, with a capable and proved little army ready to hand, did not warrant an attempt being made to recover gradually the Sudan provinces abandoned by Egypt in 1885 on the advice of Mr Gladstone's Government.

***Dongola campaign, 1896.***

Such being the condition of public and official sentiment, the crushing defeat of the Italians by the Abyssinians at the battle of Adowa on 1st March 1896, and the critical

state of Kassala—held by Italy at British suggestion, and now closely invested by the dervishes—made it not only desirable but necessary to take immediate action.

On the 14th March 1896 Major-General Sir H. Kitchener, who succeeded Sir Francis Grenfell as Sirdar of the Egyptian army in 1892, received orders to reoccupy Akasheh, 50 miles south of Sarras, and to carry the railway on from Sarras. Subsequent operations were to depend upon the amount of resistance he encountered. On the 20th March Akasheh was occupied without opposition by an advanced column of Egyptian troops under Major J. Collinson, who formed an entrenched camp there. The reserves of the Egyptian army were called out, and responded with alacrity. The troops were concentrated at Wadi Halfa; the railway reconstruction, under Lieutenant E. P. Girouard, R.E., pushed southward; and a telegraph line followed the advance. At the commencement of the campaign the Egyptian army, including reserves, consisted of 16 battalions of infantry, of which 6 were Sudanese, 10 squadrons of cavalry, 5 batteries of artillery, 3 companies of garrison artillery, and 8 companies of camel corps, and it possessed 13 gunboats for river work. Colonel L. Rundle was Chief of the Staff; Major R. Wingate was head of the Intelligence Department, with Slatin Bey as his assistant; and Colonel A. Hunter was in command of Sarras, and south. The 1st battalion of the North Staffordshire Regiment moved up from Cairo to join the Egyptian army.

In the meantime the advance to Akasheh had already relieved the pressure at Kassala, Osman Digna having withdrawn a considerable force from the investing army and proceeded with it to Suakin. To meet Osman Digna's movement Lieutenant-Colonel G. E. Lloyd, the Suakin commandant, advanced to the Taroi Wells, nineteen miles south of Suakin, on the 15th April to co-operate with the "Friendlies," and with Major H. M. Sidney, advancing with a small force from Tokar. His cavalry, under Major Fenwick, went out to look for Sidney's force, and were surprised by a large number of dervishes. Fenwick, with some 40 officers and men, seized an isolated hill and held it through the night, repulsing the dervishes, who were the same night driven back with such heavy loss in attacking Lloyd's zeriba that they retired to the hills, and comparative quiet again reigned at Suakin. At the end of May an Indian brigade arrived for garrison duty, and the Egyptian troops were released for service on the Nile.

The dervishes first came in contact with the Egyptian cavalry on the Nile near Akasheh, on the 1st May, and were repulsed. The army concentrated at Akasheh early in June, and on the 6th Kitchener moved to the attack of Firket, 16 miles away, where the Emir Hamuda, with 3000 men, was encamped. The attack was made in two columns: one, under Colonel Hunter, marching along the river-bank, approached Firket from the north; while the other, under Major Burn-Murdoch, making a detour through the desert, approached it from the south. The co-operation of the two columns was admirably timed, and on the morning of the 7th the dervish camp was surrounded, and, after a sharp fight, Hamuda and many emirs and about 1000 men were killed and 500 prisoners taken. The dash and discipline of the Egyptian troops in this victory were a good augury for the future.

By the end of June the railway was advanced beyond Akasheh, and headquarters were at Kosheh, 10 miles farther south. Cholera and fever were busy both with the North Staffordshire Regiment at Gemai, whither they had been moved on its approach, and with the Egyptian troops at the front, and carried off many officers and men. The railway reached Kosheh early in August; the cholera disappeared, and stores were collected and arrangements steadily made for a farther advance. The North Staffordshire moved up to the front, and in September the army moved on Kerma, which was found to be evacuated, the dervishes having crossed the river to Hafir. There they were attacked by the gunboats and Kitchener's artillery from the opposite bank, and forced to retire, with their commander, Wad Bishara, seriously wounded. Dongola was bombarded by the gunboats and captured by the army on the 23rd September. Bishara and his men retreated, but were pursued by the Egyptians until the retreat became a hopeless rout. Guns, small arms, and ammunition, with large stores of grain and dates, were captured, many prisoners taken, while hundreds surrendered voluntarily, among them a brother of the Emir Wad en Nejumi. The dervish Dongola army had practically ceased to exist. Debbeh was seized on the 3rd October, Korti and Merawi occupied soon after, and the principal sheiks came in and submitted to the Sirdar. The Dongola campaign was over, and the province recovered to Egypt. The Indian brigade at Suakin returned to India, and was replaced by Egyptians. The North Staffordshire returned to Cairo. The work of consolidation began, and preparations were made for a farther advance when everything should be ready.

The railway up the right bank of the Nile was continued to Kermah, in order to evade the difficulties of the 3rd Cataract; but the Sirdar had conceived the bold project of cutting off the great angle of the Nile from Wadi Halfa to Abu Hamed, involving nearly 600 miles of navigation and including the Fourth Cataract, by

***The Sudan campaign, 1897.***

constructing a railway across the Nubian desert, and so bringing his base at Wadi Halfa within a few hours of his force, when it should have advanced to Abu Hamed, instead of ten days. Early in 1897 this new line of railway was commenced from Wadi Halfa across the great Nubian desert 230 miles to Abu Hamed. The first-mentioned line reached Kerma in May, and by July the second had advanced 130 miles into the desert towards Abu Hamed, when it became necessary, before it was carried farther, to secure that terminus by an advance from Merawi.

In the meantime the Khalifa was not idle. He occupied Abu Klea wells and Metemmeh; recalled the Emir Ibrahim Khalil, with 4000 men, from the Ghezira; brought to Omdurman the army of the west under Mahmud—some 10,000 men; entrusted the line of the Atbara—Ed Damer, Adarama, Asubri, and El Fasher—to Osman Digna; constructed defences in the Shabluka Gorge; and personally superintended the organization and drill of the forces gathered at Omdurman, and the collection of vast stores of food and supplies of camels for offensive expeditions.

Towards the end of June the chief of the Jaalin tribe, Abdalla wad Said, who occupied Metemmeh, angered by the Khalifa, made his submission to Kitchener and asked for support, at the same time foolishly sending a defiant letter to the Khalifa. The Sirdar sent him rifles and ammunition across the desert from Korti; but before they arrived, Mahmud's army, sent by the Khalifa, swept down on Metemmeh on 1st July and massacred Abdalla wad Said and his garrison.

On the 29th July, after several reconnaissances, Major-General Hunter, with a flying column, marched up the Nile from near Merawi to Abu Hamed, 133 miles distant, along the edge of the Monassir desert. He arrived on 7th August and captured it by storm, the dervishes losing 250 killed and 50 prisoners. By the end of the month the gunboats had surmounted the Fourth Cataract and reached Abu Hamed. Berber was found to be deserted, and occupied by Hunter on the 5th September, and in the

following month a large force was entrenched there. The Khalifa, fearing an attack on Omdurman, moved Osman Digna from Adarama to Shendi. On the 23rd October Hunter, with a flying column lightly equipped, left Berber for Adarama, which he burned on the 2nd November, and after reconnoitring for 40 miles up the Atbara, returned to Berber. The Nile was falling, and Kitchener decided to keep the gunboats above the impassable rapid at Um Tuir, 4 miles north of the confluence of the Atbara with the Nile, where he constructed a fort. The gunboats made repeated reconnaissances up the river, bombarding Metemmeh with effect. The railway reached Abu Hamed on the 4th November, and was pushed rapidly forward along the right bank of the Nile towards Berber.

The forces of the Khalifa remaining quiet, the Sirdar visited Kassala and negotiated with the Italian General Caneva for its restoration to Egypt. The Italians were anxious to leave it; and on Christmas Day 1897 Colonel Parsons, with an Egyptian force from Suakin, took it formally over, together with a body of Arab irregulars employed by the Italians. These troops were at once despatched to capture the dervish posts at Asabri and El Fasher, which they did with small loss.

On his return from Kassala to Berber the Sirdar received information of an intended advance of the Khalifa northward. He at once ordered a concentration of Egyptian troops towards Berber, and telegraphed to Cairo for a British brigade. By the end of January the concentration was complete, and the British brigade, under Major-General Gatacre, was at Dakhesh, south of Abu Hamed. Disagreement among the Khalifa's generals postponed the dervish advance and gave Kitchener much-needed time. But at the end of February, Mahmud crossed the Nile to Shendi with some 12,000 fighting men, and with Osman Digna advanced along the right bank of the Nile to Aliab, where he struck across the desert to Nakheila, on the Atbara, intending to turn Kitchener's left flank at Berber. The Sirdar took up a position at Ras el Hudi, on the Atbara. His force consisted of Gatacre's British brigade (1st Warwicks, Lincolns, Seaforths, and Camerons) and Hunter's Egyptian division (3 brigades under Colonels Maxwell, MacDonald, and Lewis respectively), Broadwood's cavalry, Tudway's camel corps, and Long's artillery. The dervish army reached Nakheila on the 20th March, and entrenched themselves there in a formidable zeriba. After several reconnaissances, in which fighting took place with Mahmud's outposts, it was ascertained from prisoners that their army was short of provisions and that great leakage was going on. Kitchener, therefore, did not hurry. He sent his flotilla up the Nile and captured Shendi, the dervish depôt, on the 27th March. On the 4th April he advanced to Abadar. A final reconnaissance was made on the 5th. On the following day he bivouacked at Umdabia, where he constructed a strong zeriba, which was garrisoned by an Egyptian battalion, and on the night of the 7th he marched to the attack of Mahmud's zeriba, which, after an hour's bombardment on the morning of the 8th April, was stormed with complete success. Mahmud and several hundred dervishes were captured, 40 emirs and 3000 Arabs killed, and many more wounded; the rest escaped to Gedaref. The Sirdar's casualties were 80 killed and 472 wounded.

*Sudan campaign, 1898.*

Preparations were now made for the attack on the Khalifa's force at Omdurman; and in the meantime the troops were camped in the neighbourhood of Berber, and the railway carried on to the Atbara. At the end of July reinforcements were forwarded from Cairo; and on the 24th August the following troops were concentrated for the advance at Wad Hamad, above Metemmeh, on the western bank of the Sixth Cataract:—British division, under Major-General Gatacre, consisting of 1st Brigade, commanded by Colonel H. G. Wauchope (1st Warwicks, Lincolns, Seaforths, and Camerons), and 2nd Brigade, commanded by Colonel the Hon. N. G. Lyttelton (1st Northumberlands and Grenadier Guards, 2nd Lancashire and Rifle Brigade); Egyptian division, under Major-General Hunter, consisting of four brigades, commanded by Colonels MacDonald, Maxwell, Lewis, and Collinson; mounted troops — 21st Lancers, Camel Corps, and Egyptian Cavalry; artillery, under Colonel Long, 2 British batteries, 5 Egyptian batteries, and 20 machine guns; detachment of Royal Engineers. The flotilla, under Commander Keppel, R.N., consisted of 10 gunboats and 5 transport steamers. The total strength was nearly 26,000 men.

While the army moved along the west bank of the river, a force of Arab irregulars or "Friendlies" marched along the east bank, under command of Major Stuart-Wortley and Lieutenant Wood, to clear it of the enemy as far as the Blue Nile; and on the 12th September the gunboats bombarded the forts on both sides of the river and breached the great wall of Omdurman. Kitchener met with no opposition; and on the 1st September the army bivouacked in zeriba at Egeiga, on the west bank of the Nile, within 4 miles of Omdurman. Here, on the morning of the 2nd September, the Khalifa's army, 40,000 strong, attacked the zeriba, but was repulsed with slaughter. Kitchener then moved out and marched towards Omdurman, when he was again twice fiercely attacked on the right flank and rear, MacDonald's brigade bearing the brunt. MacDonald distinguished himself by his tactics, and completely repulsed the enemy. The 21st Lancers gallantly charged a body of 2000 dervishes which was unexpectedly met in a khor on the left flank, and drove them westward, the Lancers losing a fifth of their number in killed and wounded. The Khalifa was now in full retreat, and the Sirdar, sending his cavalry in pursuit, marched into Omdurman. The dervish loss was over 10,000 killed, as many wounded, and 5000 prisoners. The Khalifa's black flag was captured and sent home to the Queen. The British and Egyptian casualties together were under 500. The European prisoners of the Khalifa found in Omdurman—Charles Neufeld, Joseph Ragnotti, Sister Teresa Grigolini, and some 30 Greeks—were released; and on Sunday the 4th September the Sirdar, with representatives from every regiment, crossed the river to Khartum, where the British and Egyptian flags were hoisted, and a short service held in memory of General Gordon, near the place where he met his death.

*Battle of Omdurman.*

The results of the battle of Omdurman were the practical destruction of the Khalifa's army, the extinction of Mahdism in the Sudan, and the recovery of nearly all the country formerly under Egyptian authority.

The Khalifa fled with a small force to Obeid in Kordofan. The British troops were quickly sent down stream to Cairo, and the Sirdar, shortly afterwards created Lord Kitchener of Khartum, was free to turn his attention to the reduction of the country to some sort of order.

He had first, however, to deal with a somewhat serious matter—the arrival of a French expedition at Fashoda, on the White Nile, some 600 miles above Khartum. He started for the south on the 10th September, with 5 gunboats and a small force, dispersed a body of 700 dervishes at Reng on the 15th, and four days later arrived at Fashoda, to find the French Captain Marchand, with 120 Senegalese soldiers, entrenched there and the French flag flying. He arranged with Marchand to leave the political question to be settled

*Captain Marchand at Fashoda.*

by diplomacy, and contented himself with hoisting the British and Egyptian flags to the south of the French flag, and leaving a gunboat and a Sudanese battalion to guard them. He then steamed up the river and established a post at Sobat; and after sending a gunboat up the Bahr-el-Ghazal to establish another post at Meshra-er-Rek, he returned to Omdurman. The French expedition had experienced great difficulties in the swampy region of the Bahr-el-Ghazal, and had reached Fashoda on the 10th July. It had been attacked by a dervish force on the 25th August, and was expecting another attack when Kitchener arrived and probably saved it from destruction. The Fashoda incident was the subject of important diplomatic negotiations, which at one time approached an acute phase; but ultimately the French position was found to be untenable, and on 11th December Marchand and his men returned to France by the Sobat, Abyssinia, and Jibuti. In the following March the spheres of interest of Great Britain and France in the Nile basin were defined by a declaration making an addition to Article IV. of the Niger Convention of the previous year.

During the Sirdar's absence from Omdurman Colonel Hunter commanded an expedition up the Blue Nile, and by the end of September had occupied and garrisoned Wad Medina, Sennar, Karkoj, and Roseires. In the meantime Colonel Parsons marched with 1400 men from Kassala on the 7th September, to capture Gedaref. He encountered 4000 dervishes under Emir Saadalla outside the town, and after a desperate fight, in which he lost 50 killed and 80 wounded, defeated them and occupied the town on the 22nd. The dervishes left 500 dead on the field, among whom were four emirs. Having strongly entrenched himself, Parsons beat off, with heavy loss to the dervishes, two impetuous attacks made on the 28th by Ahmed Fedil. But the garrison of Gedaref suffered from severe sickness, and Colonel Collinson was sent to their aid with reinforcements from Omdurman. He steamed up the Blue Nile and the Rahad river to Ain-el-Owega, whence he struck across the desert, reaching Gedaref on the 21st October, to find that Ahmed Fedil had gone south with his force of 5000 men towards Roseires. Colonel Lewis, who was at Karkoj with a small force, moved to Roseires, where he received reinforcements from Omdurman, and on the 26th December caught Ahmed Fedil's force as it was crossing the Blue Nile at Dakheila, and after a very severe fight cut it up. The dervish loss was 500 killed, while the Egyptians had 24 killed and 118 wounded. Two thousand five hundred fighting men surrendered later, and the rest escaped with Ahmed Fedil to join the Khalifa in Kordofan.

***Operations in the Sudan, 1899.***

On the 25th January 1899 Colonel Walter Kitchener was despatched by his brother, in command of a flying column of 2000 Egyptian troops and 1700 Friendlies, which had been concentrated at Faki Kohi, on the White Nile, some 200 miles above Khartum, to reconnoitre the Khalifa's camp at Sherkela, 130 miles west of the river, in the heart of the Baggara country in Kordofan, and if possible to capture it. The position was found to be a strong one, occupied by over 6000 men; and as it was not considered prudent to attack it with an inferior force at such a distance from the river base, the flying column returned. No further attempt was made to interfere with the Khalifa in his far-off retreat until towards the end of the year, when, good order having been generally established throughout the rest of the Sudan, it was decided to extend it to Kordofan.

In the autumn of 1899 the Khalifa was at Jebil Gedir, a hill in Southern Kordofan, about 80 miles from the White Nile, and was contemplating an advance. Lord Kitchener concentrated 8000 men at Kaka, on the river, 380 miles south of Khartum, and moved inland on the 20th October. On arriving at Fongor it was ascertained that the Khalifa had gone north, and the cavalry and camel corps having reconnoitred Jebil Gedir, the expedition returned. On the 13th November the Emir Ahmed Fedil debouched on the river at El Alub, but retired on finding Colonel Lewis with a force in gunboats. Troops and transport were then concentrated at Faki Kohi, and Colonel Wingate sent with reinforcements from Khartum to take command of the expedition and march to Gedid, where it was anticipated the Khalifa would be obliged to halt. A flying column, comprising a squadron of cavalry, a field battery, 6 machine guns, 6 companies of the Camel Corps, and a brigade of infantry and details, in all 3700 men, under Wingate, left Faki Kohi on the 21st November. The very next day he encountered Ahmed Fedil at Abu Aadel, drove him from his position with great loss, and captured his camp and a large supply of grain he was convoying to the Khalifa. Gedid was reached on the 23rd, and the Khalifa was ascertained to be at Om Dubreikat. Wingate marched at midnight of the 24th, and was resting his troops on high ground in front of the Khalifa's position, when at daybreak of the 25th his picquets were driven in, and the dervishes attacked. They were repulsed with great slaughter, and Wingate advancing, carried the camp. The Khalifa Abdullah el Taaishi, unable to rally his men, gathered many of his principal emirs around him, among whom were his sons and brothers, Ali Wad Helu, Ahmed el Fedil, and other well-known leaders, and they met their death unflinchingly from the bullets of the advancing Sudanese infantry. Three thousand men and 29 emirs of importance, including Sheik-ed-din, the Khalifa's eldest son and intended successor, surrendered. The dervish loss in the two actions was estimated at 1000 killed and wounded, while the Egyptian casualties were only 4 killed and 29 wounded. Thus ended the power of the Khalifa and of Mahdism.

***Death of the Khalifa.***

On the 19th January 1900 Osman Digna, who had been so great a supporter of Mahdism in the Eastern Sudan, and had always shown great discretion in securing the safety of his own person, was surrounded and captured at Jebel Warriba, as he was wandering a fugitive among the hills beyond Tokar.

The reconquest of Dongola and the Sudan provinces during the three years from March 1896 to December 1898, considering the enormous extent and difficulties of the country, was achieved at an unprecedentedly small cost, while the main item of expenditure—the railway—remains a permanent benefit to the country. The figures are:[1]—

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|---|---|
| Railways | £E.1,181,372 |
| Telegraphs | 21,825 |
| Gunboats | 154,934 |
| Military | 996,223 |
| Total | £E.2,354,354 |

The railway, delayed by the construction of the big bridge over the Atbara, was opened to the Blue Nile opposite Khartum, 187 miles from the Atbara, at the end of 1899. (R. H. V.)

**Egyptology.**—Since 1880 the appearance of almost every part of Egyptology has been changed. In the history, the kings who used to be thought mythical are now as well known as those of late times, and the long prehistoric age is better known than that of any other country. In the archæology, total ignorance is now replaced by an accurate discrimination of the ages of all the usual manufactures. In the language, the guess-work

[1] See Lord Cromer's Report, dated at Cairo, 26th February 1899.

of earlier times has faded before elaborate grammatical studies, which formulate a great deal more than the Egyptians themselves knew about their own writing.

### History.

The earliest stage of man that is known in Egypt is the Palæolithic; this was contemporary with a rainy climate, which enabled at least some vegetation to grow on the high desert, for the great bulk of the worked flints are found 500–1500 ft. above the Nile, on a table-land which is now entirely barren desert. Water-worn palæoliths are found in the beds of the stream courses, now entirely dried up, and flaked flints of a rather later style occur in the deep beds of Nile gravels, which are 20 or 30 ft. above the highest level of the present river. This type of work, however, lasted on to the age of the existing conditions, for perfectly sharp and fresh palæoliths are found on the desert as low down as the present high Nile.

The date of the change of climate is roughly shown by the depth of the Nile deposits. It is well known, by a scale extending over about 3000 years, that in different parts of Egypt the rise of the Nile bed has been on an average about 4 inches per century, owing to the annual deposits of mud during the inundation (7) (23).* And in various borings that have been made, the depth of the Nile mud is only about 25 or 30 ft. (7). Hence an age of about 8000 or 9000 years for the cultivable land may be taken as a minimum, probably to be somewhat extended by slighter deposit in the earlier time.

The continuous history extends to about 5000 B.C., and the prehistoric age of continuous culture known to us covers probably 2000 years more; hence our continuous knowledge probably extends back to about 7000 B.C., or to about the time when the change of climate took place. At that time we find a race of European type starting on a continuous career, but with remains of a steatopygous race of "Bushman" (Koranna) type known and represented in modelled figures (8). We can hardly avoid the conclusion that this steatopygous race was that of Palæolithic man in Egypt, especially as that equivalence is also known in the French cave remains. It is noticeable that all the figures known of this race—in France, Malta, and Egypt—are women, suggesting that the men were exterminated by the newer people, but the women were kept as slaves, and hence were familiar to the pioneers of the European race. These Palæolithic women were broadly built, with deep lumbar curve, great masses of fat on the hips and thighs, with hair along the lower jaw and over most of the body.

The fresh race which entered Egypt was of European type—slender, fair-skinned, with long wavy brown hair. The skull was closely like that of the ancient and modern Algerians of the interior; and as one of the earliest classes of their pottery is similar in material and decoration to the present Kabyle pottery, we may consider them a branch of Algerians (8). They seem to have entered the country as soon as the Nile deposits rendered it habitable by an agricultural people. They already made well-formed pottery by hand, knew copper as a rarity, and were clad in goat-skins (9). Entering a fertile country, and mixing probably with the earlier race, they made a rapid advance in all their products, and in a few generations they had an able civilization. Their work in flint was fine and bold, with more delicate handiwork than that of any other people except their descendants; their stone vases were cut in the hardest materials with exquisite regularity; their carving of ivory and slate was better than anything which followed for over a thousand years; and they had a large number of signs in use, which were probably the first stages of our alphabet (12).

After some centuries of this culture a change appears, at the same point of time in every kind of work. A difference of people seems probable, but no great change of race, as the type is unaltered. The later people show some Eastern affinities; and it seems as if a part of the earlier Libyan people had entered Syria or North Arabia and had afterwards flowed back through Egypt, modified by their Semitic contact. It is perhaps to this influx that the Semitic element in the Egyptian language is due.

This later prehistoric people brought in new kinds of pottery and more commerce, which provided gold, silver, and various foreign stones; they also elaborated the art of flint-working to its highest pitch of regularity and beauty, and they greatly extended the use of copper, and developed the principal tools to full size (9). But they show even less artistic feeling than the earlier branch, for all figure-carving quickly decayed, both in ivory and in stone. The use of amulets was brought in, and also forehead-pendants of shell. And the signs which were already in use almost entirely disappeared. (See Fig. 1.)

In the earlier, and still more in the later, age, ships or galleys rowed by oars were familiar; and these were sometimes of large size, figured with sixty oars. That commerce was already carried on in the Mediterranean is shown by the foreign pottery imported into Egypt, even before the middle of the prehistoric age; by the supply of gold in the Ist Dynasty, apparently from Asia Minor, and by the pottery of the Ægean being brought in at the same time (12).

This prehistoric civilization was much decayed when it was overcome by a new influx of people, who founded the dynastic rule. These came apparently from the Red Sea, as they entered Egypt in the region of Koptos, and not either from the north or from the Upper Nile. They were a highly artistic people, as the earliest works attributable to them—the Min sculptures at Koptos—show better drawing (Plate, Fig. 2) than any work by the older inhabitants (11); and they rapidly advanced in art to the noble works of the Ist Dynasty. They also brought in the hieroglyphic system, which was developed along with their art. It seems probable that they came up from the Land of Pun, at the south of the Red Sea, and they may have been a branch of the Punic race in its migration from the Persian Gulf round by sea to the Mediterranean. They rapidly subdued the various tribes who were in Egypt, and at least five different types of man are shown on the monuments of their earliest kings. The oldest records are those sculptured in relief on the palettes of slate, which show the battles, conquests, and triumphs of the dynastic race, culminating in the great palette of King Narmer (Fig. 2), who seems to have reigned very shortly before Menes (10). These kings seem to be the dynasty of 10 kings of Thinis (Abydos) who reigned for 350 years, according to Manetho. The names recovered which appear to belong to them are Ka, Zeser, Nar-mer, and Sma: of Narmer a magnificent slate with triumphal carvings was found at Hierakonpolis (10).

The completion of the conquest of Egypt led to Men (Mena, Menes) being called the founder of the Ist Dynasty (Fig. 3). And this period, which has often been supposed fabulous, is now as well known to us as most of the later dynasties, owing to the study of the inscriptions and remains from the royal tombs of Abydos (12). The early dynasties have hitherto been known only by the list of kings carved in the XIXth Dynasty at Abydos by Sety I., and by the Greek transcription of Manetho. We now have recovered the original forms

* Reference numbers refer to list of books at the end.

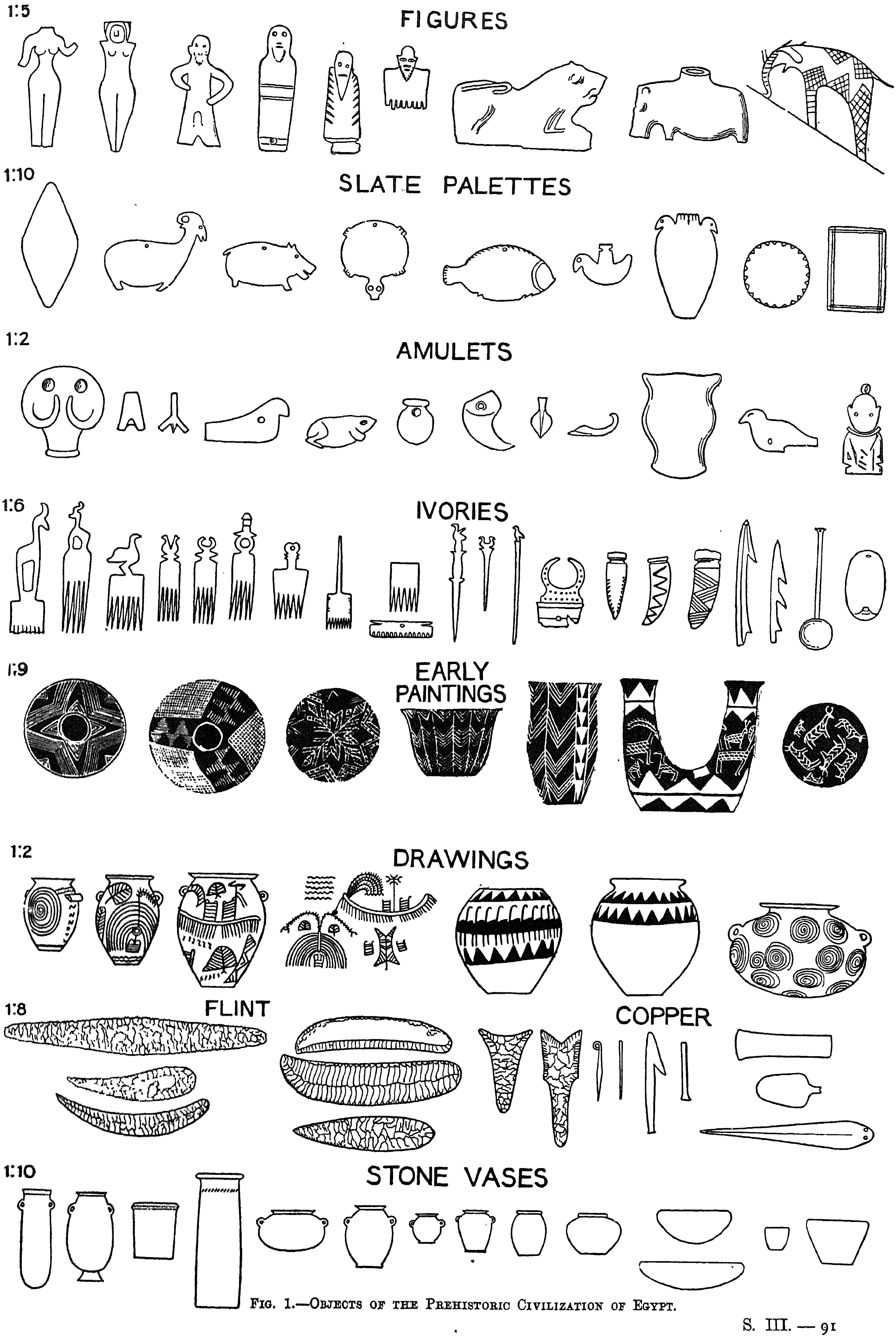



Fig. 1.—Objects of the Prehistoric Civilization of Egypt.

of the names, and the names of the *Ka* or double of each king. Our present knowledge stands thus :—

| | List Names. | | |
|---|---|---|---|
| KA name. | Tombs. | Sety I. | Manetho. |
| 1. AHA | MEN | MENA | Menes |
| 2. ZER | TA | TETA | Athothis |
| 3. ZET | ATH | ATETH | Kenkenes |
| 4. . . . | MERNEIT | ATA | Uenefes |
| 5. DEN | SETUI | HESEPTI | Usafais |
| 6. AZAB | MERPABA | MERBAPA | Miebis |
| 7. MERSEKHA | SHEMSU | SAMENPTAH | Sempses |
| 8. QAA | SEN | QEBH | Bienekhes |

On Menes, see *Recueil*, xxi. 105. King Merneit (Plate, Fig. 5) is only assigned to the name in the list of Sety I. by his presumable position; but the order and the names of the others agree with those of the list, excepting that each name has been misread somewhat in the lapse of time between those kings and Sety I., which was longer than that between Sety and ourselves.

The course of civilization was rising at the beginning of the dynasty, and the finest work appears in the middle; at the close the work is commoner and coarser.

Of the IInd Dynasty the names remaining are :—

| KA name in tombs. | Sety I. | Manetho. |
|---|---|---|
| 1. HOTEPAHAUI | BEZAU | BOETHOS |
| 2. RA NEB | KAKAU | KAIECHOS |
| 3. NETEREN | BANETEREN | BINOTHRIS |
| 4. PERABSEN | UAZNES | TLAS |
| KHASEKHEMUI | ZAZA ? | ? |

The order of the tombs is fixed, and the first three kings are named on the back of the granite figure No. 1 in Cairo Museum. The connexion of these *Ka* names with the names given by Sety I. seems probable at No. 3. Two statues and some large vases of a King Khasekhem were found at Hierakonpolis, and probably belong to this time. But so far the remains cannot be connected with the names in the historical lists.

Of the IIIrd Dynasty the step-pyramid of Saqqara is the great monument; for the late inscription at Sehel shows that Neterkhet is the name of King Zeser (1). But of the same king, Neterkhet, is also a great brick mastaba near Beit Khallaf; and by that is also a tomb of another king, Hon-nekht. The step-pyramid is the first great development of the mastaba tomb, successively added to and enlarged; and it led to the more regularly enlarged tomb of Seneferu, which was the first to have a continuous sloping casing, and so to begin the series of pyramids.

At the close of the IIIrd Dynasty we reach the period of abundant remains of the Old Kingdom, when in each reign many magnificent tombs were built by the court officials, and a complete picture of the civilization is preserved to us (1). A stone lately found at Saqqara shows the adoration of Zeser-nub (dyn. iii. 3), Teta (iii. 6), and Userkaf (v. 1); thus the kings of the IIIrd Dynasty were still worshipped in the Vth. Seneferu, whose mastaba-pyramid remains at Medum (4), was certainly the same as Sēfuris, the 8th king of the IIIrd Dynasty. His position has been cleared up by finding the name of King Shaaru (*S.B.A.P.* xxi. 108), which is clearly the origin of Sōris, the 1st king of the IVth Dynasty in the lists, thus throwing Seneferu back to the IIIrd Dynasty.

The kings of the IVth Dynasty are nearly all recorded on the numerous monuments of this age, which was above all the period of colossal building (see art. PYRAMID in ninth edition).

From the time of Seneferu the king's eldest son was high priest of Heliopolis, and in the close of the IVth Dynasty the kings took this priesthood themselves, and Shepseskaf and the Vth Dynasty kings built immense temples with obelisks dedicated to the sun-god Ra. One of these temples has been fully explored at Abusir by German work. This priesthood is echoed in later tales by the Vth Dynasty kings being said to be born of a priestess of Ra; and the title "son of Ra" begins at this date. At the close of the Vth Dynasty begins the series of inscribed pyramids, with long copies of the early form of the Book of the Dead, and the texts of a ritual nature, intended to direct and preserve the soul. These pyramids of Unas, Teta, Pepy I., Merenra, and Pepy II. were all opened in 1881. The texts are published in the *Recueil*, vols. iii.–xvi. The copper statues of Pepy I. and his

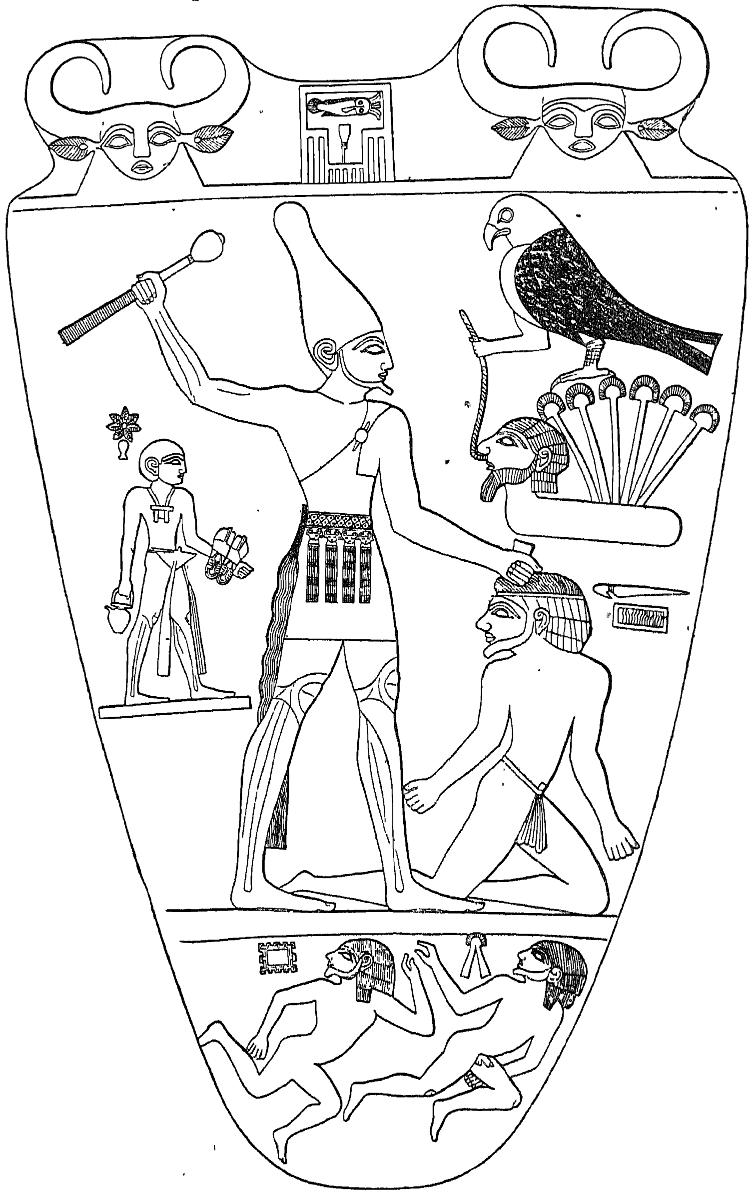


FIG. 3.—Slate Palette of King Narmer smiting the Chief of Fayum. (*Circa* 4800 B.C.)

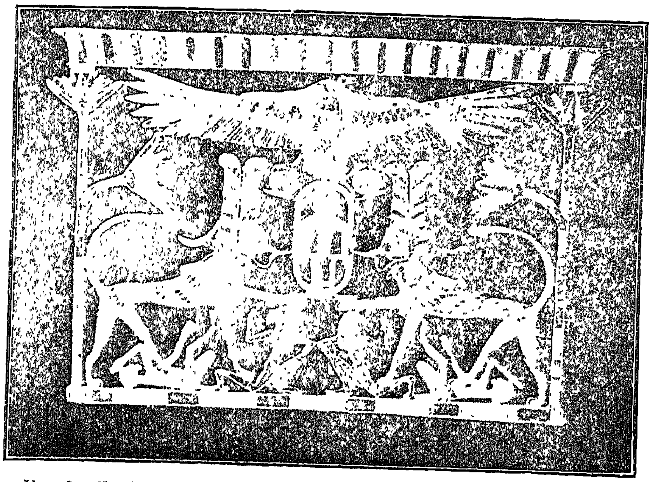


FIG. 8. Pectoral of gold, inlaid with coloured stones, of Usertesen III. (*Circa* 2650 B.C.)

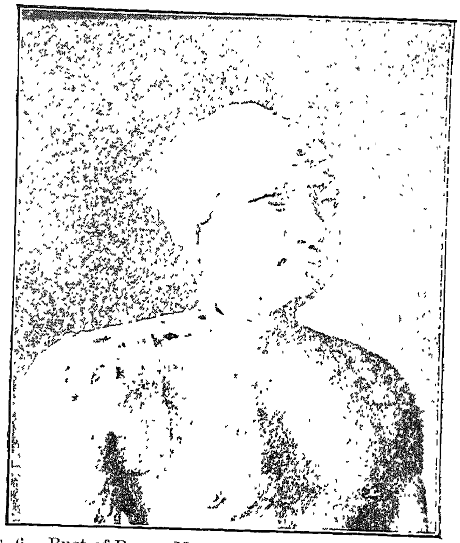


FIG. 6.—Bust of Prince Merenra in copper. (*Circa* 3450 B.C.)

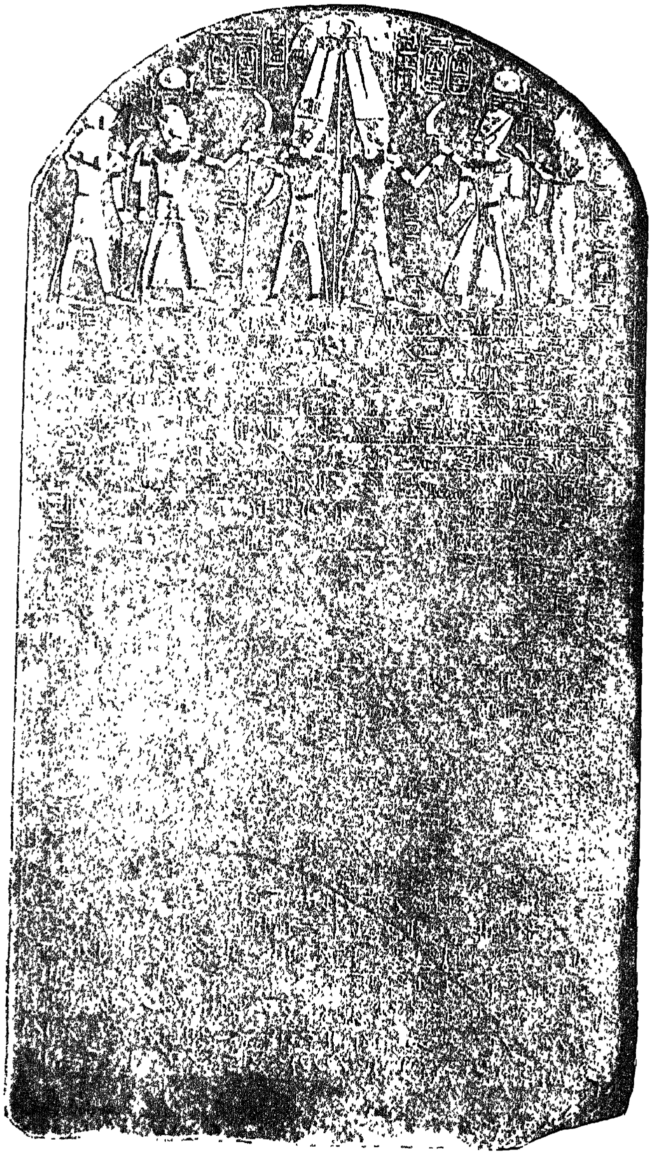


FIG. 9.—Granite tablet of Merenptah recording the conquest of the Israelites.

FIG. 2.—Figures in low relief of elephant, bird, hyæna, and bull. Earliest sculptures from Koptos. (*Circa* 5000 B.C.)

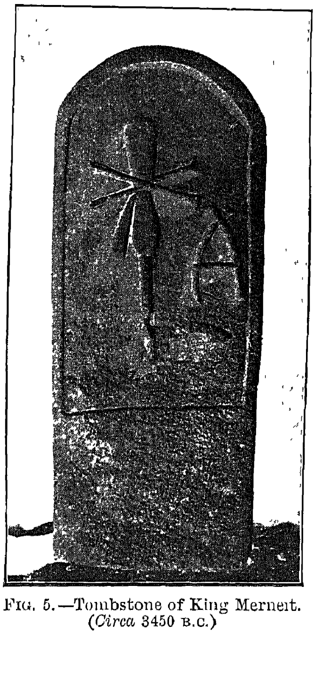


FIG. 5.—Tombstone of King Merneit. (*Circa* 3450 B.C.)

EGYPTOLOGY.

son (Plate, Fig. 6) are the most important figures remaining.

Of the VIth–Xth Dynasties no great discovery has been made The inscriptions at Siut of Khety I., Tefaba, and Khety II. belong to the age of Ka-mery-ra of the Xth Dynasty (4). The general course of art through this dark age has been traced out in the cemetery of Dendereh (15).

The group of foreign kings mainly known by scarabs (Fig. 7) and cylinders, Khyan, Samqan, Anthar, Yaqebhar, Shesha, and Uazed, are probably of the XVth – XVIth Dynasties, though some connexions place them shortly before the XIIth Dynasty. The works of Khyan have been found as far apart as Crete and Baghdad. The whole class of so-called Hyksos statues and sphinxes are also in the same position of doubt. And in this class it seems most probable that the peculiar style and physiognomy was followed in the VIIth, the XVIth, and even the XXIst Dynasty. There are certainly several different foreign types confounded together at present in one class of royal heads.

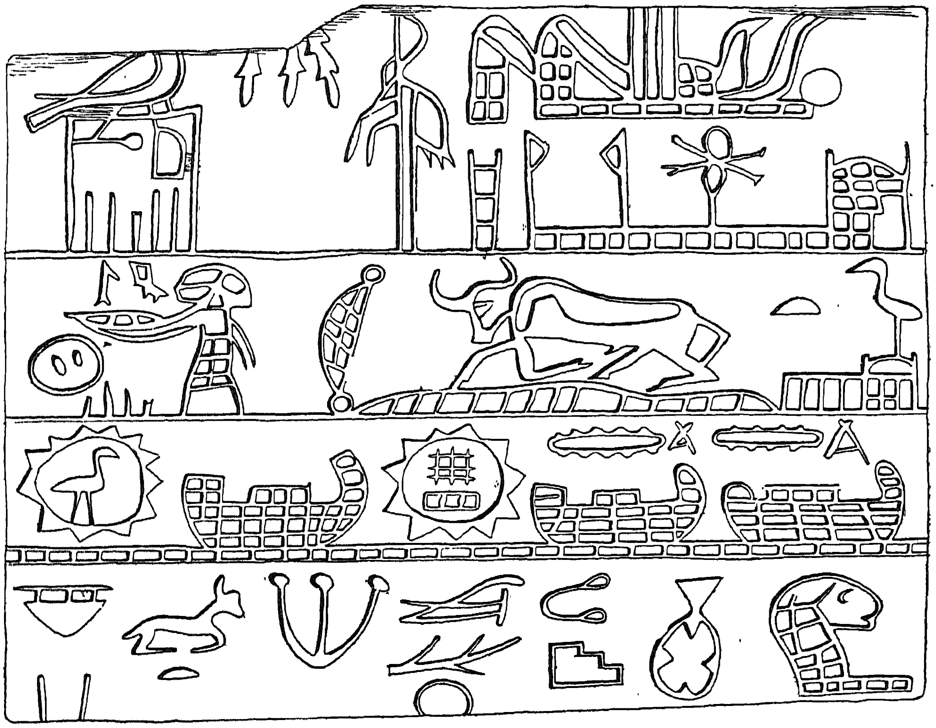


FIG. 4.—Ebony Tablet of Mena: the oldest written sentence known. (*Circa* 4700 B.C.)

The XIth Dynasty has been mainly illustrated by the sculptures of Koptos (Antef V.) (11) and of Dendereh tombs (15). The old style of the IVth to VIth Dynasties continued in a constantly degrading form until the name of Antefs shows that the beginning of the XIth Dynasty is reached (15). During that dynasty a rapid recovery took place, and the close of the XIth and early XIIth Dynasty is the highest point of this age. The main new discoveries of this period are the temple sculptures of Koptos (11) (Amenemhat I., Usertesen I.); the statues and pyramid of Lisht (Usertesen I.); the jewellery of the princesses from Dahshur (14) (Usertesen II., III. [Plate, Fig. 8], and Amenemhat III.); the pyramid of Usertesen III. (14) (Dahshur); the pyramid of Usertesen II. (18) (El Lahun); the pyramid of Hawara (17) and colossi of Biahmu (16) (Amenemhat III.).

Of the XIIIth–XVIIth Dynasties no great discovery has been made. An attempt to bring some of the Antef kings into the XIIIth Dynasty (see *A.Z.* xxxiii. 77) is contradicted both by the style of the monuments and by the list of the Turin Papyrus.

The most astonishing discovery of the 19th century was that of the actual mummies of many of the kings of the XVIIIth–XXIst Dynasties at Thebes (19). They had been collected into two hiding-places for safety, the tomb of Amenhotep II. (*a*), and the tomb of the priest-kings of the XXIst Dynasty, near Deir-el-Bahri (*b*). The bodies found (4) are those of:—

XVII Dynasty:
- 7 Seqenenra III. *b*

XVIII Dynasty:
- 1 Aahmes I. *b*
- Nefertari *b*
- 2 Amenhotep I. *b*
- 3 Tahutmes I. *b*
- 4 Tahutmes II. *b*
- 6 Tahutmes III. *b*
- 7 Amenhotep II. *a*
- 8 Tahutmes IV. *a*
- 9 Amenhotep III. *a*

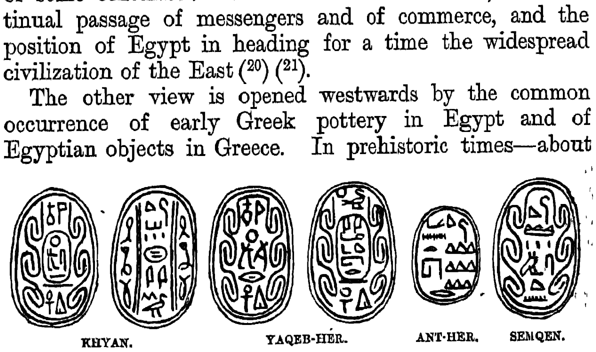
XIX Dynasty:
- 1 Ramessu I. *b*
- 2 Sety I. *b*
- 3 Ramessu II. *b*
- 4 Merenptah *a*
- 5 Sety II. *a*
- 7 Siptah *a*
- 8 Setnekht *a*

XX Dynasty:
- 1 Ramessu III. *b*
- 2 Ramessu IV. *a*
- 3 Ramessu V. *a*
- 4 Ramessu VI. *a*
- 10 Ramessu XII. (?) *b*

XXI Dynasty:
- 1 Nezemt *b*
- 2 Painezem I. *b*
- 3 Masahart *b*
- 4 Painezem II. *b*

To the age of the XVIIIth Dynasty belong some of the most important foreign connexions (2). The discovery at Tell-el-Amarna of some hundreds of tablets of cuneiform correspondence, between the kings of Egypt and the kings and governors of Mesopotamia and Syria, has shown a brief glimpse of about ten or fifteen years out of an intercourse of some centuries: we see the wealth of Asia, the continual passage of messengers and of commerce, and the position of Egypt in heading for a time the widespread civilization of the East (20) (21).

The other view is opened westwards by the common occurrence of early Greek pottery in Egypt and of Egyptian objects in Greece. In prehistoric times—about



KHYAN. YAQEB-HER. ANT-HER. SEMQEN.

FIG. 7.—Scarabs of Foreign Kings. (*Circa* 3450 B.C.)

6000 B.C.—large ships (seen painted on tombs and vases) carried the trade of the Mediterranean, and brought foreign pottery to Egypt. In the Ist Dynasty the earliest style of Greek pottery yet known is found in the tombs of the kings (about 4500 B.C.), and the silvery alloy of the royal gold points to its source in Asia Minor. In the XIIth Dynasty pottery identical with that of Crete is found in the town ruins (Kahun), and designs from objects of the XIIth Dynasty are found in Crete, as also a diorite statue from Egypt. In the XVIIIth Dynasty hundreds of pieces of vases of Rhodian types are found in the palace rubbish

of Tell-el-Amarna ([20]), and whole vases in many tombs; and in Mycenae and Cyprus many objects of Amenhotep III., and copies of designs of his age, show the common intercourse. The connexions of Egypt and Greece are the foundation for all accurate knowledge of early European chronology.

In the XIXth Dynasty the largest monument lately found is the black granite stele of Amenhotep III., reinscribed by Merenptah ([22]), giving an account of his triumph over the Libyan invaders (Plate, Fig. 9). At the close is a mention of "the people of Israel being spoiled and having no seed," an allusion the sense of which has been much disputed, but which is the only instance of the name Israel on any ancient monument. The probability of the Exodus having taken place in this reign is discussed, and the short period of Judges advocated, in a paper in *S.B.A.P.* xviii. 243.

The succession of the XXIst Dynasty kings is still obscure (see *Recueil*, xxi. 9). In the XXIInd Dynasty began a series of observations on high Nile levels at Thebes, during three centuries (see *A.Z.* xxxiv. 95, 119). These corroborate the general rising of the Nile plain by the mud of the inundation. The origin of the XXIInd Dynasty was formerly attributed to Assyria, on the ground of the names Takeloth (Tiglath), Usarkon (Sargon), and Namuroth (Nimrod); then these were disputed, and a Libyan origin advocated because the eldest sons were princes of the Mashuash (Libyan Maxyes). This fact, however, does not preclude their eastern origin; and the recent discovery of Shushanqu as a Babylonian name strongly corroborates the Mesopotamian origin of this dynasty.

Of the XXVth Dynasty are the important inscriptions at Karnak about the royal estates, the female priesthood of Amen, and the adoption of royal heiresses (see *A.Z.* xxxv. 12). For all later periods see Maspero ([3]) and Wiedemann ([5]).

The ruling family of the XXVIth Dynasty was certainly foreign, as shown by their names, and probably Libyan. The type was quite un-Egyptian, as seen in the head of Psamtik I. (*A.Z.* xxxiii. 116). The co-regency of Apries and Amasis is described on a monument, which shows that Apries was still in authority until slain in a rising in the third year of Amasis (*Recueil*, xxii. 1). The early historic Greeks in Egypt have been traced in their great settlement at Naukratis ([23]), from which a large number of very early inscriptions were obtained, and also in their fort and camp at Daphnæ ([24]). These were the two main posts of mercenaries, west and east of the Delta. The Greek and Roman periods are so well known that there is no ground for great discoveries. But the large quantities of papyri found in recent years, in the Fayum and at Oxyrhynchos ([27]), have made us familiar with the details of government and daily life, as well as providing some very valuable literary remains.

Some mention should be made of the chronology. It is generally agreed that as far back as the beginning of the XVIIIth Dynasty (1587 B.C.) there is certain dating by the occasional records of the day of the rising of Sirius in the movable calendar, which shifted through all the seasons in 1460 years ([4]). A recent discovery of a papyrus (*A.Z.*), which seems by the same method to date the XIIth Dynasty to about 2000 B.C., is, however, still debated; as such a date would leave an impossibly short time for the XIIIth–XVIIth Dynasties, it would seem rather that (if this record be accurate) the date must go back a whole cycle of 1460 years, and place the XIIth Dynasty about 3400 B.C., which would closely accord with the full chronology of Manetho as given by Africanus. There is also a vague dating of the inundation in the reign of Pepy I., which would place that VIth Dynasty about 3400 B.C. Other datings have been proposed by Mahler: (1) in connexion with the new moons for Tahutmes III., which has lately been amended by working from the visible new moon and not the theoretical; and (2) by the star diagrams in the Ramesside tombs — but as these do not accord well with the safer dating by Sirius, it seems that they were probably copied from diagrams drawn up a generation or two before. (See several papers in *A.Z.*)

In the shorter periods, within a dynasty, much help is gained by studying the family relations ([4]); even vague facts of the ages of mummies of the kings are of value in working out the family genealogies and the possibilities of lengths of reigns. In several instances the accuracy of Manetho has been well verified: the kings of the Ist Dynasty are in their right order; and in the later periods the family histories accord well with the lengths of reigns which he states; in one case, where most writers had discredited a reign of 26 years (Amenhotep II.), it has lately been entirely confirmed ([22]).

### ARCHÆOLOGY.

When the article in the ninth edition was written, scarcely anything was known of the ages of Egyptian products; even the commonest, such as pottery and beads, were entirely undated. The work of the period since 1880 has especially been the accurate dating and history of every kind of handwork. The large amount of carefully conducted and recorded excavation by English workers has given opportunity for this, and we now can date most objects to within a single dynasty, and sometimes to a single reign.

*Pottery* is the most important material for dating, as it is so common, so variable, and so short a time in use. The principal varieties are shown in Fig. 10. Of the prehistoric age there are several different kinds of pottery more or less contemporary, and there is such a great variety of form that over 900 are drawn for reference. All is hand-made. It is from this variety that the relative dating of the prehistoric periods is obtained; and the range of each form in an adopted scale of "sequence dates" is published ([8]) ([9]). The later prehistoric pottery leads us to the forms of the Ist Dynasty ([12]). Those of the IVth and Vth are well known ([13]), and the wheel became almost universal in this age. The decay of this pottery in the following dynasties has been traced ([15]), until the rise of a new style in the XIIth Dynasty (drab pottery). That class modified gradually into the XVIIIth Dynasty, when a new class of highly polished hard pottery appears ([18]). After the XIXth the periods are not accurately known till the XXVIth, when new classes appeared ([24]); the Ptolemaic is not well known, but the Roman is very familiar, especially the ribbed amphoræ beginning in the middle of the 2nd century, and the Constantine ware.

*Beads* have been carefully studied also. In the prehistoric age there is great variety, both in stone and in glazed stone and pottery. Few have been found in the Old Kingdom, but in the VIth and VIIth Dynasties discs of black and green glaze, and minute beads of carnelian and gold are usual ([9]). In the XIIth Dynasty are mostly large ball beads of amethyst, carnelian, and blue glazed pottery ([9]). In the XVIIIth Dynasty the beads are smaller; glass begins, and is very varied and common at the close. Green glazed beads and amulets are usual in the XXIIIrd Dynasty. Little is known about beads after that, until the Roman age, when a profusion of glass beads again appears. The only dated collections of beads and of pottery for study are in University College, London.

*Stone vases* are usual from the beginning of the prehistoric age ([8]) ([9]), at first cylindrical and later barrel-shaped.

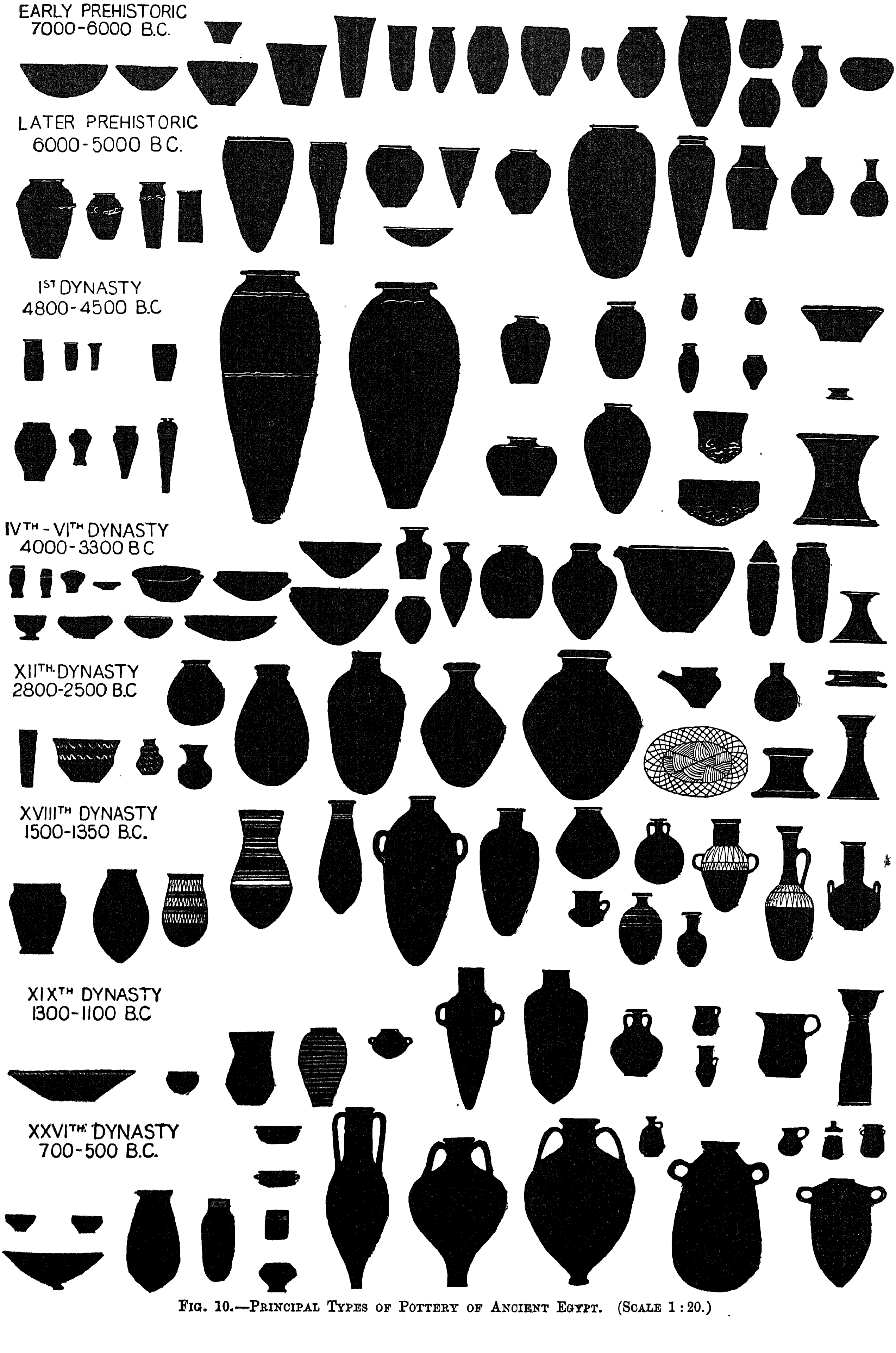



Fig. 10.—Principal Types of Pottery of Ancient Egypt. (Scale 1 : 20.)

The most magnificent stones and finest work were early in the Ist Dynasty, after which there is a continued deterioration throughout the history. Only soft stones, alabaster and serpentine, were used in the XIIth and XVIIIth Dynasties. The history of the forms has been traced from the VIth to the XVIIIth Dynasties (9). After that time stone was rarely worked into vases.

*Copper* was wrought into thin vessels as early as the Ist Dynasty. The forms of tools and weapons are well known from the XIth to the XIXth Dynasties (9) (17); and the vessels of bronze from the XVIIIth Dynasty to the Roman age; but much has yet to be done to write a continuous history. Copper alone, or with some hardening such as arsenic, was used till the XIIth Dynasty; and bronze appears general in the XVIIIth. The life-size copper statue of King Pepy I. (VIth Dynasty) is the largest piece of metal-work preserved; it shows a complete artistic mastery of the material.

*Textiles* have rarely been preserved from the prehistoric time. The finest weaving known is that of the Ist and VIth Dynasties, in royal wrappings; considerable outfits of the latter age have been found (13). Enormous quantities of mummy linen of the XVIIIth Dynasty to Roman times are found. The coloured textiles and embroideries are of Christian period, preserved owing to the change of burying immediately in the daily dress, instead of embalming (16).

The recent works referred to are :—

*History in general.*—Maspero, (1) *Dawn of Civilization*; (2) *Struggle of the Nations*; (3) *Passing of the Empires* (English edition best, being indexed). Petrie, (4) *Student's History of Egypt*, vols. i. ii. Wiedemann, (5) *Geschichte*. Maspero, (6) *Egyptian Archæology*.

*Prehistoric.*—De Morgan, (7) *Recherches*, i. ii. Petrie, (8) *Naqada*; (9) *Diospolis Parva*.

*Early Dynasties.*—Quibell, (10) *Hierakonpolis*, i. Petrie, (11) *Koptos*; (12) *Royal Tombs*, i. ii.; (13) *Deshasheh*.

*VIth–XIIIth Dynasties.*—De Morgan, (14) *Dahshur*. Petrie, (15) *Dendereh*; (16) *Hawara*; (17) *Kahun*; (18) *Illahun*.

*XVIIIth–XXth Dynasties.*—Maspero, (19) *Momies Royales de Deir el Bahari*. Petrie, (20) *Tell el Amarna*; (21) *Syria and Egypt*; (22) *Six Temples*.

*XXVIth Dynasty and on.*—Gardner and Petrie, (23) *Naukratis*, i. and ii. Petrie, (24) *Tanis*, ii. (*Daphnæ*). Mahaffy, (25) *Empire of the Ptolemies*. Milne, (26) *Roman Egypt*. Grenfell and Hunt, (27) *Oxyrhynchus Papyri*, &c.

*Journals.*—*A.Z. Zeitschrift für Ægyptische Sprache*. *Recueil*, published by Maspero. *S.B.A.P.* (*Proceedings of Society of Biblical Archæology.*) (W. M. F. P.)

## THE LANGUAGE.

The elaborate article on HIEROGLYPHICS by Dr Poole in vol. xi. of the ninth edition of the *Encyclopædia Britannica* was founded on the then (1880) standard work of De Rougé; the chief recent developments of Egyptian grammatical knowledge began, however, in that year, and they are of sufficient importance to deserve a somewhat full notice. In 1880 Ludwig Stern (*Koptische Grammatik*) admirably classified the grammatical forms of Coptic. The much more difficult task of recovering the grammar of Egyptian has occupied a quarter of a century of special study by Adolf Erman and his school at Berlin, and has now reached an advanced stage. The greater part of Egyptian texts after the Middle Kingdom having been written in what was even then practically a dead language, as dead as Latin was to the mediæval monks in Italy who wrote and spoke it, Erman selected for special investigation those texts which really represented the growth of the language at different periods, and, as he passed from one epoch to another, compared and consolidated his results.

The *Neuægyptische Grammatik* (1880) dealt with texts written in the vulgar dialect of the New Kingdom (Dyns. XVIII. to XX.). Next followed, in the *Zeitschrift für Ægyptische Sprache und Alterthumskunde*, studies on the Old Kingdom inscription of Una, and the Middle Kingdom contracts of Siut, as well as on an "Old Coptic" text of the 3rd century A.D. At this point a papyrus of stories written in the popular language of the Middle Kingdom provided Erman with a stepping-stone from Old Egyptian to the Late Egyptian of the *Neuægyptische Grammatik*, and gave the connexions that would bind solidly together the whole structure of Egyptian grammar (see *Sprache des Papyrus Westcar*, 1889). The very archaic pyramid texts enabled him to sketch the grammar of the earliest known form of Egyptian (*Zeitschrift d. Deutsch. Morgenl. Gesellschaft*, 1892), and in 1894 he was able to write a little manual of Egyptian for beginners (*Ægyptische Grammatik*), centering on the language of the standard inscriptions of the Middle and New Kingdoms, but accompanying the main sketch with references to earlier and later forms. Of the work of Erman's pupils we may mention Steindorff's little *Koptische Grammatik*, 1894, improving greatly on Stern's standard work in regard to phonology and the relationship of Coptic forms to Egyptian, and Sethe's *Das Ægyptische Verbum*, 1899. The latter is an extensive work on the verb in Egyptian and Coptic by a brilliant and laborious philologist. Owing to the very imperfect notation of sound in the writing, the highly important subject of the verbal roots and verbal forms was perhaps the obscurest branch of Egyptian grammar when Sethe first attacked it in 1895. The subject has been reviewed by Erman, *Die Flexion des Ægyptischen Verbums* in the *Sitzungsberichte* of the Berlin Academy, 1900. The Berlin school, having settled the main lines of the grammar, next turned its attention to lexicography. It has devised a scheme, founded on that for the Latin Thesaurus of the Berlin Academy, which almost mechanically sorts the whole number of occurrences of every word in any text examined. Scholars in England, America, and Denmark, as well as in Germany, are taking part in this great enterprise, and though the completion of it may be far off, the collections of classified material already made are very valuable for consultation. At present Egyptologists depend on Heinrich Brugsch's admirable but somewhat antiquated *Wörterbuch* and on Levi's useful but entirely uncritical *Vocabolario*. Though demotic has not yet received serious attention at Berlin, the influence of that great school has made itself felt amongst demotists, especially in Switzerland, Germany, America, and England. The death of Heinrich Brugsch in 1895 was a very severe blow to demotic studies; but it must be admitted that his brilliant gifts lay in other directions than exact grammatical analysis. Apart from their philological interest, as giving the history of a remarkable language during a period of several thousand years, the grammatical studies of the last quarter of the 19th century are beginning to bear fruit in regard to the exact interpretation of historical documents on Egyptian monuments and papyri. Not long ago the supposed meaning of these was extracted chiefly by brilliant guessing, and the published translations of even the best scholars could carry no guarantee of more than approximate exactitude, where the sense depended at all on correct recognition of the syntax. Now the translator proceeds in Egyptian with some of the sureness with which he would deal with Latin or Greek. The meaning of many words may be still unknown, and many constructions are still obscure; but at least he can distinguish fairly between a correct text and a corrupt text. Egyptian writing lent itself only too easily to misunderstanding, and the writings of one period were but half intelligible to the learned scribes of another. The mistaken readings of the old inscriptions by the priests at Abydos, when attempting to record the names of the kings of the Ist Dynasty on the walls of the temple of Sety I., are now admitted on all sides; and no palæographer, whether his field be Greek, Latin, Arabic, Persian, or any other class of MSS., will be surprised to hear that the Egyptian papyri and inscriptions abound in corruptions and mistakes. The translator of to-day can, if he wishes, mark where certainty ends and mere conjecture begins, and it is to be hoped that advantage will be taken more widely of this new power. The Egyptologist who has long lived in the realm of conjecture is too prone to consider any series of guesses good enough to serve as a translation, and forgets to insert the notes of interrogation which would warn workers in other fields from implicit trust.

The stages of the language are now distinguished as follows :—

*Old Egyptian.*—This is properly the language of the Old Kingdom. In it we have (*a*) the recently discovered inscriptions of the Ist Dynasty, too brief and concise to throw much light on the language of that time; and the great collections of spells and ritual texts found inscribed in the Pyramids of the Vth and VIth Dynasties, which must even then have been of high antiquity, though they contain later additions made in the same style. (*b*) A few historical texts and an abundance of short inscriptions representing the language of the IVth, Vth, and VIth Dynasties.

The ordinary *literary language* of the monuments of its later ages is modelled on Old Egyptian. It is often much affected by contemporary speech, but preserves in the main the characteristics of the language of the Old Kingdom.

*Middle and Late Egyptian.*—These represent the vulgar speech of the Middle and New Kingdom respectively. The former is found chiefly in tales, letters, &c., written in hieratic on papyri of the XIIIth Dynasty to the end of the Middle Kingdom; also in some inscriptions of the XVIIIth Dynasty. Late Egyptian is seen in hieratic papyri of the XVIIIth to the XXIst Dynasties. The spelling of Late Egyptian is very extraordinary, full of false etymologies, otiose signs, &c., the old orthography being quite unable to adapt itself neatly to the profoundly modified language; nevertheless, this clumsy spelling is expressive, and the very mistakes are instructive as to the pronunciation.

*Demotic.*—Demotic Egyptian seems to represent approximately the vulgar speech of the Saite period, and is written in the "demotic" character, which may be traced back to the XXVth Dynasty, if not to a still earlier time. With but moderate changes, this form of the language is found in documents reaching down to the fall of paganism in the 4th century A.D.[1] In the earlier times the spelling is excessively concise; in later Ptolemaic and in the Roman period, it is comparatively full and expressive. Though documents from Egypt in Greek are more abundant than in demotic, the language of the ruling classes had not penetrated the masses deeply.

*Coptic.*—This, in the main, represents the popular language of early Christian Egypt from the 3rd to perhaps the 8th century A.D., when the growth of Coptic as a literary language must have ceased. The Greek alphabet, reinforced by a few signs borrowed from demotic, rendered the spoken tongue so accurately that five distinct, though closely allied, dialects are readily distinguishable in Coptic MSS.; ample remains are found of renderings of the Scriptures into all these dialects. The distinctions between the dialects consist largely in pronunciation, but extend also to the vocabulary, word-formation, and syntax. Such interchanges are found as *l* for *r*, ϭ (*k*, *ch*) for ϫ (*dj*), final *i* for final *e*, *a* for *e*, *a* for *o*. Early in the 2nd century A.D., pagan Egyptians, or perhaps foreigners settled in Egypt, essayed, as yet unskilfully, to write the native language in Greek letters. This *Old Coptic*, as it is termed, was still almost entirely free from Greek loan-words, and its strong archaisms are doubtless accounted for by the literary language having moved more slowly than the speech of the people. Christian Coptic, though probably at first contemporary with some documents of Old Coptic, contrasts strongly with the latter. The monks whose task it was to perfect the adaptation of the alphabet to the dialects of Egypt and translate the Scriptures out of the Greek, flung away all pagan traditions. It is clear that the basis which they chose for the new literature was the simplest language of daily life in the monasteries, charged as it was with expressions taken from Greek, pre-eminently the language of patristic Christianity. There is evidence that the amount of stress on syllables, and the consequent length of vowels, varied greatly in spoken Coptic, and that the variation gave much trouble to the scribes; the early Christian writers must have taken as a model for each dialect the deliberate speech of grave elders or preachers, and so secured a uniform system of accentuation. The remains of Old Coptic, though very instructive in their marked peculiarities, are as yet too few for definite classification. The main divisions of Christian Coptic as recognized and named at present are: Sahidic (formerly called Theban); spoken in the upper Thebais. Akhmimic; in the neighbourhood of Akhmim. Fayumic; in the Fayum (formerly named wrongly "Bashmuric," from a province of the Delta). Memphite; in the neighbourhood of Memphis. Bohairic, the dialect of the "coast district" (formerly named "Memphite"); spoken in the north-western Delta. Coptic, much alloyed with Arabic, was spoken in Upper Egypt as late as the 15th century, but it has long been a dead language.[2] Sahidic and Bohairic are the most important dialects, each of these having left abundant remains; the former spread over the whole of Upper Egypt, and the latter since the 15th century has been the language of the sacred books of Christianity throughout the country, owing to the hierarchical importance of Alexandria and the influence of the ancient monasteries established in the north-western desert.

Coptic is the only stage of the language in which the spelling gives a clear idea of the pronunciation. It is therefore the mainstay of the scholar in investigating or restoring the word-forms of the ancient language. Greek transcriptions of Egyptian names are sometimes valuable as evidence for the vocalization of Egyptian, and they abound as far back as the 4th century B.C., but they seem very inaccurate. A few cuneiform transcriptions, reaching as far back as the XVIIIth Dynasty, also give valuable hints. Coptic itself is of course quite inadequate to enable us to restore Old Egyptian. In it the Old Egyptian verbal forms are mostly replaced by periphrases; though the strong roots are often preserved entire, the weaker consonants and the ע have largely or entirely disappeared, so that the language appears as one of biliteral rather than triliteral roots. Coptic is strongly impregnated with Greek words adopted late; moreover, a certain number of Semitic loan-words had flowed into Egyptian from the 16th century B.C. onwards, displacing earlier words. It is only by the most careful scrutiny and the exercise of the most piercing insight that the imperfectly spelled Egyptian is made to yield up one grammatical secret after another in the light brought to bear upon it from Coptic. Demotic grammar ought soon to be thoroughly comprehensible in its forms, and the study of Late Egyptian should not stand far behind that of demotic. Middle Egyptian and Old Egyptian, on the other hand, will perhaps always be to us little more than consonantal skeletons, the flesh and blood of their vocalization being for the most part irretrievably lost.

In common with the Semitic languages, the Berber languages of North Africa, and the Cushite languages of North-East Africa, Egyptian of all periods possesses grammatical gender, expressing masculine and feminine. Singularly few language groups have this peculiarity; and our own great Indo-European group, which possesses it, is distinguished from those above mentioned by having the neuter gender in addition. The characteristic triliteral roots of all the Semitic languages seemed to separate them widely from others; but certain traits have caused the Egyptian, Berber, and Cushite groups to be classed together as three subfamilies of a Hamitic group, remotely related to the Semitic. The biliteral character of Coptic, and the biliteralism which was believed to exist in Egyptian, led philologists to suspect that Egyptian might be a surviving witness to that far-off stage of the Semitic languages when triliteral roots had not yet been formed from presumed original biliterals; Sethe's investigations, however, prove that the Coptic biliterals are themselves derived from Old Egyptian triliterals, and that

[1] In the temple of Philæ, where the worship of Isis was permitted to continue till the reign of Justinian, Brugsch found demotic inscriptions with dates to the end of the 5th century.

[2] The Arabic dialects which gradually displaced Coptic as Mahommedanism supplanted Christanity adopted but a few words of the old native stock.

the triliteral roots enormously preponderated in Egyptian of the earliest known form; that view is, therefore, no longer tenable. Many remarkable resemblances have been observed in the grammatical structure of the Berber and Cushite groups with Semitic (cf. Zimmern, *Vergleichende Grammatik d. Semitischen Sprache*, especially pronouns and verbs); but the relationship must be very distant, and there are no ancient documents that can take back the history of any one of those languages more than a few centuries. Their connexion with Semitic and Egyptian, therefore, remains at present an obscure though probable hypothesis. On the other hand, Egyptian is certainly related to Semitic. Even before the triliterality of Old Egyptian was recognized, Erman showed that the so-called pseudo-participle had been really in meaning and in form a precise analogue of the Semitic perfect, though its original employment was almost obsolete in the time of the earliest known texts. Triliteralism is considered the most essential and most peculiar feature of Semitic. But there are, besides, many other resemblances in structure between the Semitic languages and Egyptian, so that, although the two vocabularies present few points of clear contact, there seems no adequate reason for doubting that Egyptian was originally a characteristic member of the Semitic family of languages. See Erman, *Das Verhältniss d. Ægyptischen zu d. Semitischen Sprachen* (*Zeitschrift d. Deutschen Morgenl. Gesellschaft*, 1892); Zimmern, *Vergl. Gram.* 1898; Erman, *Flexion d. Ægyptischen Verbum* (*Sitzungsberichte d. Berl. Akad.*, 1900). The Egyptians proper are not, and so far as we can tell never were, Semitic in physical feature. As a possible explanation of the facts, Erman supposes that a horde of conquering Semites, like the Arabs of a later day, imposed their language on the country, but disappeared, being weakened by the climate or absorbed by the native population. The latter acquired the Semitic language imperfectly from their conquerors; they expressed the verbal conjugations by periphrases, mispronounced the consonants, and so changed greatly the appearance of the vocabulary, which also would certainly contain a large proportion of native non-Semitic roots. Strong consonants gave way to weak consonants (as ق (*q*) to ا ('), in the modern Arabic of Egypt), and then the weak consonants disappearing altogether produced biliterals from the triliterals. Much of this must have taken place, according to the theory, in the prehistoric period; but the loss of weak consonants, of *y*, and of one of two repeated consonants, and the development of periphrastic conjugations continued to the end. The typical Coptic root thus became biliteral rather than triliteral, and the verb, by means of periphrases, developed tenses of remarkable precision—perhaps under the influence of Greek. Such verbal resemblances as exist between Coptic and Semitic are largely due to late exchanges with Semitic neighbours.

The following sketch of the Egyptian language, mainly in its earliest form, which dates from some three or four thousand years B.C., is founded upon Erman's works. It will serve to contrast with Coptic grammar on the one hand and Semitic grammar on the other.

*The Egyptian Alphabet.*

=*y*; so transcribed in this article, but is often א, especially at the beginning of words, and from the earliest times is used in a manner corresponding to the Arabic *hamza*, to indicate a prosthetic vowel. Often lost or changed to '.

=' (א); easily lost or changes to *y*.

=' (ע); lost in Coptic. This rare sound, well known in Semitic, occurs also in Berber and Cushite languages.

=*w*; often changes to *y*.

=*b*.

=*p*.

=*f*.

=*m*.

=*n*.

=*r*; often lost, or changes to *y*. *r* and *l* are distinguished in later demotic and in Coptic.

=*h*.
=*ḥ*. } distinction lost in Coptic.

=*ḫ*; in Coptic ϣ (*sh*) or ϧ (*kh*) correspond to it.

=*ẖ*; generally written with (*š*) in the Old Kingdom, but corresponds to *kh* in Coptic.

=*s*.
=*ś*. } distinction lost at the end of the Old Kingdom.

=*š* (*sh*).

=*q*; Coptic ⲕ.

=*k*
=*g* } Coptic ⲕ; or ϫ, ϭ according to dialect.

=*t*; often lost at the end of words.

=*ṯ* (*θ*); often changes to *t*. Coptic ⲧ; or ϫ, ϭ.

=*d*; in Coptic reduced to *t*.

=*ḏ* (*z*); often changes to *d*; in Coptic ϫ.

*Roots.*

Egyptian roots consist of consonants and semi-consonants only, the inflexion being effected by internal vowel-change and the addition of consonants or vowels at the beginning or end. The Egyptian system of writing, as opposed to the Coptic, showed only the consonantal skeletons of words: it could not record internal vowel-changes; and semi-consonants, even when radicals, were often omitted in writing.

*Personal Pronouns.*

| | | | | |
|---|---|---|---|---|
| Sing. | 1. c. *yw* (?) later *wy*. | Pl. | 1. c. *n*. | Du. |
| | 2. m. *kw*. | | 2. c. *ṯn*. | 2. c. *ṯny*. |
| | f. *ṯn*. | | | |
| | 3. m. **fy*, surviving only in a special verbal form. | | 3. m. *śn*, early lost, except as suffix. | 3. c. *śny*. |
| | f. *śy*. | | f. **śt*, surviving as 3. c. | |

From these are derived the suffixes, which are shortened forms attached to nouns to express the possessor, and to verbs to express the subject. In the latter case the verb was probably in the participle, so that *śḏmyy-śn*, "they hear," is literally "hearing are they." The singular suffixes are: 1. c. -*y*; 2. m. -*k*, f. -*ṯ*; 3. m. -*f*, f. -*ś*;—the dual and plural have no special forms.

Another series of absolute pronouns is: 2. m. *ṯwt*, *ṯw*; f. *ṯmt*, *ṯm*; 3. m. *śwt*, *św*; f. *śtt*, *śt*. Of these *ṯwt*, *ṯmt*, &c., are emphatic forms.

Many of the above absolute pronouns were almost obsolete even in the Old Kingdom. In ordinary texts some survive, especially as objects of verbs, namely: *wy*, *tw*, *tn*, *sw*, *st*. The suffixes of all numbers and persons except the dual were in full use throughout, to Coptic; -*śn*, however, giving way to a new suffix, -*w*, which developed first in the New Kingdom.

Another absolute pronoun of the first person is *ynk*, ⲁⲛⲟⲕ, like Heb. אנכי. It is associated with a series for the second and third persons: *nt-k*, *nt-ṯ*, *nt-f*, *nt-śn*, &c.; but from their history, use, and form, it seems probable that the last are of later formation, and are not to be connected with the Semitic pronouns (chiefly of the 2nd person) resembling them.

*Demonstrative Pronouns.*

There are several series based on m. *p*; f. *t*; pl. *n*; but *n* as a plural seems later than the other two. From them are developed a weak demonstrative to which possessive suffixes can be attached, producing the definite and possessive articles (*p'*, *t'*, *n'*, "the," *p'y-f*, "his," *p'y-s* "her," &c.) of Middle Egyptian and the later language.

*Nouns.*

Two genders, m. (ending *w*, or nothing), f. (ending *ṯ*). Three numbers: singular, dual (m. *wy*, f. *ty*, gradually became obsolete), plural (m. *w*; f. *wt*). No case-endings are recognizable, but construct forms—to judge by Coptic—were in use. Masculine and feminine nouns of instrument or material are formed from verbal roots by prefixing *m*; *e.g.*, *m.sdm.t*, "stibium," from *sdm*, "paint the eye." Substantives and adjectives are formed from substantives and prepositions by the addition of *y* in the masculine; *e.g.*, *n.t*, "city," *nt.y*, "belonging to a city," "citizen"; *ḥr*, "upon," *ḥr.y* (f. *ḥr.t*; pl. *ḥr.w*), "upper." This is not unlike the Semitic *nisbe* ending *iy*, *ay* (*e.g.*, Ar. *beled*, "city," *beledi*, "belonging to a city"). Adjectives follow the nouns they qualify.

*Numerals.*

1, *w'*; 2, *śn*; 3, *ḫmt*; 4, *fdw*; 5, *dw'*; 6, *sys*; 7, *sfḫ*; 8, *ḫmn*; 9, *psḏ*; 10, *mt*. 2, 6, 7, 8, and 9 (?) resemble Semitic numerals. 20 and 30 (*m'b*) had special names; 40–90 were named as if plurals of the units 4–9, as in Semitic. 100, *šnt*; 1000, *ḫ'*; 10,000, *ḏb'*; 100,000, *ḫfnw*.

*Verbs.*

The forms observable in hieroglyphic writing lead to the following classification:—

| | | |
|---|---|---|
| STRONG VERBS. | Biliteral . . | Often showing traces of an original III. inf.; in early times very rare. |
| | Triliteral . . | Very numerous. |
| | Quadriliteral, Quinqueliteral | Generally formed by reduplication. In late Egyptian they were no longer inflected, and were conjugated with the help of *yry*, "do." |
| WEAK VERBS. | II. geminatæ . | Properly triliterals, but, with the 2nd or 3rd radical alike, these coalesced in many forms where no vowel intervened, and gave the word the appearance of a biliteral. |
| | III. gem. . . . | Rare. |
| | III. inf. . . . | Numerous. III. *w*, and III. *y* were unified early. Some very common verbs, "do," "give," "come," "bring" are irregular. |
| | IV. inf. . . . | Partly derived from adjectival formations in *y*, from nouns and infinitives:—*e.g.*, *ś.yp*, inf. *śypt*; adj. *śypty*; verb (4 lit.), *śypty*. |

Many verbs with weak consonants—1*y*, 1*w*, II. inf. (*m*[*w*]*t*), and those with א—are particularly difficult to trace accurately, owing to defective writing.

It seems that all the above classes may be divided into two main groups, according to the form of the infinitive:—with masculine infinitive the strong triliteral type, and with feminine infinitive the type of the III. inf. The former group includes all except III. inf., IV. inf., and the causative of the biliterals, which belong to the second group.

It is probable that the verb had a special form denoting condition, as in Arabic. There was a causative form prefixing *ś*, and traces of forms resembling *Piël* and *Niphal* are observed. Some roots are reduplicated wholly or in part with a frequentative meaning, and there are traces of gemination of radicals.

*Pseudo-Participle.*—In very early texts this is the past indicative, but more commonly it is used in sentences such as, *gm-n-f wy 'ḥ'.kwy*, "he found me I stood," *i.e.*, "he found me standing." The indicative use was soon given up and the pseudo-participle was employed only as predicate, especially indicating a state; *e.g.*, *ntr.t šm.ty*, "the goddess goes"; *yw-k wḏ'.ty*, "thou art prosperous." The endings were almost entirely lost in New Egyptian. For early times they stand thus:—

| | | | | | | |
|---|---|---|---|---|---|---|
| Sing. | 3. | masc. | *y*, late *w*. | Dual *wyy*. | Pl. | *w*. |
| | | fem. | *ty*. | *tyyw*. | | *ty*. |
| | 2. | masc. | *ty*. | | | *tywny*. |
| | | fem. | *ty*. | | | |
| | 1. | c. | *kwy*. | | | *wyn*. |

The pseudo-participle seems, by its inflection, to have been the perfect of the original Semitic conjugation. The simplest form being that of the 3rd person, it is best arranged like the corresponding tense in Semitic grammars, beginning with that person. There is no trace of the Semitic imperfect in Egyptian. The ordinary conjugation is formed quite differently. The verbal stem is here followed by the subject-suffix or substantive—*śḏm-f*, "he hears"; "*śḏmw štn*, "the king hears." It is varied by the addition of particles, &c., *n*, *yn*, *ḫr*, *tw*, thus:—

*śḏm-f*, "he hears"; *śḏm-w-f*, "he is heard" (pl. *śḏm-yy-śn*, "they are heard"); *śḏm-tw-f*, "he is heard"; *śḏm-n-f*, "he heard"; *śḏm-n-tw-f*, "he was heard"; also, *śḏm-yn-f*, *śḏm-ḫr-f*, *śḏm-k'-f*. Each form has special uses, generally difficult to define. *śḏm-f* seems rather to be imperfect, *śḏm-n-f* perfect, and generally to express the past. Later, *śḏm-f* is ordinarily expressed by periphrases; but by the loss of *n*, *śḏm-n-f* became itself *sdm-f*, which is the ordinary past in demotic. Coptic preserves *śḏm-f* forms of many verbs in its causative (*e.g.*, ⲦⲀⲚϦⲞϤ "cause him to live," from Egyptian *dy.t 'nḫ-f*), and, in its periphrastic conjugation, the same forms of *wn*, "be," and *yry*, "do." With *śḏm-f* (*śeḏmo-f*) was a more emphatic form (*eśḏomef*), at any rate in the weak verbs.

The above, with the relative forms mentioned below, are supposed by Erman to be derived from the participle, which is placed first for emphasis: thus, *śḏm.w štn*, "hearing is the king"; *śḏm-f*, for *sḏm-fy*, "hearing he is." This Egyptian paraphrase of Semitic is just like the Irish paraphrase of English, "It is hearing he is."

The *imperative* shows no ending in the singular; in the plural it has *y*, and later *w*; cf. Semitic imperative.

The *infinitive* is of special importance on account of its being preserved very fully in Coptic. It is generally of masculine form, but feminine in III. inf. (as in Semitic), and in causatives of biliterals.

There are relative forms of *śḏm-f* and *śḏm-n-f*, respectively *śḏm.w-f* (masc.), *śḏm.t-n-f* (fem.), &c. They are used when the relative is the object of the relative sentence, or has any other position than the subject. Thus *śḏm.t-f* may mean "she whom he hears," "she who[se praises] he hears," "she [to] whom he hears [someone speaking]," &c. There are close analogies between the function of the relative particles in Egyptian and Semitic; and the Berber languages possess a relative form of the verb.

*Participles.*—These are active and passive, perfect and imperfect, in the old language, but all are replaced by periphrases in Coptic.

*Verbal Adjectives.*—There is a peculiar formation, *śḏm-ty-fy*, "he who shall hear," probably meaning originally "he is a hearer," *śḏm.ty* being an adjective in *y* formed from a feminine (*t*) form of the infinitive, which is occasionally found even in triliteral verbs; the endings are: sing., masc. *ty-fy*, fem. *ty-śy*; pl., masc. *ty-śn*, fem. *ty-śt*. It is found only in Old Egyptian.

*Particles.*—There seems to be no special formation for adverbs, and little use is made of adverbial expressions. Prepositions, simple and compound, are numerous. Some of the commonest simple propositions are *n* "for," *r* "to," *m* "in, from," *ḥr* "upon." A few enclitic conjunctions exist, but they are indefinite in meaning—*śwt* a vague "but," *grt* a vague "moreover," &c.

Coptic presents a remarkable contrast to Egyptian in the precision of its periphrastic conjugation. There are two present tenses, an imperfect, two perfects, a pluperfect, a present and a past frequentative, and three futures besides future perfect; there are also conjunctive and optative forms. The negatives of some of these are expressed by special prefixes. The gradual growth of these new forms can be traced through all the stages of Egyptian. Throughout the history of the language we note a tendency to periphrasis and pleonasm; but there was no great advance towards *precision* before demotic. In demotic there are distinguishable a present tense, imperfect, perfect, frequentative, future, future perfect, conjunctive, and optative; also present, past, and future negatives, &c. The passive was extinct before demotic; demotic and Coptic express it, clumsily it must be confessed, by an impersonal "they," *e.g.*, "they bore him" stands for "he was born."

It is worth noting how, in other departments besides the verb, the Egyptian language was far better adapted to practical ends during and after the period of the Deltaic dynasties (XXII.–XXX.) than ever it was before. It was both simplified and enriched. The inflections rapidly disappeared, and little was left of the distinctions between masculine and feminine, singular dual and plural—except in the pronouns. The dual number had been given up entirely at an earlier date. The pronouns, both personal and demonstrative, retained their forms very fully. As prefixes, suffixes, and articles, they, together with some auxiliary verbs, provided the principal mechanism of the renovated language. An abundant supply of useful adverbs was gradually accumulated, as well as conjunctions, so far as the functions of the latter were not already performed by the verbal prefixes. These great improvements in the language correspond to great changes in the economic condition of the country; they were the result of active trade and constant intercourse of all classes of Egyptians with foreigners from Europe and Asia. Probably the best stage of Egyptian speech was that which immediately preceded Coptic. Though Coptic is here and there more exactly expressive than the best demotic, it was spoilt

by too much Greek, duplicating and too often expelling native expressions that were already adequate for its very simple requirements. Above all, it is absurdly and clumsily pleonastic.

### The Writing.

The ancient Egyptian system of writing, so far as we know, originated, developed, and finally expired strictly within the limits of the Nile Valley. The germ of its existence may have come from without, but, as we know it, it is essentially Egyptian and intended for the expression of the Egyptian language. About the 2nd century B.C. the semi-barbarous inhabitants of Ethiopia contrived to adapt it to their own idiom in modified forms of hieroglyphic and demotic, which are still undecipherable, and the demotic writing of Ethiopia may have been employed as late as the 5th or 6th century A.D. Egyptian hieroglyphic was carried by conquest into Syria, certainly under the XIXth Dynasty, and again under the XXVIth for the engraving of Egyptian inscriptions; but in the earlier period the cuneiform syllabary, and in the later the "Phœnician" alphabet, had obtained a firm hold there, and we may be sure that no attempt was made to substitute the Egyptian system for either of these. In very early times a number of systems of writing already reigned in different countries forming a compact and not very large area—from South Arabia to Asia Minor, and from Persia to Crete and Egypt. Whether they all sprang from one common stock of picture-writing we shall perhaps never know, nor can we as yet trace the influence which one great system may have had on another. From the evidence at present available, it seems likely that Egyptian hieroglyphic was not the direct ancestor of any system outside the valley of the Nile.

It is certain that the mode of writing in Egypt from the IVth Dynasty onwards was essentially the same as that which was extinguished by the fall of paganism in the 4th century A.D. Its elements in the hieroglyphic form are pictorial, but each hieroglyph has one or more well-defined functions, fixed by convention in such a manner that the Egyptian language is expressed word by word. Although a picture sign may at times have embarrassed the skilled native reader by offering a choice of fixed values or functions, it was never intended to convey merely an idea, so as to leave to him the task of putting the idea into his own words. How far this holds good for the period before the IVth Dynasty it is difficult to say. The known inscriptions of the earlier times are so brief and so limited in range that the mode of writing them cannot yet be fully investigated. As far back as the Ist Dynasty, phonograms (see below) were in full use. But the spelling then was very concise: it is possible that some of the slighter words, such as prepositions, were omitted in the writing and were intended to be supplied from the context. As a whole, we gain the impression that a really distinct and more primitive stage of hieroglyphic writing by a substantially vaguer notation of words lay not far behind the time of the Ist Dynasty.

The employments of the signs are of three kinds: each represents (1) a whole word; or (2) a sound as part of a word; or (3) pictorially defines the meaning of a word the sound of which has already been given by a sign or group of signs preceding. For instance, is the conventional picture of a draughtboard (shown in plan), with the draughtsmen (shown in elevation) on its edge:—this sign (1) signifies the word *mn*, "set," "firm"; or (2), in the group , represents the same sound as part of the word *mnḫ*, "good"; or (3), in the group , *snt*, it shows that the meaning is a "draughtboard," or "draughts." Thus signs, according to their employment, are said to be (1) "word-signs," (2) "phonograms," or (3) "determinatives."

Word-Signs.—The word-sign value of a sign is, in the first place, the name of the object it represents, or of some material, or quality, or action, or idea suggested by it. Thus is *ḥr*, "face"; , a vase of ointment, is *mrḥ.t*, "ointment"; is *wdb*, "turn." Much investigation is still required to establish the origins of the values of the signs; in some cases the connexion between the pictures and the primary values seems to be curiously remote. Probably all the signs in the hieroglyphic signary can be employed in their primary sense. The *secondary* value expresses the consonantal root of the name, and any, or almost any, derivative from that root: as when , a mat with a cake upon it, is not only *ḥtp*, an "offering-mat," but also *ḥtp* in the sense of "conciliation," "peace," "rest," "setting" (of the sun), with many derivatives. In the third place, some signs may be *transferred* to express another root having the same consonants as the first: thus , the ear, by a play upon words can express not only *śḏm*, "hear," but also *śdm*, "paint the eyes."

Phonograms.—Only a limited number of signs are found with this use, but they are of the greatest importance. By searching throughout the whole mass of inscriptions, earlier than the periods of Greek and Roman rule, when great liberties were taken with the writing, probably no more than one hundred different phonograms can be found. The number of those commonly employed in good writing is between seventy and eighty. The most important phonograms are the uniliteral or alphabetic signs, twenty-four in number in the Old Kingdom and without any homophones: later these were increased by homophones to thirty. Of biliteral phonograms—each expressing a combination of two consonants—there were about fifty commonly used: some fifteen or twenty were rarely used. As Egyptian roots seldom exceeded three letters, there was no need for triliteral phonograms to spell them. There is, however, one triliteral phonogram, the eagle, , *tyw*, or *tiu* (?), used for the plural ending of adjectives in *y* formed from words ending in *t* (whether radical or the feminine ending).

The phonetic values of the signs are derived from their word-sign values and consist usually of the bare root, though there are rare examples of the retention of a flexional ending; they often ignore also the weaker consonants of the root, and on the same principle reduce a repeated consonant to a single one, as when the hoe , *ḥnn*, has the phonetic value *ḥn*. The history of some of the alphabetic signs is still very obscure, but a sufficient number of them have been explained to make it nearly certain that the values of all were obtained on the same principles.[1] Some of the ancient words from which the phonetic values were derived probably fell very early into disuse, and may never be discoverable in the texts that have come down to us. The following are among those most easily explained:—

, reed flower, value *y* and ℵ; from , *y'*, "reed."

(It seems as if the two values *y* and ℵ are obtained by choosing first one and then the other of the two semi-consonants composing the name.)

, forearm, value ʿ(ν); from , ʿ(ν), "hand."

, mouth, = *r*; ,, , *r*, "mouth."

, belly and teats, = *ẖ*; ,, , *ẖ.t*, "belly."

(The feminine ending is here, as usual, neglected.)

, tank, value *š*; from , *š*, "tank."

, slope, = *q*; ,, , *q'*, "slope," "height."

(The doubled weak consonant is here neglected.)

, hand, value *d*; from , *d.t*, "hand."

, cobra, = *z*; ,, , *z.t*, "cobra."

For some alphabetic signs more than one likely origin might be found, while for others, again, no clear evidence of origin is yet forthcoming.

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[1] "Acrophony" (giving to a sign the value of the first letter of its name) was indulged in only by priests of the latest age, inventing fantastic modes of writing their "vain repetitions" on the temple walls.

It has already been explained that the writing expresses only consonants. In the Græco-Roman period various imperfect attempts were made to render the vowels in foreign names and words by the semi-vowels as also by , the consonant *'ayin*, which originally represented, having been reduced in speech by that time to the power of *aleph* only. Thus, Πτολεμαιος is spelt *Ptwrmys*, Antoninus, *'Nt'nynws* or *Yntnyns*, &c. &c. Much earlier, throughout the New Kingdom, a special "syllabic" orthography was used for foreign names and words; according to W. Max Muller (*Asien und Europa*, 1893, chap. v.), this represents an endeavour to express the vocalization; but, if so, it was carried out with very little system.

Determinatives.—Almost any sign can be used as a determinative, but there are certain generic determinatives that are very common, *e.g.*:—

; of all actions of the mouth—eating and speaking, likewise silence, and hunger.

, ripple-lines; of liquid.

, hide; of animals, also leather, &c.

; of plants and fibres.

; of flesh.

, a sealed papyrus-roll; of books, teaching, law, and of abstract ideas generally.

Orthography.—The most primitive form of spelling in the hieroglyphic system would be by one sign for each word, and the monuments of the Ist Dynasty show a decided tendency to this mode. Examples of it in later times are preserved in the royal cartouches, for here the monumental style demanded special conciseness. Thus, for instance, the name of Thothmes III.—MN-ḪPR-R'—is spelled . (As R' is the name of the Sun-god, with customary deference to the deity it is written first though pronounced last.) A number of common words—prepositions, &c.—with only one consonant are spelled by single alphabetic signs in ordinary writing. Word-signs used singly for the names of objects are generally marked with | in classical writing, as— , *yb*, "heart," , *ḥr*, "face," &c.

But the use of bare word-signs is not common. Flexional consonants are almost always marked by phonograms, except in very early times; as when the feminine word = *z.t*, "cobra," is spelled . Also, if a sign had more than one value, a phonogram would be added to indicate which of its values was intended: thus in is *św*, "he," but in it is *śtn*, "king." Further, owing to the vast number of signs employed, to prevent confusion of one with another in rapid writing they were generally provided with "phonetic complements," a group being less easily misread than a single letter. *E.g.* , *wd*, "command," is regularly written , *wd(w)*; but , *ḥz*, "white," is written , *ḥz(z)*. Redundance in writing is the rule; for instance, *b'* is often spelled *(b)b' (')*. Biliteral phonograms are very rare as phonetic complements, nor are two biliteral phonograms employed together in writing the radicals of a word.

Spelling of words purely in phonetic or even alphabetic characters is not uncommon, the determinative being generally added. Thus in the pyramid texts we find in one copy of a text *ḫpr*, "become," written , in another . Such variant spellings are very important for fixing the readings of word-signs. It is noteworthy that though words were so freely spelled in alphabetic characters, especially in the time of the Old Kingdom, no advance was ever made towards excluding the cumbersome word-signs and biliteral phonograms, which, by a judicious use of determinatives, might well have been rendered quite superfluous.

Palæography.—*Hieroglyphic.*—The main division is into monumental or epigraphic hieroglyphs and written hieroglyphs. The former may be rendered by the sculptor or the painter in stone, on wood, &c., with great delicacy of detail, or may be simply sunk or painted in outline. When finely rendered they are of great value to the student investigating the origins of their values. No other system of writing bears upon its face so clearly the history of its development as the Egyptian; yet even in this a vast amount of work is still required to detect and disentangle the details. Monumental hieroglyphic did not cease till the 3rd century A.D. The written hieroglyphs, formed by the scribe with the reed pen on papyrus, leather, wooden tablets, &c., have their outlines more or less abbreviated, producing eventually the cursive scripts hieratic and demotic. The written hieroglyphs were employed at all periods, especially for religious texts.

*Hieratic.*—A kind of cursive hieroglyphic or hieratic writing is found even in the Ist Dynasty. In the Middle Kingdom it is well characterized, and in its most cursive form seems hardly to retain any definable trace of the original hieroglyphic pictures. The style varies much at different periods.

*Demotic.*—Widely varying degrees of cursiveness are at all periods observable in hieratic; but, about the XXVIth Dynasty, which inaugurated a great commercial era, there was something like a definite parting between the uncial hieratic and the most cursive form afterwards known as demotic. The employment of the one was thenceforth almost confined to the copying of religious texts on papyrus, while the other was used for all common purposes. Towards the end of the Ptolemaic period, though hieroglyphic and hieratic continued to be employed, demotic became the medium for writing every class of text, literary and religious works as well as the legal documents and letters, to which its use up to that time seems to have been practically limited. The cursive ligatures of old demotic had given birth to new symbols which were carefully and distinctly formed, and an epigraphic variety was engraved on stone, as in the case of the Rosetta Stone itself. One of the most characteristic distinctions of later demotic is the minuteness of the writing.

Egypt had long been bilingual when, in papyri of the 2nd century A.D., we begin to find transcripts of the Egyptian language into Greek letters: so written we have a magical text and a horoscope, probably made by foreigners or for their use. The infinite superiority of the Greek alphabet with its full notation of vowels was readily seen, but religious scruples as yet barred the way to its full adoption. The triumph of Christianity banished the old system once and for all; even at the beginning of the 4th century the native Egyptian script scarcely survived north of the Nubian frontier at Philæ; a little later it expired entirely, leaving six signs as a legacy to the Coptic alphabet.

For investigations into the origins of hieroglyphs, see Petrie's *Medum*, 1892, and the *Memoirs* of the Archæological Survey of the Egypt Exploration Fund, especially *Beni Hasan*, pt. iii., 1896; *A Collection of Hieroglyphs*, 1898; and *The Mastaba of Ptahhetep and Akhethetep*, pt. i. 1900. (F. LL. G.)

**Ehrenfeld,** formerly a town of Prussia, now united municipally with Cologne (*q.v.*). Population (1900), 26,895.

**Eibenstock,** a town of Germany, near the Mulde, 17 miles south-south-east by rail of the town and in the circle of Zwickau, kingdom of Saxony. It is a principal seat of the tambour embroidery. Population (1890), 7166; (1900), 7468.

**Eider,** a river of Prussia, in the province of Schleswig-Holstein. It rises to the south of Kiel, flows first north, then west (with wide-sweeping curves), and after a course of 117 miles enters the North Sea at Tönning. It is navigable up to Rendsburg, and is embanked through the marshes, across which in its lower course it cuts its way. The Eider Canal, constructed in 1777–84, leaves the Eider at the point where it turns to the west and enters the Bay of Kiel at Holtenau. Length, 28 miles; super-

ficial width, 100 feet; depth, $11\frac{3}{4}$ feet. It was hampered by six sluices, but was used annually by some 4000 vessels. This was in 1887–95 converted into the Emperor William Canal, for which see CANALS.

**Eiffel Tower.**—Erected for the Exposition of 1889, the Eiffel Tower, in the Champ de Mars, Paris, is by far the highest artificial structure in the world, and its height of 300 metres (1092 feet) surpasses that of the obelisk at Washington by 537 feet, and that of St Paul's Cathedral by 688 feet. Its framework is composed essentially of four uprights, which rise from the corners of a square measuring 100 metres on the side; thus the area it covers at its base is nearly $2\frac{1}{2}$ acres. These uprights are supported on huge piers of masonry and concrete, the foundations for which were carried down, by the aid of iron caissons and compressed air, to a depth of about 15 metres on the side next the Seine, and about 9 metres on the other side. At first they curve upwards at an angle of 54°; then they gradually become straighter, until they unite in a single shaft rather more than half-way up. The first platform, at a height of 57 metres, has an area of 5860 square yards, and is reached either by staircases or lifts. The next, accessible by lifts only, is 115 metres up, and has an area of 32 square yards; while the third, at 276, supports a pavilion capable of holding 800 persons. Nearly 25 metres higher up still is the lantern, with a gallery 5 metres in diameter. The work of building this structure, which is mainly composed of iron lattice-work, was begun on 28th January 1887, and the full height was reached on 13th March 1889. Besides being one of the sights of Paris, to which visitors resort in order to enjoy the extensive view that can be had from its higher galleries on a clear day, the tower is used to some extent for scientific and semi-scientific purposes; thus meteorological observations are carried on. It formed the objective in the flying-machine trials of October 1901, when M. Santos-Dumont succeeded in winning the Deutsch prize with an air-ship designed and constructed by himself. The engineer under whose direction the tower was constructed was M. ALEXANDRE GUSTAVE EIFFEL (born at Dijon on 15th December 1832), who had already had a wide experience in the construction of large metal bridges, and who designed the huge sluices for the Panama Canal, in connexion with which there were the famous scandals in 1893.

**Eilenburg,** a town of Prussia, province of Saxony, 31 miles by rail east from Halle. It has manufactures of cloth, calico, chemicals, machinery, tobacco, and baskets, quilting, and brewing. Population (1885), 11,032; (1900), 15,145.

**Einbeck,** a town of Prussia, province of Hanover, 50 miles by rail south from Hanover. The municipal antiquarian museum is preserved in the chapel (restored) of Zum Heiligen Geist. Here are an engineering school and a textile school. Population (1885), 7091; (1900), 7974.

**Eisenach,** a town of Germany, second capital of the grand duchy of Saxe-Weimar, at the north-west foot of the Thuringian Forest, 32 miles by rail west from Erfurt. The Nicolai Kirche was restored in 1887, and Georg Kirche in 1899. There are monuments to Sebastian Bach (1884), to Luther (1895), and to the war of 1870–71. The house (now museum) in which Fritz Reuter lived (1863–74), his grave in the new churchyard, and the Richard Wagner Museum should be mentioned. At Eisenach are a school of forestry, a school of design and the industrial arts, teachers' seminaries, an infirmary, and a prison. Population (1885), 19,743; (1901), 31,580.

**Eisenerz** ("Iron ore"), a market-place and old mining town in the government district of Leoben, Upper Styria, Austria, the chief centre of the Styrian iron industry. It is situated in a deep valley, dominated on the east by the Pfaffenstein (6140 feet) and on the west by the Kaiserschild (6830 feet). It has an interesting example of a mediæval fortified church, a Gothic edifice founded by Rudolph of Hapsburg in the 13th century and rebuilt in the 16th. The Erzberg, or Ore Mountain, which closes the valley on the south, furnishes such rich ore that it is quarried in the open air like stone, in the summer months. There is documentary evidence of the mines having been worked as far back as the 12th century. They afford employment to two to three thousand hands in summer and about half as many in winter, and yield some 150,000 tons of iron per annum. Eisenerz possesses, in addition, twenty-five furnaces, which produce iron, and particularly steel, of exceptional excellence. It is connected with the neighbouring mining and smelting centre of Vordernberg, at the other side of the Erzberg (3000 inhabitants), by a mountain railway on the cogged-wheel system, with an average gradient of 68 : 1000. Population (1890), 5740; (1900), 6494.

**Eisleben,** a town of Prussia, province of Saxony, 24 miles by rail west by north from Halle. It was the birthplace and deathplace of Luther, to whom a monument by Siemering was unveiled in 1883. Eisleben has a mining school, and is the seat of copper, silver, and iron mines, and of works for smelting the ore, and also produces flower and vegetable seeds. Population (1885), 23,175; (1900), 23,898.

**Ekaterinburg,** a district town of Russia, 311 miles by rail south-east of Perm, on the Iset river. It is the most important and most rapidly developing town of the Urals. Population (1860), 19,830; (1897), 55,488. It is the seat of the central mining administration, and has a mining chemical laboratory for the assay of gold extracted both in the Urals and Siberia, a mining school, an Imperial stone-cutting factory, the Ural Society of Naturalists, a first-class magnetic and meteorological observatory, and many banks. Altogether, it is one of the best provincial towns of Russia. There are, besides, one large steam flour mill, candle works, several machinery works, woollen mills, paper works, soap works, and tanneries, and many stone-cutting factories and workshops, the produce of which is widely exported. Altogether, over 2000 persons work in the factories, and nearly as many in the workshops. Many of the residents are engaged in gold mining. The trade in goods exported from the Urals and imported from Russia is very large, and two important fairs are held. Nearly 40 gold and platinum mines, 32 iron works, and numbers of other works and factories are scattered in the district, while wheels, travelling boxes, all sorts of hardware, boots, and so on are fabricated on a great scale in the villages.

**Ekaterinodar,** a town of Russia, North Caucasia, capital of the province of Kubañ, situated on the right bank of the Kubañ, 531 miles north-west of Tiflis, on the railway from Rostov to Novorossiysk, 85 miles by rail from this seaport. Founded in 1794 as a small fort, its population has grown from 9620 in 1860 to 65,700 in 1897. It has gymnasia for boys and girls, various professional schools, an experimental fruit-farm, and a natural history museum. A considerable trade, especially in grain, is carried on by its merchants.

**Ekaterino-Nikolskaya,** a Cossack village of Russia, province of the Amur, 340 miles below Blagovyeschensk, at the spot where the Amur enters a gorge through which it pierces the Little Khingan. The road which runs along the middle Amur ends at this spot, and when the

river carries ice in spring and winter, all communication with the lower Amur is practically interrupted there. It is the centre of government for the Amur Cossacks. Population, about 2000.

**Ekaterinoslav,** a province of South Russia, having Poltava and Kharkoff on the N., the Don province on the E., the Sea of Azov and Taurida on the S., and Khersoñ on the W. Area, 24,478 square miles. Its surface is undulating prairie gently sloping south and north, with a few hills reaching 1320 ft. in the north-east, where a gentle swelling (the Don Hills) compels the Don to make a great curve eastwards. Another row of hills, to which the eastward bend of the Dnieper is due, rises in the west. These hills have a crystalline core (granites, syenites, and diorites), while the surface strata are Carboniferous, Permian, Cretaceous, and Tertiary. The province is rich in minerals, especially in anthracite and coal, iron ores, and rock-salt. Granite, limestone, grindstone, slate, as also graphite, manganese, and mercury, are found. It is watered by the Dnieper, the Don, and their tributaries, and several affluents of the Sea of Azov. The soil is a very fertile black earth, but the crops have occasionally to suffer from droughts—the average yearly rainfall being only 15 inches. Forests are scarce. Population (1860), 1,138,750; (1897), 2,112,651—chiefly Little Russians, partly Great Russians, and some Greeks. The land is owned as follows: the peasants hold in communal ownership 37 per cent., and in private ownership 4 per cent.; nobility, 31 per cent.; German colonists, 9·5 per cent.; Greeks, 7 per cent.; the remainder being owned by various persons and companies.

Wheat is grown extensively with the aid of modern machinery, and the average crops are 7,580,000 quarters of various cereals, 577,000 quarters of potatoes, and about 1000 cwt. of tobacco. Vines have been grown lately. There were in 1895, 295,670 horses, 653,770 horned cattle, and 2,174,350 sheep—nearly 6700 tons of raw wool being obtained every year. Mining attains every year more and more importance, the returns in South Russia (Ekaterinoslav and Don) being, in 1896, coal from 83 mines, 2,926,000 tons (12,000 workers); iron ore from 19 mines, 1,208,000 tons; manganese ore (4 mines), 45,550 tons; iron (all in Ekaterinoslav), 608,600 tons; steel, 51,100 tons; rails, 246,000 tons; iron goods, 50,000 tons. Besides, mercury, ore, and fireclay are extracted. Nearly 40,000 persons find occupation in factories, of which the iron works and the 34 agricultural machinery works are the most important, while in the district of Mariupol the making of agricultural implements and machinery has undergone a very great extension as a domestic industry in the villages. Grain is exported to a very large extent (about 950,000 tons, and 520,000 tons in transit), *viâ* the Dnieper, the Sebastopol railway, and the port of Mariupol. Nearly 4000 boats and 1000 rafts are loaded and unloaded every year, carrying over 2,000,000 tons of goods (value 13,000,000 roubles), and giving occupation to 27,000 men. The port of Mariupol is visited every year by about 80 steamers and 40 sailing vessels engaged in foreign trade, and 1600 vessels engaged in coasting. The government is better provided with schools, gymnasia, professional and primary, than many other governments of Russia. The chief towns of its 8 districts are: Ekaterinoslav (121,216 inhabitants), Alexandrovsk (16,393), Bakhmut (19,416), Mariupol (31,772), Novomoskovsk (12,862), Pavlograd (17,188), Slavyanoserbsk (3120), and Verkhnednyeprovsk (11,607).

(P. A. K.)

**Ekaterinoslav,** capital of the above province, on the right bank of the Dnieper, 607 miles by rail south-south-west of Moscow. It is a rapidly growing town, well provided with schools, including a number of professional ones, and is an important depot for timber shipped down the Dnieper, as also for grain. Its iron works, steam flour-mills, and agricultural machinery works give occupation to 5000 workers. Considerable trade is carried on in cattle, grain, and raw wool. Population (1861), 18,881, without suburbs; (1897), 121,216.

**Elabuga,** a district town of Russia, government and 279 miles south-east of Vyatka, on Kama river, near its junction with Totma. It has steam flour-mills, and carries on a brisk trade in exporting corn. Population, 9776.

The famous *Ananiinskiy Moghilnik* (burial-place) is on the right bank of the Kama, 3 miles from above the town. It was discovered in 1858, was excavated by Alabin, Lerch, and Nevostruyeff, in charge of the Archæological Commission, and has since supplied extremely valuable collections of archæological objects belonging to the Stone, Bronze, and Iron Ages. It represented first a mound, about 500 feet in circumference, adorned with decorated stones (which have disappeared), and contained an inner wall, 65 feet in circumference, made of uncemented stone flags. Nearly 50 skeletons were discovered in it, mostly laid upon burned logs, surrounded with pots filled with partially burned bones. A great variety of bronze decorations and glazed clay pearls were strewn round the skeletons. The knives, daggers, and arrow-points are of slate, bronze, and iron, the two last being very rough imitations of stone implements. On one of the funeral flags the image of a man, without moustaches or beard, dressed in a costume and helmet recalling those of the Circassians, was discovered. The exact period of these funeral mounds is not known.

**Elastic Systems.**—In the article ELASTICITY (*Ency. Brit.* vol. vii.) there is an outline of the general mathematical theory of Elasticity, and an account of the results obtained by applying it to the solution of the very important problem of the torsion of prisms. The present article is meant to supplement the former one by giving an account of some of the results that have been arrived at in the application of the theory to other problems.

1. *Flexure of a Beam.*—The simple theory of the bending of a beam by applied couples has been explained in the original article, §§ 57–62. If M is the couple, the central line of the beam is bent into a circle of radius EI/M, where E is the Young's modulus of the material, and I is the moment of inertia of the cross-section about the axis through its centroid at right angles to the plane of flexure. This plane is supposed to contain one principal axis of inertia of each cross-section,[1] and the locus of the perpendicular principal axes after flexure is a surface cutting the plane of flexure at right angles and known as the "neutral surface"; the traces of this surface are dotted in Fig. 1. The quantity EI is known as the "flexural rigidity." The applied couple M is balanced at any section by a couple arising from the stress exerted across the section. Supposing, to fix ideas, that the curve into which the central line is bent is concave downwards, the stress at any point above (below) the neutral surface is simple longitudinal tension (pressure) of amount per unit area equal to the product of M/I and the distance of the point from the neutral surface. The corresponding strain consists of extension (contraction) of the longitudinal fibres above (below) the neutral surface accompanied by lateral contraction (extension) of the perpendicular fibres, and the effect of the lateral strain is seen in the change of shape of the section producing the anticlastic curvature of the beam (cf. ELASTICITY, *Ency. Brit.* vol. vii. p. 809). The extension (contraction) of a longitudinal fibre distant $y$ above (below) the neutral surface is $My/EI$, and the lateral contraction (extension) is $\sigma My/EI$, where $\sigma$ is the "Poisson's ratio" of the material (a fraction nearly equal to $\frac{1}{4}$ for most hard solids). The displacements produced are—(1) a deflexion of the central line by which the centroid of each cross-

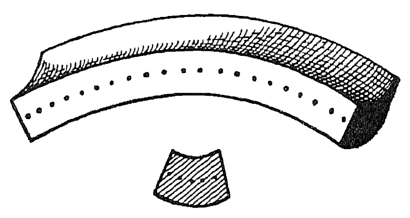

Fig. 1.

[1] When this is the case the beam is said to be bent in a "principal plane."

section comes to its proper place on the curved central line; (2) a rotation of the plane of each cross-section about the axis through its centroid at right angles to the plane of flexure, of such an amount as to place it at right angles to the curved central line; (3) a distortion of the shape of each cross-section in its own plane producing the anticlastic curvature.

2. That this theory requires modification when the load does not consist simply of terminal couples can be seen most easily by considering the problem of a beam loaded at one end with a weight W, and supported in a horizontal position at its other end. The forces that are exerted at any section $p$, to balance the weight W, must reduce statically to a vertical force W and a couple, and these forces arise from the action of the part A$p$ on the part B$p$ (see Fig. 2), *i.e.*, from the stresses across the section at $p$. The stress that suffices in the simpler problem gives rise to no vertical force, and it is clear that in addition to longitudinal tensions and pressures there must be shearing stresses at the cross-sections. The determination of the character of these, and of the corresponding strains and displacements, was effected by Saint-Venant and Clebsch for a number of forms of sections by means of an analysis of the same kind as that employed in the solution of the torsion problem.

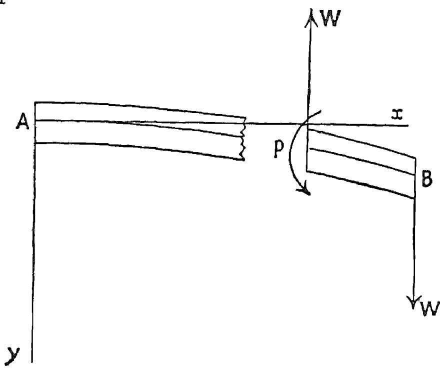


Fig. 2.

3. Let $l$ be the length of the beam, $x$ the distance of the section $p$ from the fixed end A, $y$ the distance of any point below the horizontal plane through the centroid of the section at A, then the bending moment at $p$ is $W(l-x)$, and the longitudinal tension P at any point on the cross-section is $-W(l-x)y/I$, and this is related to the bending moment exactly as in the simpler problem.

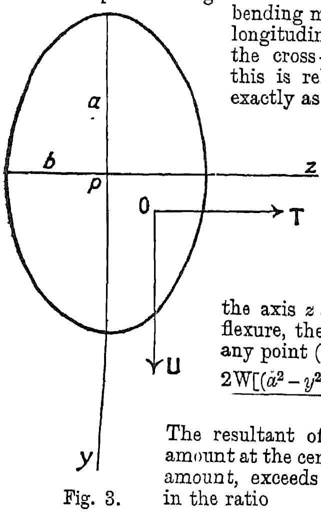


Fig. 3.

4. The expressions for the shearing stresses depend on the shape of the cross-section. Taking the beam to be of isotropic material and the cross-section to be an ellipse of semiaxes $a$ and $b$ (Fig. 3), the $a$ axis being vertical in the unstrained state, and drawing the axis $z$ at right angles to the plane of flexure, the vertical shearing stress U at any point $(y, z)$ on any cross-section is

$$\frac{2W[(a^2-y^2)\{2a^2(1+\sigma)+b^2\}-z^2a^2(1-2\sigma)]}{\pi a^3 b(1+\sigma)(3a^2+b^2)}.$$

The resultant of these stresses is W, but the amount at the centroid, which is the maximum amount, exceeds the average amount, $W/\pi ab$, in the ratio

$$\{4a^2(1+\sigma)+2b^2\}/(3a^2+b^2)(1+\sigma).$$

Taking $\sigma=\frac{1}{4}$, this ratio is $\frac{7}{5}$ for a circle, nearly $\frac{4}{3}$ for a flat elliptic bar with the longest diameter vertical, nearly $\frac{8}{5}$ for a flat elliptic bar with the longest diameter horizontal.

In the same problem the horizontal shearing stress T at any point on any cross-section is of amount

$$-\frac{4Wyz\{a^2(1+\sigma)+b^2\sigma\}}{\pi a^3 b(1+\sigma)(3a^2+b^2)}.$$

The resultant of these stresses vanishes; but, taking as before $\sigma=\frac{1}{4}$, and putting for the three cases above $a=b$, $a=10b$, $b=10a$, the ratio of the maximum of this stress to the average vertical shearing stress has the values $\frac{3}{5}$, nearly $\frac{1}{15}$, and nearly 4. Thus the stress T is of considerable importance when the beam is a plank.

As another example we may consider a circular tube of external radius $r_0$ and internal radius $r_1$. We find

$$\left.\begin{aligned}
P &= -\frac{4W}{\pi(r_0^4-r_1^4)}(l-x)y,\\
U &= \frac{W}{2(1+\sigma)\pi(r_0^4-r_1^4)}\Big[(3+2\sigma)\Big\{r_0^2+r_1^2-y^2\\
&\qquad -\frac{r_0^2 r_1^2}{(y^2+z^2)^2}(y^2-z^2)\Big\}-(1-2\sigma)z^2\Big]\\
T &= -\frac{W}{(1+\sigma)\pi(r_0^4-r_1^4)}\Big\{1+2\sigma+(3+2\sigma)\frac{r_0^2 r_1^2}{(y^2+z^2)^2}\Big\}yz;
\end{aligned}\right\}$$

and for a tube of radius $r$ and small thickness $t$ the value of P and the maximum values of U and T reduce approximately to

$$P = -W(l-x)y/\pi r^3 t$$
$$U_{max} = W/\pi rt,\quad T_{max} = W/2\pi rt.$$

The greatest value of U is in this case approximately twice its average value, but it is possible that these results for the bending of very thin tubes may be seriously at fault if the tube is not plugged, and if the load is not applied in the manner contemplated in the theory (cf. § 9). In such cases the extensions and contractions of the longitudinal fibres may be practically confined to a small part of the material near the ends of the tube, while the rest of the tube is deformed without stretching.

5. The shearing stresses U, T on the cross-sections are necessarily accompanied by shearing stresses on the longitudinal sections, and on each such section the shearing stress is parallel to the central line; on a vertical section $z=$ const. its amount at any point is T, and on a horizontal section $y=$ const. its amount at any point is U.

The internal stress at any point is completely determined by the components P, U, T, but these are not *principal stresses*. Clebsch has given an elegant geometrical construction for determining the principal stresses at any point when the values of P, U, T are known.

From the point O (Fig. 4) draw lines OP, OU, OT, to represent the stresses P, U, T at O, on the cross-section through O, in magnitude, direction and sense, and compound U and T into a resultant represented by OE; the plane EOP is a principal plane of stress at O, and the principal stress at right angles to this plane vanishes. Take M the middle point of OP, and with centre M and radius ME describe a circle cutting the line OP in A and B; then OA and OB represent the magnitudes of the two remaining principal stresses. On AB describe a rectangle ABDC so that DC passes through E; then OC is the direction of the principal stress represented in magnitude by OA, and OD is the direction of the principal stress represented in magnitude by OB.

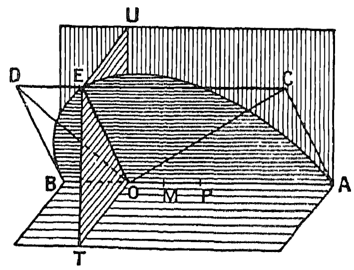


Fig. 4.

6. As regards the strain in the beam, the longitudinal and lateral extensions and contractions depend on the bending moment in the same way as in the simpler problem; but, the bending moment being variable, the anticlastic curvature produced is also variable. In addition to these extensions and contractions there are shearing strains corresponding to the shearing stresses T, U. The shearing strain corresponding to T consists of a relative sliding parallel to the central line of different longitudinal linear elements combined with a relative sliding in a transverse horizontal direction of elements of different cross-sections; the latter of these is concerned in the production of those displacements by which the variable anticlastic curvature is brought about; to see the effect of the former we may most suitably consider for the case of an elliptic cross-section the distortion of the shape of a rectangular portion

of a plane of the material which in the natural state was horizontal; all the boundaries of such a portion become parabolas of small curvature, which is variable along the length of the beam, and the particular effect under consideration is the change of the transverse horizontal linear elements from straight lines such as HK to parabolas such as H′K′ (Fig. 5); the lines HL and KM are parallel to the central line, and the figure is drawn for a plane above the neutral plane. When the cross-section is not an ellipse the character of the strain is the same, but the curves are only approximately parabolic.

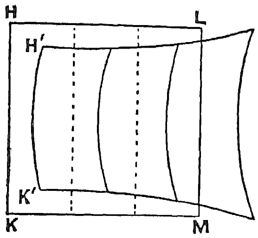

Fig. 5.

The shearing strain corresponding to U is a distortion which has the effect that the straight vertical filaments become curved lines which cut the longitudinal filaments obliquely, and thus the cross-sections do not remain plane, but become curved surfaces, and the tangent plane to any one of these surfaces at the centroid cuts the central line obliquely (Fig. 6). The angle between these tangent planes and the central line is the same at all points of the line; and, denoting it by $\frac{1}{2}\pi + s_0$, the value of $s_0$ is expressible as

$$\frac{\text{shearing stress at centroid}}{\text{rigidity of material}},$$

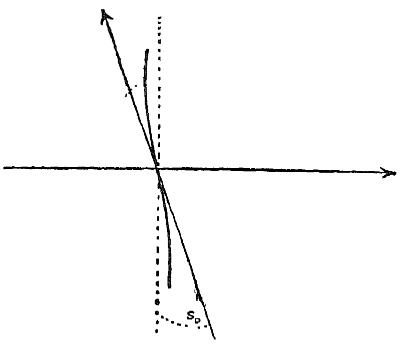

Fig. 6.

and it thus depends on the shape of the cross-section; for the elliptic section of § 4 its value is

$$\frac{4W}{E\pi ab}\,\frac{2a^2(1+\sigma)+b^2}{3a^2+b^2};$$

for a circle with $\sigma=\frac{1}{4}$, this becomes $7W/2E\pi a^2$. The vertical filament through the centroid of any cross-section becomes a cubical parabola, as shown in Fig. 6, and the contour lines of the curved surface into which any cross-section is distorted are shown in Fig. 7 for a circular section.

7. The deflexion of the beam is determined from the equation

curvature of central line = bending moment ÷ flexural rigidity,

and the special conditions at the supported end; there is no alteration of this statement on account of the shears. As regards the special condition at an end which is *encastrée*, or built-in, Saint-Venant proposed to assume that the central tangent plane of the cross-section at the end is vertical; with this assumption the tangent to the central line at the end is inclined downwards and makes an angle $s_0$ with the horizontal (see Fig. 8); it is, however, improbable that this condition is exactly realized in practice. In the application of the theory to the experimental determination of Young's modulus, the small angle which the central line at the support makes with the horizontal is an unknown quantity, to be eliminated by observation of the deflexion at two or more points.

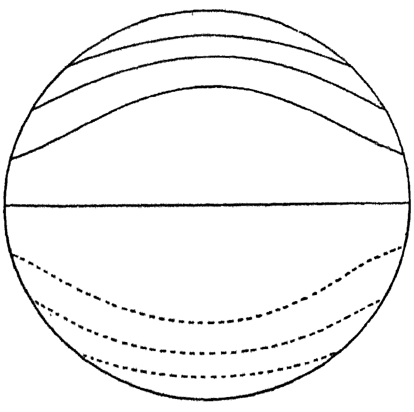
Fig. 7.

8. We may suppose the displacement in a bent beam to be produced by the following operations: (1) the central line is deflected into its curved form, (2) the cross-sections are rotated about axes through their centroids at right angles to the plane of flexure so as to make angles equal to $\frac{1}{2}\pi + s_0$ with the central line, (3) each cross-section is distorted in its own plane in such a way that the appropriate variable anticlastic curvature is produced, (4) the cross-sections are further distorted into curved surfaces. The contour lines of Fig. 7 show the disturbance from the central tangent plane, not from the original vertical plane.

9. *Practical Application of Saint-Venant's Theory.*—The theory above described is exact provided the forces applied to the loaded end, which have W for resultant, are distributed over the terminal section in a particular way, not likely to be realized in practice; and the application to practical problems depends on a principle due to Saint-Venant, to the effect that, except for comparatively small portions of the beam near to the loaded and fixed ends, the resultant only is effective, and its mode of distribution does not seriously affect the internal strain and stress. In fact, the actual stress is that due to forces with the required resultant distributed in the manner contemplated in the theory, superposed upon that due to a certain distribution of forces on each terminal section which, if applied to a rigid body, would keep it in equilibrium; according to Saint-Venant's principle, the stresses and strains due to such distributions of force are unimportant except near the ends. For this principle to be exactly applicable it is necessary that the length of the beam should be very great compared with any linear dimension of its cross-section; for the practical application it is sufficient that the length should be about ten times the greatest diameter.

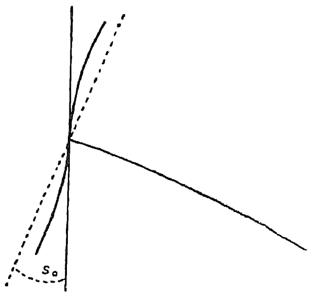

Fig. 8.

10. The theoretical determination of the stress in a bent beam under conditions as to load and support other than those considered in §§ 2–8 is attended by difficulties which have not yet been surmounted, but the equation for the deflexion

curvature of central line = bending moment ÷ flexural rigidity

is sufficiently exact whenever the length is a considerable multiple of the greatest diameter of the cross-section. This result is indicated by the theories of indefinitely thin wires developed by Kirchhoff and Boussinesq, and has been confirmed by special researches made by Pochhammer and Pearson. The equation for the deflexion above written is the basis of the treatment of continuous beams resting on three or more supports and carrying distributed loads. The calculation of the bending moment can be replaced by a method of graphical construction, due to Mohr, and depending on the two following theorems:—

(I.) The curve of the central line of each span of a

beam, when the bending moment M is given,[1] is identical with the catenary or funicular curve passing through the ends of the span under a (fictitious) load per unit length of the span equal to M/EI, the horizontal tension in the funicular being unity.

(II.) The directions of the tangents to this funicular curve at the ends of the span are the same for all statically equivalent systems of (fictitious) load.

When M is known, the magnitude of the resultant shearing stress at any section is $dM/dx$, where $x$ is measured along the beam.

11. Let $l$ be the length of a span of a loaded beam (Fig. 9), $M_1$ and $M_2$ the bending moments at the ends, M the bending moment at a section distant $x$ from the end ($M_1$), M′ the bending moment at

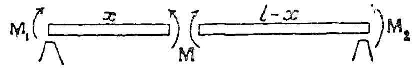


Fig. 9.

the same section when the same span with the same load is simply supported; then M is given by the formula

$$M = M' + M_1\frac{l-x}{l} + M_2\frac{x}{l},$$

and thus a fictitious load statically equivalent to M/EI can be easily found when M′ has been found. If we draw a curve (Fig. 10) to pass through the ends of the span, so that its ordinate represents the value of M′/EI, the corresponding fictitious loads are statically equivalent to a single load, of amount represented by the area of the curve, placed at the point of the span vertically above the centre of gravity of this area. If PN is the ordinate of this curve, and if at the ends of the span we erect ordinates in the proper sense to represent $M_1$/EI and $M_2$/EI, the bending moment at any point is represented by the length PQ.[2] For a uniformly distributed load the curve of M′ is a parabola $M' = \frac{1}{2}wx(l-x)$, where $w$ is the load per unit of length; and the statically equivalent fictitious load is $\frac{1}{12}wl^3$/EI placed at the middle point G of the span; also the loads statically equivalent to the fictitious loads $M_1(l-x)/l$EI and $M_2x/l$EI are $\frac{1}{3}M_1l$/EI and $\frac{1}{3}M_2l$/EI placed at the points $g$, $g'$ of trisection of the span. The funicular polygon for

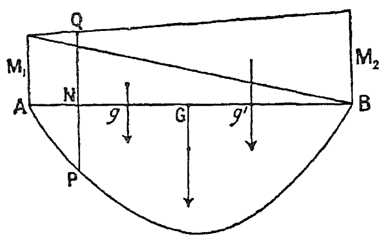


Fig. 10.

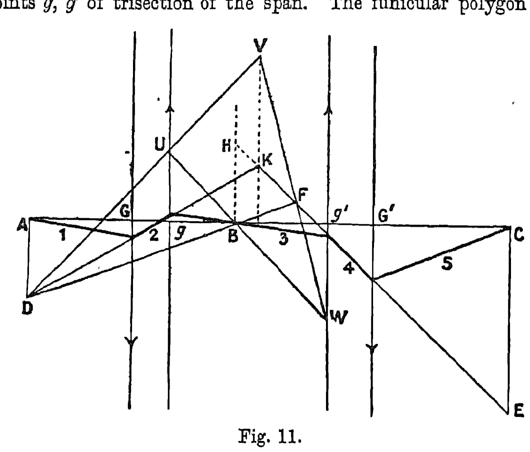


Fig. 11.

the fictitious loads can thus be drawn, and the direction of the central line at the supports is determined when the bending moments at the supports are known.

[1] The sign of M is shown by the arrow-heads in Fig. 9, for which, with $y$ downwards,

$$EI\frac{d^2y}{dx^2} + M = 0.$$

[2] The figure is drawn for a case where the bending moment has the same sign throughout.

12. When there is more than one span the funiculars in question may be drawn for each of the spans, and, if the bending moments at the ends of the extreme spans are known, the intermediate ones can be determined. This determination depends on two considerations: (1) the fictitious loads corresponding to the bending moment at any support are proportional to the lengths of the spans which abut on that support; (2) the sides of two funiculars that end at any support coincide in direction. Fig. 11 illustrates the method for the case of a uniform beam on three supports A, B, C, the ends A and C being freely supported. There will be an unknown bending moment $M_0$ at B, and the system[3] of fictitious loads is $\frac{1}{12}w\mathrm{AB}^3$/EI at G the middle point of AB, $\frac{1}{12}w\mathrm{BC}^3$/EI at G′ the middle point of BC, $-\frac{1}{3}M_0\mathrm{AB}$/EI at $g$ and $-\frac{1}{3}M_0\mathrm{BC}$/EI at $g'$, where $g$ and $g'$ are the points of trisection nearer to B of the spans AB, BC. The centre of gravity of the two latter is a fixed point independent of $M_0$, and the line VK of the figure is the vertical through this point. We draw AD and CE to represent the loads at G and G′ in magnitude; then D and E are fixed points. We construct any triangle UVW whose sides UV, UW pass through D, B, and whose vertices lie on the verticals $g$U, VK, $g'$W; the point F where VW meets DB is a fixed point, and the lines EF, DK are the two sides (2, 4) of the required funiculars which do not pass through A, B, or C. The remaining sides (1, 3, 5) can then be drawn, and the side 3 necessarily passes through B; for the triangle UVW and the triangle whose sides are 2, 3, 4 are in perspective.

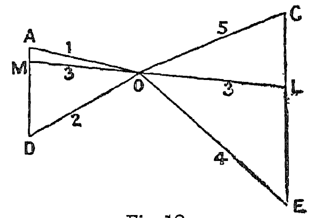


Fig. 12.

The bending moment $M_0$ is represented in the figure by the vertical line BH where H is on the continuation of the side 4, the scale being given by

$$\frac{\mathrm{BH}}{\mathrm{CE}} = \frac{\frac{1}{2}M_0\mathrm{BC}}{\frac{1}{12}w\mathrm{BC}^3};$$

this appears from the diagrams of forces, Fig. 12, in which the oblique lines are marked to correspond to the sides of the funiculars to which they are parallel.

In the application of the method to more complicated cases there are two systems of fixed points corresponding to F, by means of which the sides of the funiculars are drawn.

13. *Finite Bending of Thin Rod.*—The equation

curvature = bending moment ÷ flexural rigidity

may also be applied to the problem of the flexure in a principal plane of a very thin rod or wire, for which the curvature need not be small. When the forces that produce the flexure are applied at the ends only, the curve into which the central line is bent is one of a definite family of curves, to which the name *elastica* has been given, and there is a division of the family into two species according as the external forces are applied directly to the ends or are applied to rigid arms attached to the ends; the curves of the former species are characterized by the presence of inflexions at all the points at which they cut the line of action of the applied forces.

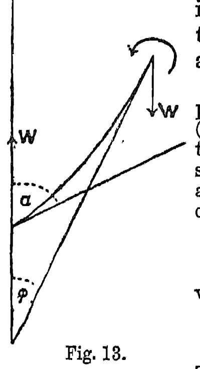


Fig. 13.

Selecting this case for consideration, the problem of determining the form of the curve (cf. Fig. 13) is mathematically identical with the problem of determining the motion of a simple circular pendulum oscillating through a finite angle, as is seen by comparing the differential equation of the curve

$$EI\frac{d^2\phi}{ds^2} + W\sin\phi = 0$$

with the equation of motion of the pendulum

$$l\frac{d^2\phi}{dt^2} + g\sin\phi = 0.$$

The length L of th curve between two inflexions corresponds to the time of oscillation of the pendulum from rest to rest, and we thus have

$$L\sqrt{(W/EI)} = 2K,$$

where K is the real quarter period of elliptic functions of modulus

[3] $M_0$ is taken to have, as it obviously has, the opposite sense to that shown in Fig. 9.

$\sin\frac{1}{2}\alpha$, and $\alpha$ is the angle at which the curve cuts the line of action of the applied forces. Unless the length of the rod exceeds $\pi\sqrt{(EI/W)}$ it will not bend under the force, but when the length is great enough there may be more than two points of inflexion and more than one bay of the curve; for $n$ bays ($n+1$ inflexions) the length must exceed $n\pi\sqrt{(EI/W)}$. Some of the forms of the curve are shown in Fig. 14.

For the form $d$, in which two bays make a figure of eight, we have

$$L\sqrt{(W/EI)}=4{\cdot}6, \ \alpha=130^\circ$$

approximately (see Hess, *Math. Ann.* xxiii., 1884). It is noteworthy that whenever the length and force admit of a sinuous form, such as $a$ or $b$, with more than two inflexions, there is also possible a crossed form, like $c$, with two inflexions only; it is probable that the latter form is stable and the former unstable.

14. The particular case of the above for which $\alpha$ is very small is a curve of sines of small amplitude, and the result in this case has been applied to the problem of the buckling of struts under thrust. When the strut, of length L′, is maintained upright at its lower end, and loaded at its upper end, it is simply compressed, unless

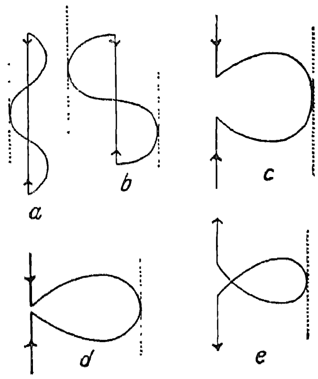

Fig. 14

$$L'^2W>\tfrac{1}{4}\pi^2EI;$$

for the lower end corresponds to a point at which the tangent is vertical on an elastica for which the line of inflexions is also vertical, and thus the length must be half of one bay (Fig. 15, $a$). For greater lengths or loads the strut tends to bend or buckle under the load; for a very slight excess of $L'^2W$ above $\frac{1}{4}\pi^2EI$, the theory on which the above discussion is founded, is not quite adequate, as it assumes the central line of the strut to be free from extension or contraction, and it is probable that bending without extension does not take place when the length or the force exceeds the critical value but slightly. It should be noted also that the formula has no application to short struts, as the theory from which it is derived is founded on the assumption that the length is great compared with the diameter (cf. § 10).

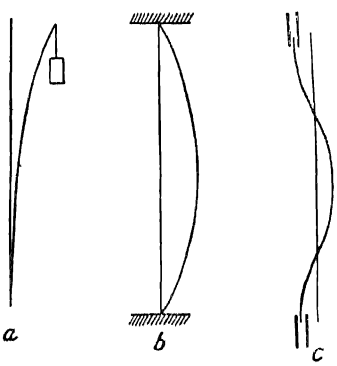

Fig. 15.

The condition of buckling, corresponding to the above, for a long strut, of length L′, when both ends are free to turn is $L'^2W>\pi^2EI$; for the central line forms a complete bay (Fig. 15, $b$); if both ends are maintained in the same vertical line, the condition is $L'^2W>4\pi^2EI$, the central line forming a complete bay and two half bays (Fig. 15, $c$).

15. In our consideration of flexure it has so far been supposed that the bending takes place in a principal plane. We may remove this restriction by resolving the forces that tend to produce bending into systems of forces acting in the two principal planes. To each plane there corresponds a particular flexural rigidity, and the systems of forces in the two planes give rise to independent systems of stress, strain, and displacement, which must be superposed in order to obtain the actual state. Applying this process to the problem of §§ 2–8, and supposing that one principal axis of a cross-section at its centroid makes an angle $\theta$ with the vertical, then for any shape of section the neutral surface or locus of unextended fibres cuts the section in a line DD′, which is conjugate to the vertical diameter CP with respect to any ellipse of inertia of the section. The central line is bent into a plane curve which is not in a vertical plane, but is in a plane through the line CY which is perpendicular to DD′ (Fig. 16).

16. *Bending and Twisting of Thin Rods.*—When a very thin rod or wire is bent and twisted by applied forces, the forces on any part of it limited by a normal section are balanced by the stresses across the section, and these stresses are statically equivalent to certain forces and couples at the centroid of the section; we shall call them the *stress-resultants* and the *stress-couples*. The stress-couples consist of two flexural couples in the two principal

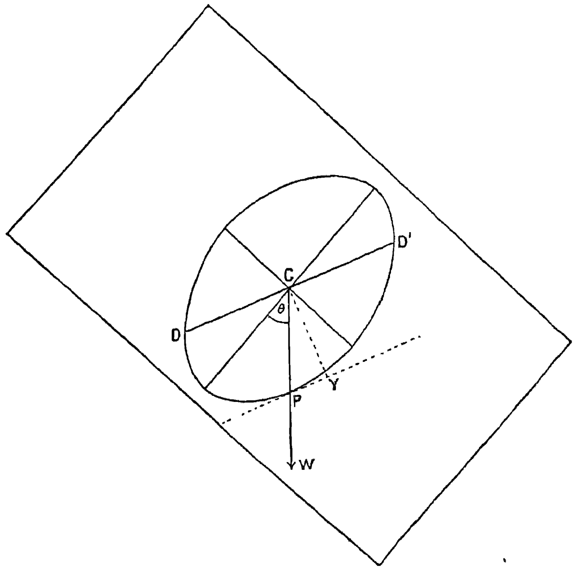

Fig. 16.

planes, and the torsional couple about the tangent to the central line. The torsional couple is the product of the torsional rigidity and the twist produced; the torsional rigidity is exactly the same as for a straight rod of the same material and section twisted without bending, as in Saint-Venant's torsion problem (ELASTICITY, *Ency. Brit.* vol. vii. p. 812). The twist $\tau$ is connected with the deformation of the wire in this way: if we suppose a very small ring which fits the cross-section of the wire to be provided with a pointer in the direction of one principal axis, and to move along the wire with velocity $v$, the pointer will rotate about the central line with angular velocity $\tau v$. The amount of the flexural couple for either principal plane at any section is the product of the flexural rigidity for that plane, and the resolved part in that plane of the curvature of the central line at the centroid of the section; the resolved part of the curvature along the normal to any plane is obtained by treating the curvature as a vector directed along the normal to the osculating plane and projecting this vector. The flexural couples reduce to a single couple in the osculating plane proportional to the curvature when the two flexural rigidities are equal, and in this case only.

The stress-resultants across any section are shearing stresses in the two principal planes, and a tension or thrust along the central line; when the stress-couples and the applied forces are known these stress-resultants are determinate. The existence in particular of the resultant tension or thrust parallel to the central line does not imply sensible extension or contraction of the central filament, and the tension per unit area of the cross-section to which

it would be equivalent is small compared with the tensions and pressures in longitudinal filaments not passing through the centroid of the section; the moments of the latter tensions and pressures constitute the flexural couples.

17. We consider, in particular, the case of a naturally straight spring or rod of circular section, radius $c$, and of homogeneous isotropic material. The torsional rigidity is $\frac{1}{4}E\pi c^4/(1+\sigma)$; and the flexural rigidity, which is the same for all planes through the central line, is $\frac{1}{4}E\pi c^4$; we shall denote these by C and A respectively. The rod may be held bent by suitable forces into a curve of double curvature with an amount of twist $\tau$, and then the torsional couple is $C\tau$, and the flexural couple in the osculating plane is $A/\rho$, where $\rho$ is the radius of circular curvature. Among the curves in which the rod can be held by forces and couples applied at its ends only, one is a circular helix; and then the applied forces and couples are equivalent to a wrench about the axis of the helix.

Let $\alpha$ be the angle and $r$ the radius of the helix, so that $\rho$ is $r\sec^2\alpha$; and let R and K be the force and couple of the wrench (Fig. 17).

Then the couple formed by R and an equal and opposite force at any section and the couple K are equivalent to the torsional and flexural couples at the section, and this gives the equations for R and K

$$R=A\frac{\sin\alpha\cos^2\alpha}{r^2}-C\tau\frac{\cos\alpha}{r},$$

$$K=A\frac{\cos^3\alpha}{r}+C\tau\sin\alpha.$$

The thrust across any section is $R\sin\alpha$ parallel to the tangent to the helix, and the shearing stress-resultant is $R\cos\alpha$ at right angles to the osculating plane.

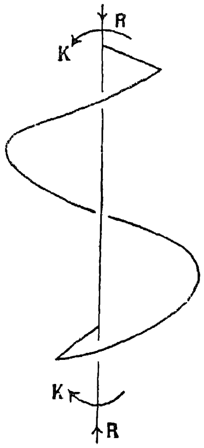


Fig. 17.

When the twist is such that, if the rod were simply unbent, it would also be untwisted, $\tau$ is $\sin\alpha\cos\alpha/r$, and then, restoring the values of A and C, we have

$$R=\frac{E\pi c^4}{4r^2}\frac{\sigma}{1+\sigma}\sin\alpha\cos^2\alpha,$$

$$K=\frac{E\pi c^4}{4r}\frac{1+\sigma\cos^2\alpha}{1+\sigma}\cos\alpha.$$

18. The theory of spiral springs affords an application of these results. The stress-couples called into play when a naturally helical spring $(\alpha, r)$ is held in the form of a helix $(\alpha', r')$, are equal to the differences between those called into play when a straight rod of the same material and section is held in the first form, and those called into play when it is held in the second form.

Thus the torsional couple is

$$C\left(\frac{\sin\alpha'\cos\alpha'}{r'}-\frac{\sin\alpha\cos\alpha}{r}\right),$$

and the flexural couple is

$$A\left(\frac{\cos^2\alpha'}{r'}-\frac{\cos^2\alpha}{r}\right).$$

The wrench (R, K) along the axis by which the spring can be held in the form $(\alpha', r')$ is given by the equations

$$R=A\frac{\sin\alpha'}{r'}\left(\frac{\cos^2\alpha'}{r'}-\frac{\cos^2\alpha}{r}\right)-C\frac{\cos\alpha'}{r'}\left(\frac{\sin\alpha'\cos\alpha'}{r'}-\frac{\sin\alpha\cos\alpha}{r}\right),$$

$$K=A\cos\alpha'\left(\frac{\cos^2\alpha'}{r'}-\frac{\cos^2\alpha}{r}\right)+C\sin\alpha'\left(\frac{\sin\alpha'\cos\alpha'}{r'}-\frac{\sin\alpha\cos\alpha}{r}\right).$$

When the spring is slightly extended by an axial force $F, =-R$, and there is no couple, so that K vanishes, and $\alpha'$, $r'$, differ very little from $\alpha$, $r$, it follows from these equations that the axial elongation, $\delta x$, is connected with the axial length $x$ and the force F by the equation

$$F=\frac{E\pi c^4}{4r^2}\frac{\sin\alpha}{1+\sigma\cos^2\alpha}\frac{\delta x}{x},$$

and that the loaded end is rotated about the axis of the helix through a small angle

$$\frac{4\sigma Fxr\cos\alpha}{E\pi c^4},$$

the sense of the rotation being such that the spring becomes more tightly coiled.

19. A horizontal pointer attached to a vertical spiral spring would be made to rotate by loading the spring, and the angle through which it turns might be used to measure the load, at any rate, when the load is not too great; but a much more sensitive contrivance is the twisted strip devised by Ayrton and Perry. A very thin, narrow rectangular strip of metal is given a permanent twist about its longitudinal middle line, and a pointer is attached to it at right angles to this line. When the strip is subjected to longitudinal tension the pointer rotates through a considerable angle. Bryan (*Phil. Mag.*, December 1890) has succeeded in constructing a theory of the action of the strip, according to which it is regarded as a strip of *plating* in the form of a right helicoid, which, after extension of the middle line, becomes a portion of a slightly different helicoid; on account of the thinness of the strip, the change of curvature of the surface is considerable, even when the extension is small, and the pointer turns with the generators of the helicoid.

Taking $b$ for the breadth and $t$ for the thickness of the strip, and $\tau$ for the permanent twist, the approximate formula for the angle $\theta$ through which the strip is untwisted on the application of a load W was found to be

$$\theta=\frac{Wb\tau(1+\sigma)}{2Et^3\left(1+\frac{(1+\sigma)}{30}\frac{b^4\tau^2}{t^2}\right)}.$$

The quantity $b\tau$ which occurs in the formula is the total twist in a length of the strip equal to its breadth, and this will generally be very small; if it is small of the same order as $t/b$, or a higher order, the formula becomes $\frac{1}{2}Wb\tau(1+\sigma)/Et^3$, with sufficient approximation, and this result appears to be in agreement with observations of the behaviour of such strips.

20. *General Theorems.*—Passing now from these questions of flexure and torsion, we consider some results that can be deduced from the general equations of equilibrium of an elastic solid body.

The form of the general expression for the potential energy (ELASTICITY, *Ency. Brit.* vol. vii. p. 823) stored up in the strained body leads, by a general property of quadratic functions, to a reciprocal theorem relating to the effects produced in the body by two different systems of forces, viz.: The whole work done by the forces of the first system acting over the displacements produced by the forces of the second system is equal to the whole work done by the forces of the second system acting over the displacements produced by the forces of the first system. By a suitable choice of the second system of forces the average values of the component stresses and strains produced by given forces, considered as constituting the first system, can be obtained, even when the distribution of the stress and strain cannot be determined.

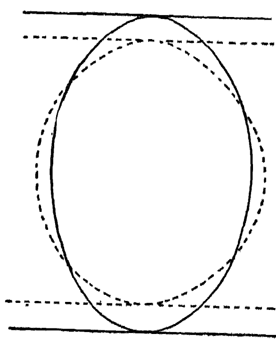

Fig. 18.

Taking for example the problem presented by an isotropic body of any form[1] pressed between two parallel planes distant $l$ apart (Fig. 18), and denoting the resultant pressure by $p$, the diminution of volume $-\delta v$ is given by the equation

$$-\delta v=lp/3k,$$

where $k$ is the modulus of compression, equal to $\frac{1}{3}E/(1-2\sigma)$. Again, taking the problem of the changes produced in a heavy body by different ways of supporting it;

[1] The line joining the points of contact must be normal to the planes.

when the body is suspended from one or more points in a horizontal plane its volume is increased by

$$\delta v = \mathrm{W}h/3k,$$

where W is the weight of the body, and $h$ the depth of its centre of gravity below the plane; when the body is supported by upward vertical pressures at one or more points in a horizontal plane the volume is diminished by

$$-\delta v = \mathrm{W}h'/3k,$$

where $h'$ is the height of the centre of gravity above the plane; if the body is a cylinder, of length $l$ and section A, standing with its base on a smooth horizontal plane, its length is shortened by an amount

$$-\delta l = \mathrm{W}l/2\mathrm{EA};$$

if the same cylinder lies on the plane with its generators horizontal, its length is increased by an amount

$$\delta l = \sigma \mathrm{W}h'/\mathrm{EA}.$$

21. In recent years important results have been found by considering the effects produced in an elastic solid by forces applied at isolated points.

Taking the case of a single force F applied at a point in the interior, it can be shown that the stress at a distance $r$ from the point consists of

(1) a radial pressure of amount

$$\frac{2-\sigma}{1-\sigma}\frac{\mathrm{F}}{4\pi}\frac{\cos\theta}{r^2},$$

(2) tension in all directions at right angles to the radius of amount

$$\frac{1-2\sigma}{2(1-\sigma)}\frac{\mathrm{F}}{4\pi}\frac{\cos\theta}{r^2},$$

(3) shearing stress acting along the radius $dr$ on the surface of the cone $\theta=$const. and acting along the meridian $d\theta$ on the surface of the sphere $r=$const. of amount

$$\frac{1-2\sigma}{2(1-\sigma)}\frac{\mathrm{F}}{4\pi}\frac{\sin\theta}{r^2},$$

where $\theta$ is the angle between the radius vector $r$ and the line of action of F. The line marked T in Fig. 19 shows the direction of this shearing stress on the spherical surface.

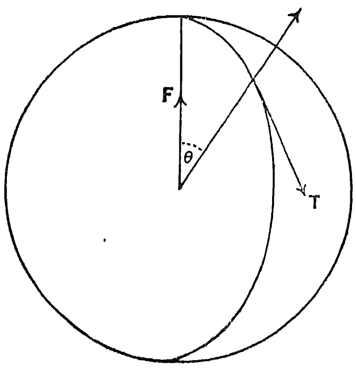


Fig. 19.

Thus the principal stresses are in and perpendicular to the meridian plane, and the direction of one of those in the meridian plane is inclined to the radius vector $r$ at an angle

$$\tfrac{1}{2}\tan^{-1}\left(\frac{2-4\sigma}{5-4\sigma}\tan\theta\right).$$

The corresponding displacement at any point is compounded of a radial displacement of amount

$$\frac{1+\sigma}{2(1-\sigma)}\frac{\mathrm{F}}{4\pi\mathrm{E}}\frac{\cos\theta}{r}$$

and a displacement parallel to the line of action of F of amount

$$\frac{(3-4\sigma)(1+\sigma)}{2(1-\sigma)}\frac{\mathrm{F}}{4\pi\mathrm{E}}\frac{1}{r}.$$

The effects of forces applied at different points and in different directions can be obtained by summation, and the effect of continuously distributed forces can be obtained by integration.

22. The stress system considered in the last section is equivalent, on the plane through the origin at right angles to the line of action of F, to a pressure of magnitude $\frac{1}{2}$F at the origin and a radial shearing stress of amount $\frac{1-2\sigma}{2(1-\sigma)}\frac{\mathrm{F}}{4\pi r^2}$, and, by the application of this system of tractions to a solid bounded by a plane, the displacement just described would be produced. There is also another (Fig. 20) stress system for a solid so bounded which is equivalent, on the same plane, to a pressure at the origin, and a radial shearing stress proportional to $1/r^2$, but these are in the ratio $2\pi : r^{-2}$, instead of being in the ratio $4\pi(1-\sigma) : (1-2\sigma)r^{-2}$.

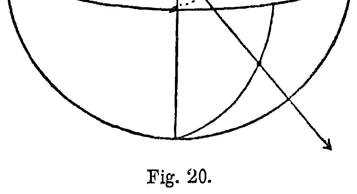


Fig. 20.

The second stress system consists of

(1) radial pressure $\mathrm{F}'r^{-2}$,

(2) tension in the meridian plane across the radius vector of amount

$$\mathrm{F}'r^{-2}\cos\theta/(1+\cos\theta),$$

(3) tension across the meridian plane of amount

$$\mathrm{F}'r^{-2}/(1+\cos\theta),$$

(4) shearing stress as in the last section of amount

$$\mathrm{F}'r^{-2}\sin\theta/(1+\cos\theta),$$

and the stress across the plane boundary consists of a pressure of magnitude $2\pi\mathrm{F}'$ and a radial shearing stress of amount $\mathrm{F}'r^{-2}$. If then we superpose the component stresses of the last section multiplied by $4(1-\sigma)\mathrm{W}/\mathrm{F}$, and the component stresses here written down multiplied by $-(1-2\sigma)\mathrm{W}/2\pi\mathrm{F}'$, the stress on the plane boundary will reduce to a single pressure W at the origin. We shall thus obtain the stress system at any point due to such a force applied at one point of the boundary.

In the stress system thus arrived at the stress across any plane parallel to the boundary is directed away from the place where W is supported, and its amount is $3\mathrm{W}\cos^2\theta/2\pi r^2$. The corresponding displacement consists of

(1) a horizontal displacement radially outwards from the vertical through the origin of amount

$$\frac{\mathrm{W}(1+\sigma)\sin\theta}{2\pi\mathrm{E}r}\left(\cos\theta-\frac{1-2\sigma}{1+\cos\theta}\right),$$

(2) a vertical displacement downwards of amount

$$\frac{\mathrm{W}(1+\sigma)}{2\pi\mathrm{E}r}\{2(1-\sigma)+\cos^2\theta\}.$$

The effects produced by a system of loads on a solid bounded by a plane can be deduced.

23. The results stated in the last section have been applied to give an account of the nature of the actions concerned in the impact of two solid bodies. The dissipation of energy involved in the impact is neglected, and the pressure between the bodies at any instant during the impact is equal to the rate of destruction of momentum of either along the normal to the plane of contact drawn towards the interior of the other. It has been shown that in general the bodies come into contact over a small area bounded by an ellipse, and remain in contact for a time which varies inversely as the fifth root of the initial relative velocity.

For equal spheres of the same material, with $\sigma=\frac{1}{4}$, impinging directly with relative velocity $v$, the patches that come into contact are circles of radius

$$\left(\frac{75\pi}{256}\right)^{\frac{1}{5}}\left(\frac{v}{\mathrm{V}}\right)^{\frac{2}{5}}r,$$

where $r$ is the radius of either, and V is the velocity of longitudinal waves in a thin bar of the material. The duration of the impact is approximately

$$(2{\cdot}9432)\left(\frac{375\pi^2}{128}\right)^{1/5}\frac{r}{v^{1/5}\mathrm{V}^{4/5}}.$$

For two steel spheres of the size of the earth impinging with a velocity of 10 mm. per second the duration of the impact would be about twenty-seven hours. The fact that the duration of impact is, for moderate velocities, a considerable multiple of the time taken by a wave of compression to travel through either of two impinging bodies has been ascertained experimentally,[1] and constitutes the reason for the adequacy of the statical theory here described.

24. *Spheres and Cylinders.*—Simple results can be found for spherical and cylindrical bodies strained by radial forces.

For a sphere of radius $a$, and of homogeneous isotropic material of density $\rho$, strained by the mutual gravitation of its parts, the stress at a distance $r$ from the centre consists of

(1) uniform hydrostatic pressure of amount $\frac{1}{10}g\rho a(3-\sigma)/(1-\sigma)$,

(2) radial tension of amount $\frac{1}{10}g\rho(r^2/a)(3-\sigma)/(1-\sigma)$,

[1] Cf. Auerbach in Winkelmann's *Handbuch der Physik*, i. 303. Breslau, 1891.

(3) uniform tension at right angles to the radius vector of amount

$$\tfrac{1}{10}g\rho(r^2/a)(1+3\sigma)/(1-\sigma),$$

where $g$ is the value of gravity at the surface. The corresponding strains consist of

(1) uniform contraction of all lines of the body of amount

$$\tfrac{1}{30}k^{-1}g\rho a(3-\sigma)/(1-\sigma),$$

(2) radial extension of amount $\tfrac{1}{10}k^{-1}g\rho(r^2/a)(1+\sigma)/(1-\sigma)$,

(3) extension in any direction at right angles to the radius vector of amount

$$\tfrac{1}{30}k^{-1}g\rho(r^2/a)(1+\sigma)/(1-\sigma),$$

where $k$ is the modulus of compression. The volume is diminished by the fraction $g\rho a/5k$ of itself. The parts of the radii vectores within the sphere $r=a\{(3-\sigma)/(3+3\sigma)\}^{1/2}$ are contracted, and the parts without this sphere are extended. The application of the above results to the state of the interior of the earth is restricted by the circumstance that, unless the modulus of compression is much greater than that of any known material, the stresses and strains expressed above would, in a sphere of the size of the earth, greatly exceed the elastic limits.

25. In a spherical shell of homogeneous isotropic material, of internal radius $r_1$ and external radius $r_0$, subjected to pressure $p_0$ on the outer surface, and $p_1$ on the inner surface, the stress at any point distant $r$ from the centre consists of

(1) uniform tension in all directions of amount $\dfrac{p_1r_1^3-p_0r_0^3}{r_0^3-r_1^3}$,

(2) radial pressure of amount $\dfrac{p_1-p_0}{r_0^3-r_1^3}\dfrac{r_0^3r_1^3}{r^3}$,

(3) tension in all directions at right angles to the radius vector of amount

$$\frac{1}{2}\frac{p_1-p_0}{r_0^3-r_1^3}\frac{r_0^3r_1^3}{r^3}.$$

The corresponding strains consist of

(1) uniform extension of all lines of the body of amount

$$\frac{1}{3k}\frac{p_1r_1^3-p_0r_0^3}{r_0^3-r_1^3},$$

(2) radial contraction of amount $\dfrac{1}{2\mu}\dfrac{p_1-p_0}{r_0^3-r_1^3}\dfrac{r_0^3r_1^3}{r^3}$,

(3) extension in all directions at right angles to the radius vector of amount

$$\frac{1}{4\mu}\frac{p_1-p_0}{r_0^3-r_1^3}\frac{r_0^3r_1^3}{r^3},$$

where $\mu$ is the modulus of rigidity of the material, $=\frac{1}{2}\mathrm{E}/(1+\sigma)$. The volume included between the two surfaces of the body is increased by the fraction $\dfrac{p_1r_1^3-p_0r_0^3}{k(r_0^3-r_1^3)}$ of itself, and the volume within the inner surface is increased by the fraction

$$\frac{3(p_1-p_0)}{4\mu}\frac{r_0^3}{r_0^3-r_1^3}+\frac{p_1r_1^3-p_0r_0^3}{k(r_0^3-r_1^3)}$$

of itself. For a shell subject only to internal pressure $p$ the greatest extension is the extension at right angles to the radius at the inner surface, and its amount is

$$\frac{pr_1^3}{r_0^3-r_1^3}\left(\frac{1}{3k}+\frac{1}{4\mu}\frac{r_0^3}{r_1^3}\right);$$

the greatest tension is the transverse tension at the inner surface, and its amount is $p(\frac{1}{2}r_0^3+r_1^3)/(r_0^3-r_1^3)$.

26. In the problem of a cylindrical shell under pressure a complication may arise from the effects of the ends; but when the ends are free from stress the solution is very simple. With notation similar to that in § 25 it can be shown that the stress at a distance $r$ from the axis consists of

(1) uniform tension in all directions at right angles to the axis of amount

$$\frac{p_1r_1^2-p_0r_0^2}{r_0^2-r_1^2},$$

(2) radial pressure of amount $\dfrac{p_1-p_0}{r_0^2-r_1^2}\dfrac{r_0^2r_1^2}{r^2}$,

(3) hoop tension numerically equal to this radial pressure.

The corresponding strains consist of

(1) uniform extension of all lines of the material at right angles to the axis of amount

$$\frac{1-\sigma}{\mathrm{E}}\frac{p_1r_1^2-p_0r_0^2}{r_0^2-r_1^2},$$

(2) radial contraction of amount

$$\frac{1+\sigma}{\mathrm{E}}\frac{p_1-p_0}{r_0^2-r_1^2}\frac{r_0^2r_1^2}{r^2},$$

(3) extension along the circular filaments numerically equal to this radial contraction,

(4) uniform contraction of the longitudinal filaments of amount

$$\frac{2\sigma}{\mathrm{E}}\frac{p_1r_1^2-p_0r_0^2}{r_0^2-r_1^2}.$$

For a shell subject only to internal pressure $p$ the greatest extension is the circumferential extension at the inner surface, and its amount is

$$\frac{p}{\mathrm{E}}\left(\frac{r_0^2+r_1^2}{r_0^2-r_1^2}+\sigma\right);$$

the greatest tension is the hoop tension at the inner surface, and its amount is $p(r_0^2+r_1^2)/(r_0^2-r_1^2)$.

27. The results just obtained have been applied to gun construction; we may consider that one cylinder is heated so as to slip over another upon which it shrinks by cooling, so that the two form a single body in a condition of initial stress.

We take P as the measure of the pressure between the two, and $p$ for the pressure within the inner cylinder by which the system is afterwards strained, and denote by $r'$ the radius of the common surface. To obtain the stress at any point we superpose the system consisting of radial pressure $p\dfrac{r_1^2}{r^2}\dfrac{r_0^2-r^2}{r_0^2-r_1^2}$ and hoop tension $p\dfrac{r_1^2}{r^2}\dfrac{r_0^2+r^2}{r_0^2-r_1^2}$ upon a system which, for the outer cylinder, consists of radial pressure $\mathrm{P}\dfrac{r'^2}{r^2}\dfrac{r_0^2-r^2}{r_0^2-r'^2}$ and hoop tension $\mathrm{P}\dfrac{r'^2}{r^2}\dfrac{r_0^2+r^2}{r_0^2-r'^2}$ and, for the inner cylinder consists of radial pressure $\mathrm{P}\dfrac{r'^2}{r^2}\dfrac{r^2-r_1^2}{r'^2-r_1^2}$ and hoop tension $-\mathrm{P}\dfrac{r'^2}{r^2}\dfrac{r^2+r_1^2}{r'^2-r_1^2}$. The hoop tension at the inner surface is less than it would be for a tube of equal thickness without initial stress in the ratio

$$1-\frac{\mathrm{P}}{p}\frac{2r'^2}{r_0^2+r_1^2}\frac{r_0^2-r_1^2}{r'^2-r_1^2}:1.$$

This shows how the strength of the tube is increased by the initial stress.

28. The problem of determining the distribution of stress and strain in a circular cylinder, rotating about its axis, has not yet been completely solved, but solutions have been obtained which are sufficiently exact for the two special cases of a thin disk and a long shaft.

Suppose that a circular disk of radius $a$ and thickness $2l$, and of density $\rho$, rotates about its axis with angular velocity $\omega$, and consider the following systems of superposed stresses at any point distant $r$ from the axis and $z$ from the middle plane:

(1) uniform tension in all directions at right angles to the axis of amount $\frac{1}{8}\omega^2\rho a^2(3+\sigma)$,

(2) radial pressure of amount $\frac{1}{8}\omega^2\rho r^2(3+\sigma)$,

(3) pressure along the circular filaments of amount $\frac{1}{8}\omega^2\rho r^2(1+3\sigma)$,

(4) uniform tension in all directions at right angles to the axis of amount $\frac{1}{6}\omega^2\rho(l^2-3z^2)\sigma(1+\sigma)/(1-\sigma)$.

The corresponding strains may be expressed as

(1) uniform extension of all filaments at right angles to the axis of amount

$$\frac{1-\sigma}{\mathrm{E}}\tfrac{1}{8}\omega^2\rho a^2(3+\sigma),$$

(2) radial contraction of amount

$$\frac{1-\sigma^2}{\mathrm{E}}\tfrac{3}{8}\omega^2\rho r^2,$$

(3) contraction along the circular filaments of amount

$$\frac{1-\sigma^2}{\mathrm{E}}\tfrac{1}{8}\omega^2\rho r^2,$$

(4) extension of all filaments at right angles to the axis of amount

$$\frac{1}{\mathrm{E}}\tfrac{1}{6}\omega^2\rho(l^2-3z^2)\sigma(1+\sigma),$$

(5) contraction of the filaments normal to the plane of the disk of amount

$$\frac{2\sigma}{\mathrm{E}}\tfrac{1}{8}\omega^2\rho a^2(3+\sigma)-\frac{\sigma}{\mathrm{E}}\tfrac{1}{2}\omega^2\rho r^2(1+\sigma)+\frac{2\sigma}{\mathrm{E}}\tfrac{1}{6}\omega^2\rho(l^2-3z^2)\sigma\frac{(1+\sigma)}{1-\sigma}.$$

The greatest extension is the circumferential extension near the centre, and its amount is

$$\frac{(3+\sigma)(1-\sigma)}{8\mathrm{E}}\omega^2\rho a^2+\frac{\sigma(1+\sigma)}{6\mathrm{E}}\omega^2\rho l^2.$$

The longitudinal contraction is required to make the plane faces

of the disk free from pressure, and the terms in $l$ and $z$ enable us to avoid shearing stress on any cylindrical surface. The system of stresses and strains thus expressed satisfies all the conditions, except that there is a small radial tension on the bounding surface of amount per unit area $\frac{1}{6}\omega^2\rho(l^2-3z^2)\sigma(1+\sigma)/(1-\sigma)$. The resultant of these stresses on any part of the edge of the disk vanishes, and the stress in question is very small in comparison with the other stresses involved when the disk is thin; we may conclude that for a thin disk the expressions given represent the actual condition at all points which are not very close to the edge (cf. § 9). The effect of the longitudinal contraction is that the plane faces become slightly concave (Fig. 21).

In problems of the kind just considered, where the stress consists simply of a radial tension P and a circumferential tension Q, which are functions of $r$ and $z$, the stress components, besides satisfying the equations of equilibrium, are also subject to two conditions of compatibility which can be expressed in the forms

$$(1+\sigma)\frac{\mathrm{P}-\mathrm{Q}}{r}=\frac{\partial \mathrm{Q}}{\partial r}-\sigma\frac{\partial \mathrm{P}}{\partial r},$$

$$r\frac{\partial^2}{\partial z^2}(\mathrm{Q}-\sigma\mathrm{P})=\sigma\frac{\partial}{\partial r}(\mathrm{P}+\mathrm{Q})$$

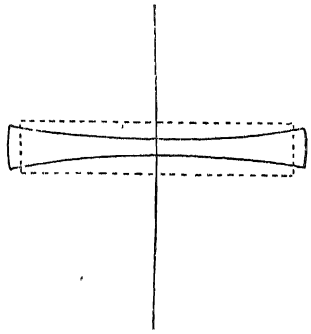

Fig. 21.

29. The corresponding solution for a disk with a circular axle-hole (radius $b$) will be obtained from that given in the last section by superposing the following system of additional stresses:

(1) radial tension of amount $\frac{1}{8}\omega^2\rho b^2(1-a^2/r^2)(3+\sigma)$,
(2) tension along the circular filaments of amount

$$\tfrac{1}{8}\omega^2\rho b^2(1+a^2/r^2)(3+\sigma);$$

and the corresponding additional strains are
(1) radial contraction of amount

$$\frac{3+\sigma}{8\mathrm{E}}\left\{(1+\sigma)\frac{a^2}{r^2}-(1-\sigma)\right\}\omega^2\rho b^2.$$

(2) extension along the circular filaments of amount

$$\frac{3+\sigma}{8\mathrm{E}}\left\{(1+\sigma)\frac{a^2}{r^2}+(1-\sigma)\right\}\omega^2\rho b^2,$$

(3) contraction of the filaments parallel to the axis of amount

$$\frac{\sigma(3+\sigma)}{4\mathrm{E}}\omega^2\rho b^2.$$

Again, the greatest extension is the circumferential extension at the inner surface, and, when the hole is very small, its amount is nearly double what it would be for a complete disk.

30. In the problem of the rotating shaft we have the following stress-system:
(1) radial tension of amount $\frac{1}{8}\omega^2\rho(a^2-r^2)(3-2\sigma)/(1-\sigma)$,
(2) circumferential tension of amount

$$\tfrac{1}{8}\omega^2\rho\{a^2(3-2\sigma)/(1-\sigma)-r^2(1+2\sigma)/(1-\sigma)\},$$

(3) longitudinal tension of amount $\frac{1}{4}\omega^2\rho(a^2-2r^2)\sigma/(1-\sigma)$.

The resultant longitudinal tension at any normal section vanishes, and the radial tension vanishes at the bounding surface; and thus the expressions here given may be taken to represent the actual condition at all points which are not very close to the ends of the shaft. The contraction of the longitudinal filaments is uniform and equal to $\frac{1}{2}\omega^2\rho a^2\sigma/\mathrm{E}$. The greatest extension in the rotating shaft is the circumferential extension close to the axis, and its amount is $\frac{1}{8}\omega^2\rho a^2(3-5\sigma)/\mathrm{E}(1-\sigma)$.

The value of any theory of the strength of long rotating shafts founded on these formulæ is diminished by the circumstance that at sufficiently high speeds the shaft may tend to take up a curved form, the straight form being unstable. The shaft is then said to *whirl*. This occurs when the period of rotation of the shaft is very nearly coincident with one of its periods of lateral vibration. (See Greenhill, *Proc. Inst. Mech. Engineers*, April 1883.) The lowest speed at which whirling can take place in a shaft of length $l$, freely supported at its ends, is given by the formula

$$\omega^2\rho=\tfrac{1}{4}\mathrm{E}a^2(\pi/l)^4.$$

As in § 14, this formula should not be applied unless the length of the shaft is a considerable multiple of its diameter. It implies that whirling is to be expected whenever $\omega$ approaches this critical value.

31. *Thin Plate under Pressure.*—The theory of the deformation of plates, whether plane or curved, is very intricate, partly because of the complexity of the kinematical relations involved. We shall here indicate the nature of the effects produced in a thin plane plate, of isotropic material, which is slightly bent by pressure. This theory should have an application to the stress produced in a ship's plates. In the problem of the cylinder (§ 26) the most important stress is the circumferential tension, counteracting the tendency of the circular filaments to expand under the pressure; but in the problem of a plane plate some of the filaments parallel to the plane of the plate are extended and others are contracted, so that the tensions and pressures along them give rise to resultant couples but not to resultant forces. Whatever forces are applied to bend the plate, these couples are always expressible in terms of the principal curvatures produced in the surface which, before strain, was the middle plane of the plate. The simplest case is that of a rectangular plate, bent by a distribution of couples applied to its edges, so that the middle surface becomes a cylinder of large radius R; the requisite couple per unit of length of the straight edges is of amount C/R, where C is a certain constant; and the requisite couple per unit of length of the circular edges is of amount $\mathrm{C}\sigma/\mathrm{R}$, the latter being required to resist the tendency to anticlastic curvature (cf. § 1). If normal sections of the plate are supposed drawn through the generators and circular sections of the cylinder, the action of the neighbouring portions on any portion so bounded involves flexural couples of the above amounts. When the plate is bent in any manner, the curvature produced at each section of the middle surface may be regarded as arising from the superposition of two cylindrical curvatures; and the flexural couples across normal sections through the lines of curvature, estimated per unit of length of those lines, are $\mathrm{C}(1/\mathrm{R}_1+\sigma/\mathrm{R}_2)$ and $\mathrm{C}(1/\mathrm{R}_2+\sigma/\mathrm{R}_1)$, where $\mathrm{R}_1$ and $\mathrm{R}_2$ are the principal radii of curvature. The value of C for a plate of small thickness $2h$ is $\frac{2}{3}\mathrm{E}h^3/(1-\sigma^2)$. Exactly as in the problem of the beam (§§ 2, 10), the action between neighbouring portions of the plate generally involves shearing stresses across normal sections as well as flexural couples; and the resultants of these stresses are determined by the conditions that, with the flexural couples, they balance the forces applied to bend the plate.

32. To express this theory analytically, let the middle plane of the plate in the unstrained position be taken as the plane of $(x, y)$, and let normal sections at right angles to the axes of $x$ and $y$ be drawn through any point. After strain let $w$ be the displacement of this point in the direction perpendicular to the plane, marked $p$ in Fig. 22. If the axes of $x$ and $y$ were parallel to the lines of

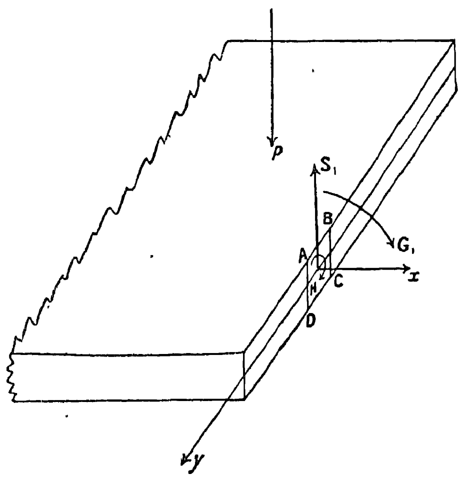


Fig. 22.

curvature at the point, the flexural couple acting across the section normal to $x$ (or $y$) would have the axis of $y$ (or $x$) for its axis; but when the lines of curvature are inclined to the axes of co-ordinates,

the flexural couple across a section normal to either axis has a component about that axis as well as a component about the perpendicular axis. Considering an element ABCD of the section at right angles to the axis of $x$, contained between two lines near together and perpendicular to the middle plane, the action of the portion of the plate to the right upon the portion to the left, across the element, gives rise to a couple about the middle line ($y$) of amount, estimated per unit of length of that line, equal to $C\left(\frac{\partial^2 w}{\partial x^2}+\sigma\frac{\partial^2 w}{\partial y^2}\right), =G_1$, say, and to a couple, similarly estimated, about the normal ($x$) of amount $-C(1-\sigma)\frac{\partial^2 w}{\partial x\partial y}, =H$, say. The corresponding couples on an element of a section at right angles to the axis of $y$, estimated per unit of length of the axis of $x$, are of amounts $-C\left(\frac{\partial^2 w}{\partial y^2}+\sigma\frac{\partial^2 w}{\partial x^2}\right), =G_2$ say, and $-H$. The resultant $S_1$ of the shearing stresses on the element ABCD, estimated as before, is given by the equation $S_1=\frac{\partial G_1}{\partial x}-\frac{\partial H}{\partial y}$ (cf. § 10), and the corresponding resultant $S_2$ for an element perpendicular to the axis of $y$ is given by the equation $S_2=-\frac{\partial H}{\partial x}-\frac{\partial G_2}{\partial y}$. If the plate is bent by a pressure $p$ per unit of area, the equation of equilibrium is $\frac{\partial S_1}{\partial x}+\frac{\partial S_2}{\partial y}=p$, or, in terms of $w$,

$$\frac{\partial^4 w}{\partial x^4}+\frac{\partial^4 w}{\partial y^4}+2\frac{\partial^4 w}{\partial x^2\partial y^2}=\frac{p}{C}.$$

This equation, together with the special conditions at the rim, suffices for the determination of $w$, and then all the quantities here introduced are determined. Further, the most important of the stress-components are those which act across elements of normal sections: the tension in direction $x$, at a distance $z$ from the middle plane measured in the direction of $p$, is of amount $-\frac{3Cz}{2h^3}\left(\frac{\partial^2 w}{\partial x^2}+\sigma\frac{\partial^2 w}{\partial y^2}\right)$, and there is a corresponding tension in direction $y$; the shearing stress parallel to $y$ on planes $x=\text{const.}$, and parallel to $x$ on planes $y=\text{const.}$, is of amount $\frac{3C(1-\sigma)z}{2h^3}\frac{\partial^2 w}{\partial x\partial y}$; these tensions and shearing stresses are equivalent to two principal tensions, in the directions of the lines of curvature of the surface into which the middle plane is bent, and they give rise to the flexural couples.

33. In the special example of a circular plate, of radius $a$, supported at the rim, and held bent by a uniform pressure $p$, the value of $w$ at a point distant $r$ from the axis is

$$\frac{1}{64}\frac{p}{C}(a^2-r^2)\left(\frac{5+\sigma}{1+\sigma}a^2-r^2\right),$$

and the most important of the stress components is the radial tension, of which the amount at any point is $\frac{3}{32}(3+\sigma)pz(a^2-r^2)/h^3$; the maximum radial tension is about $\frac{1}{3}(a/h)^2p$, and, when the thickness is small compared with the diameter, this is a large multiple of $p$.

AUTHORITIES.—The analysis requisite to prove most of the results stated in this article is given by LOVE, *Mathematical Theory of Elasticity*, Cambridge, 1892, 1893. Reference may also be made to BOUSSINESQ, *Application des potentiels*, Paris, 1885; CLEBSCH, *Theorie der Elasticität fester Körper*, Leipzig, 1862 (Saint-Venant's edition, Paris, 1883); THOMSON and TAIT, *Natural Philosophy*, Cambridge, 1879, 1883; TODHUNTER and PEARSON, *History of the Theory of Elasticity*, Cambridge, 1886–93; POCHHAMMER, *Gleichgewicht des elastischen Stabes*, Kiel, 1879; CHREE, "Changes in the Dimensions of Elastic Solids due to given Systems of Forces," *Trans. Camb. Phil. Soc.* xv., 1892; "On Thin Rotating Isotropic Disks," *Proc. Camb. Phil. Soc.* vii., 1891; "Long rotating Circular Cylinders," *Proc. Camb. Phil. Soc.* vii., 1892; HERTZ, "Über die Berührung fester elastischer Körper," *Crelle*, xcii., 1881; MICHELL, "On the Direct Determination of Stress in an Elastic Solid . . ." and other papers in *Proc. Lond. Math. Soc.* xxxi. xxxii., 1899–1900; PEARSON, "On the Flexure of Heavy Beams subjected to Continuous Systems of Load," *Quart. Journ. Math.* xxiv., 1889; PEARSON and FILON, same title, *Quart. Journ. Math.* xxxi., 1899. (A. E. H. L.)

**Elba,** an island of Italy, belonging to the province of Leghorn, 4 miles from the nearest point of the mainland (Piombino), and 35 miles south from Leghorn. Iron is not only mined, but since 1900 smelted, in Elba. Iron ore, wine, and salt are exported to the average (1891–98) value of £197,250 (£244,000 in 1899). The shipping which cleared from the various ports increased from 2692 vessels of 209,500 tons in 1891 to 3004 of 568,930 tons in 1899. There is an institute of viticulture. On this and the neighbouring island of Pianosa there are convict prisons, in which from 3000 to 4000 convicts are lodged. The principal towns are Portoferrajo (population, 3737 in 1881), Marciana (5444), Portolungone (4172), and Rio Marina (2964). Population of the island, about 27,000.

**Elbe** (the *Albis* of the Romans), one of the most important rivers of Central Europe. It rises in Bohemia, in the upper gathering-grounds of the Riesengebirge, its chief feeders being the Weisswasser, which originates near the kingly Schneekoppe, at an altitude of about 4600 feet, and the Elbseifen, which is formed in the same neighbourhood, but at a little lower elevation. After plunging down the 140 feet of the Elbfall, the latter stream unites with the steep torrential Weisswasser at Mädelstegbaude, at an altitude of 2230 feet, and thereafter the united stream of the Elbe pursues a southerly course, emerging from the mountain glens at Hohenelbe (1495 feet), and continuing on at a soberer pace to Pardubitz, where it turns sharply to the west, and at Kolin (730 feet), some 27 miles farther on, bends gradually towards the north-west. A little above Brandeis it picks up the Iser, which, like itself, comes down from the Riesengebirge, and at Melnik it has its stream more than doubled in volume by the Moldau, a river which winds northwards through the heart of Bohemia in a sinuous, trough-like channel carved through the plateaux. Some miles lower down, at Leitmeritz (433 feet), the waters of the Elbe are tinted by the reddish Eger, a stream which drains the southern slopes of the Erzgebirge. Thus augumented, and swollen into a stream 140 yards wide, the Elbe carves a path through the basaltic mass of the Mittelgebirge, churning its way through a deep, narrow rocky gorge. Then the river winds through the fantastically sculptured sandstone mountains of the "Saxon Switzerland," washing successively the feet of the lofty Lilienstein (932 feet above the Elbe), the scene of one of Frederick the Great's military exploits in the Seven Years' War, Königstein (797 feet above the Elbe), where in times of war Saxony has more than once stored her national purse for security, and the pinnacled rocky wall of the Bastei, towering 650 feet above the surface of the stream. Shortly after crossing the Bohemian-Saxon frontier, and whilst still struggling through the sandstone defiles, the stream assumes a north-westerly direction, which on the whole it preserves right away to the North Sea. At Pirna the Elbe leaves behind it the stress and turmoil of the Saxon Switzerland, rolls through Dresden, with its noble river terraces, and finally, beyond Meissen, enters on its long journey across the North German plain, touching Torgau, Wittenberg, Magdeburg, Wittenberge, Hamburg, Harburg, and Altona on the way, and gathering into itself the waters of the Mulde and Saale from the left, and those of the Schwarze Elster, Havel, and Elde from the right. Eight miles above Hamburg the stream divides into the Norder (or Hamburg) Elbe and the Süder (or Harburg) Elbe, which are linked together by several cross-channels, and embrace in their arms the large island of Wilhelmsburg and some smaller ones. But by the time the river reaches Blankenese, 7 miles below Hamburg, all these anastomosing branches have been reunited, and the Elbe, with a noble width of 4 to 9 miles between bank and bank, travels on between the green marshes of Holstein and Hanover until it becomes merged in the North Sea off Cuxhaven. From Dresden to the sea the river has a total fall of only 123 feet, although the distance is about 430 miles. For the 75 miles between Hamburg and the sea the fall is only $3\frac{1}{4}$ feet. One consequence of this is that the bed of the river

just below Hamburg is obstructed by a bar, and still lower down is choked with sandbanks, so that navigation is confined to a relatively narrow channel down the middle of the stream. But Hamburg has been unremitting in her efforts to maintain a sufficient fairway, and now vessels drawing 26 feet are able to proceed right up to her wharves, the depth of water on the bar having been increased from 14 feet in 1830 to 24½ feet in 1899. The tide advances as far as Geesthacht, a little more than 100 miles from the sea. The river is navigable as far as Melnik, that is, the confluence of the Moldau, a distance of 525 miles, of which 67 are in Bohemia. Its total length is 725 miles, of which 190 miles are in Bohemia, 77 miles in the kingdom of Saxony, and 350 miles in Prussia, the remaining 108 miles being in Hamburg and other states of Germany. The area of the drainage basin is estimated at 56,000 square miles.

Since 1842, but more especially since 1871, improvements have been made in the navigability of the Elbe by all the states which border upon its banks. As a result of these labours, there is now in the Bohemian portion of the river a minimum depth of 2 feet 8 inches, whilst from the Bohemian frontier down to Magdeburg the minimum depth is 3 feet, and from Magdeburg to Hamburg, 3 feet 10 inches. In 1896 and 1897 Prussia and Hamburg signed covenants whereby two channels are to be kept open to a depth of 9¾ feet, a width of 656 feet, and a length of 550 yards between Bunthaus and Ortkathen, just above the bifurcation of the Norder Elbe and the Suder Elbe. In 1869 the maximum burden of the vessels which were able to ply on the upper Elbe was 250 tons; but in 1899 it was increased to 800 tons. The large towns through which the river flows have vied with one another in building harbours, providing shipping accommodation, and furnishing other facilities for the efficient navigation of the Elbe. In this respect the greatest efforts have naturally been made by Hamburg (*q.v.*); but Magdeburg, Dresden, Meissen, Riesa, Tetschen, Aussig, and other places have all done their relative shares, Magdeburg, for instance, providing a commercial harbour and a winter harbour. In spite, however, of all that has been done, the Elbe remains subject to serious inundations at periodic intervals. Some of the worst floods which have been occasioned by this river have occurred in the years 1774, 1799, 1815, 1830, 1845, 1862, and 1890.

The growth of the traffic up and down the Elbe during the last quarter of the 19th century will be illustrated by the subjoined table, which shows the number of vessels, with their tonnage, which passed the river stations of Schandau (near the Saxon-Bohemian frontier), the Plauer Schleuse (some 20 miles below Magdeburg), and Hamburg-Entenwärder—(i.) the annual average for the years 1872–75, and (ii.) for the year 1899.

| | | Up-stream. | | Down-stream. | |
|---|---|---|---|---|---|
| | | Vessels. | Tons. | Vessels. | Tons. |
| Schandau | 1872–75 | 4,336 | 30,600 | 3,152 | 429,200 |
| | 1899 | 8,489 | 3,045,600 | 7,795 | 4,509,500 |
| Plauer Schleuse | 1872–75 | 2,313 | 108,600 | 2,099 | 148,000 |
| | 1899 | 5,149 | 1,223,100 | 5,269 | 1,739,500 |
| Hamburg-Entenwärder | 1872–75 | 5,053 | 438,700 | 4,725 | 256,400 |
| | 1899 | 24,480 | 6,607,000 | 26,706 | 6,174,600 |

In addition to this, timber rafts with an annual average of 154,500 tons of timber passed downwards through Schandau, and 34,400 tons through Hamburg, in the years 1872–75; the corresponding figures for 1899 being 284,100 tons through Schandau and 23,600 tons through Hamburg. The value of the goods forwarded from Hamburg to the interior of Germany up the Elbe in the year 1899 was estimated at over 34½ millions sterling, equivalent to about 20 per cent. of the entire exports from Hamburg. This vast amount of traffic is directed principally to Berlin, by means of the Havel-Spree system of canals, to the Thuringian states and the Prussian province of Saxony, to the kingdom of Saxony and Bohemia, and to the various riverine states and provinces of the lower and middle Elbe. The passenger traffic, which is in the hands of the Sächsisch-Böhmische Dampfschiffahrtsgesellschaft, is limited to Bohemia and Saxony, steamers plying up and down the stream from Dresden to Melnik, occasionally continuing the journey up the Moldau to Prague, and down the river as far as Riesa, near the northern frontier of Saxony. The carrying trade and the towing of barges are conducted by several large navigation companies.

In 1877–79, and again in 1888–95, some 100 miles of canal were dug, 5 to 6½ feet deep and of various widths, for the purpose of connecting the Elbe, through the Havel and the Spree, with the system of the Oder. The most noteworthy of these connexions are the Elbe Canal (14¼ miles long), the Reek Canal (9½ miles), the Rüdesdorfer Gewässer (11½ miles), the Rheinsberger Canal (11¼ miles), and the Sacrow-Paretzer Canal (10 miles), besides which the Spree has been canalized for a distance of 28 miles, and the Elbe for a distance of 70 miles. Since 1896 great improvements have been made in the Moldau and the Bohemian Elbe, with the view of facilitating communication between Prague and the middle of Bohemia generally on the one hand, and the middle and lower reaches of the Elbe on the other. In the year named a special commission was appointed for the regulation of the Moldau and Elbe between Prague and Aussig, at a cost estimated at about £1,000,000, of which sum two-thirds were to be borne by the Austrian empire and one-third by the kingdom of Bohemia. The regulation is being effected by the construction of locks and movable dams, the latter so designed that in times of flood or frost they can be dropped flat on the bottom of the river. When all these works are finished, the two rivers will have a minimum depth over the distances indicated of 6¾ feet, and will be able to accommodate barges of 700 to 800 tons when fully laden. In 1901 the Austrian Government laid before the Reichsrath a canal Bill, with proposals (1) for constructing a canal from the Danube (probably near Linz) to the Moldau near Budweis, a distance of 80 miles, and for regulating the Moldau from Budweis down to Prague; (2) for constructing a canal from the Danube to the Oder; (3) for constructing a canal between this last, starting at Prerau and ending at Pardubitz on the upper Elbe, and for the canalization of the Elbe from Pardubitz to Melnik; and (4) for making a navigable canal to unite the Danube-Oder section with the basin of the Vistula and with the navigable portion of the Dniester. The total cost was estimated at £31,000,000, and the time the works would take at twenty years. In 1900 Lübeck was put into direct communication with the Elbe at Lauenburg by the opening of the Elbe-Trave Canal, 42 miles in length, and constructed at a cost of £1,177,700, of which the state of Lübeck contributed £802,700, and the kingdom of Prussia £375,000. The canal has been made 72 feet wide at the bottom, 105 to 126 feet wide at the top, has a minimum depth of 8½ feet, and is equipped with seven locks, each 262½ feet long and 39¼ feet wide. It is thus able to accommodate vessels up to 800 tons burden; and the passage from Lübeck to Lauenburg occupies 18 to 21 hours. In the first year of its being open (June 1900 to June 1901) a total of 115,000 tons passed through the canal.[1] A gigantic project has also been put forward for providing water communication between the Rhine and the Elbe, and so with the Oder, through the heart of Germany. Some particulars of this scheme, which is known as the Midland Canal, are given in the article CANALS. Another canal has been projected for connecting Kiel with the Elbe by means of a canal trained through the Plön Lakes.

The Elbe is crossed by numerous bridges, as at Königgratz, Pardubitz, Kolin, Leitmeritz, Tetschen, Schandau, Pirna, Dresden, Meissen, Torgau, Wittenberg, Rosslau, Barby, Magdeburg, Rathenow, Wittenberge, Dömitz, Lauenburg, and Hamburg and Harburg. At all these places there are railway bridges, and nearly all, but more especially those in Bohemia, Saxony, and the middle course of the river—these last on the main lines between Berlin and the west and south-west of the empire—possess a greater or less strategic value. At Leitmeritz there is an iron trellis bridge, 600 yards long. Dresden has four bridges, three built in the 19th century, one of them serving also as a railway bridge, and the fourth early in the 18th century; there is a fifth bridge at Loschwitz, about three miles above the city. Meissen has a new railway bridge, in addition to an old road bridge. Magdeburg is one of the most important railway centres in Northern Germany; and the Elbe, besides being bridged—it divides there into three arms—several times for vehicular traffic, is also spanned by two fine railway bridges. At both Hamburg and Harburg, again, there are handsome new railway bridges, the one (1868–73 and 1894) crossing the Northern Elbe, and the other (1900) the Southern Elbe; and the former arm is also crossed by a fine triple-arched bridge (1888) for vehicular traffic.

The river is well stocked with fish, both salt-water and fresh-water species being found in its waters, and several varieties of fresh-water fish in its tributaries. The kinds of greatest economic value are sturgeon, shad, salmon, lampreys, eels, pike, and whiting.

In the days of the old German empire no fewer than thirty-five different tolls were levied between Melnik and Hamburg, to say nothing of the special dues and privileged exactions of various riparian owners and political authorities. After these had been *de facto*, though not *de jure*, in abeyance during the period of the Napoleonic wars, a commission of the various Elbe states met and drew up a scheme for their regulation, and the scheme, embodied

[1] See *Der Bau des Elbe-Trave Canals und seine Vorgeschichte.* Lübeck, 1900.

in the Elbe Navigation Acts, came into force in 1822. By this a definite number of tolls, at fixed rates, was substituted for the often arbitrary tolls which had been exacted previously. Still further relief was afforded in 1844 and in 1850, on the latter occasion by the abolition of all tolls between Melnik and the Saxon frontier. But the number of tolls was only reduced to one, levied at Wittenberge, in 1863, about one year after Hanover was induced to give up the Stade or Brunsbuttel toll in return for a compensation of 2,857,340 thalers. Finally, in 1870, 1,000,000 thalers were paid to Mecklenburg and 85,000 thalers to Anhalt, who thereupon abandoned all claims to levy tolls upon the Elbe shipping, and thus navigation on the river became at last entirely free.

The Elbe cannot rival the Rhine in the picturesqueness of the scenery it travels through, nor in the glamour which its romantic and legendary associations exercise over the imagination.

***History.***

But it possesses much to charm the eye in the deep glens of the Riesengebirge, amid which its sources spring, and in the bizarre rock-carving of the Saxon Switzerland. And it has been indirectly or directly associated with many stirring events in the history of the German peoples. In its lower course, whatever is worthy of record clusters round the historical vicissitudes of Hamburg—its early prominence as a missionary centre (Ansgar) and as a bulwark against Slav and marauding Northman, its commercial prosperity as a leading member of the Hanseatic League, and its sufferings during the Napoleonic wars, especially at the hands of the ruthless Davoût. The bridge over the river at Dessau recalls the hot assaults of that ill-favoured *condottiere* Ernst von Mansfeld in April 1626, and his repulse by the crafty generalship of Wallenstein. But three years later this imperious leader was checked by the heroic resistance of the "Maiden" fortress of Magdeburg; though two years later still she lost her reputation, and suffered unspeakable horrors at the hands of Tilly's lawless and unlicensed *soldatesca*. Mühlberg, just outside the Saxon frontier, is the place where Charles V. asserted his imperial authority over the Protestant elector of Saxony, John Frederick, the Magnanimous or Unfortunate, in 1547. Dresden, Aussig, and Leitmeritz are all reminiscent of the fierce battles of the Hussite wars, and the last-named of the Thirty Years' War. But the chief historical associations of the upper (*i.e.*, the Saxon and Bohemian) Elbe are those which belong to the Seven Years' War and the struggle of the great Frederick of Prussia against the power of Austria and her allies. At Pirna (and Lilienstein) in 1756, he caught the entire Saxon army in his fowler's net, after driving back at Lobositz the Austrian forces which were hastening to their assistance; but only nine months later he lost his reputation for "invincibility" by his crushing defeat at Kolin, where the great highway from Vienna to Dresden crosses the Elbe. Not many miles distant, higher up the stream, another decisive battle was fought between the same national antagonists, but with a contrary result, on the memorable 3rd July 1866.

See M. BUCHHEISTER, "Die Elbe u. der Hafen von Hamburg," in *Mitteil. d. Geog. Gesellsch. in Hamburg* (1899), vol. xv. pp. 131–188; V. KURS, "Die künstlichen Wasserstrassen des deutschen Reichs," in *Geog. Zeitschrift* (1898), pp. 601–617; and (the official) *Der Elbstrom* (1900). (J. T. BE.)

**Elberfeld,** a town of Prussia, in the Rhine province, on the river Wupper, 15 miles by rail east from Dusseldorf. Since 1874 several new and handsome quarters have been built to the south and west of the older part of the town. A new town-hall was erected in 1899–1900. The more recent buildings include the Roman Catholic church of St Suitbert's, the Reformed church in the cemetery, the royal engineering school, a hospital; and there are monuments to Moltke, Bismarck (1897), and the Emperors William I. and Frederick III. There are, further, zoological gardens, and deaf and dumb and lunatic asylums. A railway 9 miles in length, with 20 stations, on the Langen mono-rail system, suspended on the river Wupper from Elberfeld to Barmen, has recently been opened. The industries are on a scale of great magnitude; various iron and steel industries, paper, musical instruments, tobacco, and carpet manufacture, and brewing are important. Population (1885), 109,218; (1900), 156,503.

**Elbeuf,** a town in the arrondissement of Rouen, department of Seine Inférieure, France, 14 miles south-south-west of Rouen by rail. There is a large manufacture of woollen goods, the raw material being imported chiefly from Argentina (average about 4700 tons). Elbeuf is also an important entrepôt for German wools. There is a state school of manufactures for the training of practical managers and foremen. Port traffic on the Seine (1898), 58,663 tons. Population (1901), 19,050.

**Elbing,** a town of Prussia, province of West Prussia, 49 miles east-south-east from Danzig by rail and 5 miles from the Frisches Haff. The town-hall (1894) contains the historical museum. The Marienkirche (15th and 16th centuries) was restored in 1887. There is a monument of the war of 1870–71 (1887). Elbing is a place of rapidly growing industry, the principal branches being iron ship-building (one firm alone employing more than 3000 hands and doing work for the Imperial navy) and other iron industries, and cigar manufacture. There is a large trade in agricultural produce. Population (1900), 52,298.

**Elbing-Oberland Canal,** in the Prussian provinces of East and West Prussia, connecting Lake Drausen, and consequently the port of Elbing, with Lakes Geserich and Drewenz to the south—total distance, 110 miles. The width is $52\frac{1}{2}$ feet, the depth $4\frac{1}{4}$ feet; and the canal, which was made in 1845–60, cost £225,000. It consists of four inclined planes connected by three stretches of canal and shut off by five sluices, the altitude of the two lakes and their feeders being 338 feet above sea-level, and the altitude of Lake Drausen only $5\frac{1}{4}$ feet. Boats are drawn up the inclined planes on waggons, which are hauled up by machinery.

**Elche,** a town and railway station of Spain, in the province of Alicante, on the river Vinalapo. It has grown in importance, and there are now more than a million palm trees in the district, and 22,500 tons of dates are exported every year. Manufactures of oil, flour, soap, leather, alcohol, and esparto-grass rugs are prosperous industries. Population (1887), 23,847; (1897), 28,030.

**Elduayen, José de,** 1st MARQUIS DEL PAZO DE LA MERCED (1823–1898), Spanish politician, was born in Madrid, 22nd June 1823. He was educated in the capital, took the degree of civil engineer, and as such directed important works in Asturias and Galicia, entered the Cortes in 1856 as deputy for Vigo, and sat in all the parliaments until 1867 as member of the Union Liberal with Marshal O'Donnell. He attacked the Miraflores cabinet in 1864, and became under-secretary of the Home Office when Canovas was minister in 1865. He was made a councillor of state in 1866, and in 1868 assisted other members of the Union Liberal in preparing the revolution. In the Cortes of 1872 he took much part in financial debates. He accepted office as a member of the last Sagasta cabinet under King Amadeus. On the proclamation of the republic Elduayen very earnestly co-operated in the Alphonsist conspiracy, and endeavoured to induce the military and politicians to work together. He went abroad to meet and accompany the prince after the *pronunciamiento* of Marshal Campos, landed with him at Valencia, was made governor of Madrid, a marquis, grand cross of Charles III., and Minister for the Colonies in 1878. He accepted the portfolio of Foreign Affairs in the Canovas cabinet from 1883 to 1885, and was made a life senator. He always prided himself on having been one of the five members of the Cortes of 1870 who voted for Alphonso XII. when that parliament elected Amadeus of Savoy. He died at Madrid, 24th June 1898.

END OF THIRD VOLUME.

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OF

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### A

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**ANDERSON, Miss A. M.;** Principal Lady Inspector of Factories, Home Office. (A. M. AN.)

**ANDERSON, W.,** F.R.C.S., the late; Comp. of the Order of the Rising Sun (Japan); Professor at Royal Academy; Chairman of Council of the Japan Society; Medical Director, Imperial Naval Medical College, Tokio; author of 'The Pictorial Arts of Japan,' 'Japanese Wood Engravings,' 'Cat. of Chinese and Japanese Pictures in British Museum.' (WM. AN.)

**ANDERSON, Lt.-Col. W. P.;** Chief Engineer and Superintendent of Lights, Department of Marine and Fisheries, Ottawa, Canada. (W. P. A.)

**ANDREWS, Hon. Elisha Benjamin,** LL.D.; Chancellor of the University of Nebraska; late Superintendent of Schools of the City of Chicago; formerly President of Brown University; author of 'Institutes of General History,' 'Institutes of Economics,' 'History of the United States,' etc. (E. B. A.)

**ANSTRUTHER-THOMSON, Major W.,** F.G.S., F.S.A.; Inspector of Concentration Camps, S.A. (W. A.-T.)

**ARCHER, William;** dramatic critic of 'World' (London), 1884 onwards; edited and translated Ibsen's 'Prose Dramas'; author of 'Life of Macready,' 'Masks or Faces,' 'The Theatrical World,' 'Study and Stage,' 'America To-day, 1900,' 'Poets of the Younger Generation,' etc. (W. A.)

**ARMSTRONG, Edmund Archibald,** Barrister-at-Law, Inner Temple. (E. A. AR.)

**ARMSTRONG, Henry Edward,** Ph.D., LL.D., F.R.S.; Professor of Chemistry at the City and Guilds of London Central Institute, South Kensington; author of 'Carbon,' etc., in Ninth Edition of 'Ency. Brit.,' 'Introduction to the Study of Organic Chemistry.' (H. E. A.)

**ARMSTRONG, Sir Walter;** Director of the National Gallery of Ireland; author of 'Sir Joshua Reynolds,' 'Thomas Gainsborough,' 'Sir Henry Raeburn,' 'Alfred Stevens,' 'Peter de Wint,' 'Velasquez,' 'Scottish Painters,' 'J. M. W. Turner,' etc., and co-editor of 'Bryan's Dictionary of Painters.' (W. AR.)

**ASHWORTH, Philip A.,** Dr. Juris, of the Inner Temple, Barrister-at-Law; editor of Taswell-Langmead's 'Constitutional History of England,' translator of Gneist's 'History of the English Constitution,' etc. (P. A. A.)

**ASKWITH, Rev. Edward Harrison,** M.A., B.D.; Chaplain of Trinity College, Cambridge; author of 'Christian Conception of Holiness,' 'Epistle to the Galatians,' etc. (E. H. A.)

**ASTON, Major George Grey,** R.M.A.; late Professor of Fortification, Royal Naval College, Greenwich. (G. G. A.)

**ASTON, William George,** B.A., M.A., Hon. D.Lit., C.M.G.; student interpreter in Japan, 1864; interpreter and translator to British Legation at Yedo, 1870; assistant Japanese Secretary, Yedo, 1875-82; acting Consul, Hiogo, 1880-83; Consul-General for Corea, 1884; Japanese Secretary, Tokio, 1886; author of 'A Grammar of the Japanese Spoken Language,' 'A Grammar of the Japanese Written Language,' 'A Translation of the Nihongi, or Annals of Ancient Japan,' 'History of Japanese Literature,' etc. (W. G. AS.)

**ATWATER, Wilbur Olin,** Ph.D.; Professor of Chemistry, Wesleyan University, U.S.A.; Special Agent of the U.S. Department of Agriculture in charge of Nutrition investigations. (W. O. A.)

**AVES, Ernest,** M.A.; formerly Sub-Warden of Toynbee Hall; author of papers on sociology and economics. (E. A*.)

**AXON, William Edward Armitage,** LL.D.; late Dep. Librarian Manchester Free Libraries; author of 'Manchester' in Ninth Edition of 'Ency. Brit.,' 'The Annals of Manchester,' 'Manchester a Hundred Years Ago,' 'Lancashire Gleanings,' 'Stray Chapters in Literature,' 'Folk-lore and Archæology,' etc. (W. E. A. A.)

### B

**BACON, Edwin Monroe,** M.A.; editor of 'Time and the Hour' (Boston, U.S.A.); sometime editor-in-chief of the 'Boston Globe,' the 'Boston Advertiser,' and the 'Boston Post'; author of 'Boston Illustrated,' 'Bacon's Dictionary of Boston,' 'Boston of To-day,' etc. (E. M. B.)

**BADEN-POWELL, Maj. Baden F. S.;** inventor of man-lifting kites; late President Aëronautical Society; author of 'In Savage Isles and Settled Lands,' many articles on ballooning, etc. (B. F. S. B.-P.)

**BAGWELL, Richard,** M.A.; author of 'Ireland' in the Ninth Edition of the 'Ency. Brit.,' 'Ireland under the Tudors,' 'A Plea for National Education,' etc. (R. BA.)

**BAINES, Jervoise Athelstane,** C.S.I.; Hon. Sec. (gold medallist) and Vice-President Royal Statistical Society; Census Commissioner under Government of India, 1889-93; employed at India Office and as secretary to Royal Commission on Opium, 1894-95; author of Official Reports on Provincial Administration, on Indian Census Operations, 1881-91, on Indian Progress, 1894, many papers, ethnographic and statistical, for London societies. (J. A. B.)

**BAKER, Henry Frederick,** M.A., F.R.S.; Fellow and Lecturer of St John's College, Cambridge; University Lecturer in Mathematics. (H. F. BA.)

**BALCARRES, Lord,** M.P., F.S.A., F.S.A.S.; Trustee of National Portrait Gallery, London; Hon. Sec. Society for Protection of Ancient Buildings; Vice-Chairman of National Trust. (B.)

**BALDRY, Alfred Lys,** artist; author of 'Albert Moore: his Life and Works,' 'The Life and Works of Marcus Stone, R.A.,' 'Sir John Everett Millais,' 'Hubert von Herkomer,' etc. (A. L. B.)

**BALDWIN, Hon. Simeon Eben,** A.M., LL.D.; Judge of the Supreme Court of Errors of Connecticut; Professor of Constitutional and Mercantile Law, Corporations, and Wills, Yale University; sometime President of the American Bar Association and American Social Science Association; author of 'Baldwin's Connecticut Digest,' 'Cases on R.R. Law,' 'Modern Political Institutions,' etc. (S. E. B.)

**BALDWIN, W. H.,** Jr.; President of the Long Island R.R. Co., U.S.A. (W. H. B.)

**BALE, Edwin,** R.I.; Art Director, Cassell and Company; Hon. Sec. Artists' Committee for Promoting Art Copyright Bill, etc. (E. BA.)

**BALFOUR, Isaac Bayley,** M.D., D.Sc., M.A., F.R.S., F.L.S.; Regius Keeper of Royal Botanic Garden, Edinburgh; Professor of Botany, University of Edinburgh; Transit of Venus Expedition to Rodriguez, 1874; Regius Professor of Botany, University of Glasgow, 1879-84; explored island of Socotra, 1880; Sherardian Professor of Botany, University of Oxford, and Fellow of Magdalen College, 1884-88; author of 'Botany of Rodriguez,' 'Botany of Socotra,' editor of 'Annals of Botany.' (I. B. B.)

**BANCROFT, Frederic,** Ph.D.; Chief of Bureau of Rolls and Library, U.S. Department of State; author of 'Life of William H. Seward,' etc. (F. BA.)

**BANISTER, G. H.,** M.I.C.E., M.I.M.E.; late Assistant to Superintendent of the Royal Carriage Department, Woolwich; Whitworth Scholar. (G. H. BA.)

**BARCLAY, Thomas,** LL.B., Ph.D.; member of the Institute of International Law; Vice-President of the International Law Association; Examiner in Jurisprudence and International Public and Private Law to the University of Oxford, 1900; member of the Supreme Council of the Congo Free State; Vice-President of the Franco-Scottish Society; President of the British Chamber of Commerce in Paris, 1899-1900; Knight of the Legion of Honour and of the Order of Leopold; author of 'Companies in France,' and other law books, all the articles on International Law in the 'Encyclopedia of the Law of England,' etc. (T. BA.)

**BARING, The Hon. Maurice;** Attaché to the British Embassy, Paris, 1899; Third Secretary to the British Embassy, Rome, 1902. (M. BA.)

**BARLOW, Major H. W. W.,** R.A.; Secretary to Chief Superintendent, Royal Ordnance Factories, Woolwich. (H. W. B.)

**BARNES, William Emery,** D.D.; Fellow of Peterhouse, Cambridge; Hulsean Professor of Divinity, Cambridge; assist. editor of 'Journal of Theological Studies'; Lecturer in Hebrew at Clare Coll. Camb., 1885-94; in Hebrew and Divinity at Peterhouse, 1889-1901; author of 'The Genuineness of Isaiah xxiv.-xxvii.,' 'Canonical and Uncanonical Gospels,' 'The Peshitta Text of Chronicles,' I. II. Chronicles, with Introduction and Notes (Cambridge Bible). Isaiah (Churchman's Bible). (W. E. B.)

**BARNETT, Rev. Samuel Augustus,** M.A.; Canon of Bristol; Founder and Warden of Toynbee Hall, Whitechapel; President of the Sunday Society; Chairman Whitechapel Board of Guardians, 1894; Chairman of Children's Country Holiday Fund; Chairman Pupil Teachers' Scholarship Fund; author of 'Practicable Socialism' with Mrs Barnett, 'Service of God.' (S. A. B.)

**BARRETT, F. N.,** editor of the 'American Grocer' (New York). (F. N. B.)

**BARTLET, Rev. J. Vernon,** M.A.; Professor of Church History, Mansfield College, Oxford; author of 'Early Church History,' 'The Apostolic Age,' etc. (J. V. B.)

**BARTLEY, George Christopher Trout,** M.P.; Assistant-Director of Science Division of Science and Art Department, London, till 1880; established National Penny Bank, 1875; author of 'A Square Mile in the East of London,' 'Schools for the People,' 'Provident Knowledge Papers,' 'The Seven Ages of a Village Pauper,' 'The Parish Net. (G. C. T. B.)

**BARWICK, G. F.;** Assistant Keeper of Printed Books and Superintendent of Reading-room, British Museum; author of 'International Exhibitions,' 'The Laws Regulating Printing and Publishing in Spain,' and translator of various works of travel, etc. (G. F. B.)

**BASSETT, John Spencer,** Ph.D.; Professor of History, Trinity College, N.C.; author of 'Constitutional Beginnings of North Carolina,' 'Slavery and Servitude of the Colony of North Carolina,' 'Anti-Slavery Leaders of North Carolina,' 'Slavery in the State of North Carolina.' (J. S. BA.)

**BASTABLE, C. F.,** M.A., LL.D.; Professor of Political Economy, Dublin University, 1882; author of 'Money' in Ninth Edition of 'Ency. Brit.,' 'Theory of International Trade,' 'Commerce of Nations,' 'Public Finance,' 'Dictionary of Political Economy,' and 'Economic Journal. (C. F. B.)

**BATHER, Francis Arthur,** M.A., D.Sc., F.G.S.; Natural History Museum, South Kensington; Hon. Member Soc. Linnéenne de Normandie; author of 'Concise Knowledge of Natural History,' 'The Genera and Species of Blastoidea,' 'Echinoderma' (in Lankester's 'Zoology'), 'The Crinoidea of Gottland,' etc. (F. A. B.)

**BAUERMAN, H.,** F.G.S.; Lecturer on Metallurgy, Ordnance College, Woolwich; author of 'Bismuth,' 'Coal,' 'Fuel,' 'Furnace,' etc., in Ninth Edition of 'Ency. Brit.,' 'A Treatise on the Metallurgy of Iron,' 'Text-book of Systematic Mineralogy,' etc. (H. B.)

**BEALBY, J. T.,** B.A.; sometime acting editor of 'Scottish Geographical Magazine'; author of 'A Daughter of the Fen,' and numerous geographical magazine articles; joint author of 'Stanford's Compendium: Europe'; translator of Sven Hedin's 'Through Asia. (J. T. BE.)

**BEDDARD, Frank Evers,** M.A., F.R.S.; Prosector of Zoological Soc. of England since 1884, and Vice-Sec. since 1898; formerly Lecturer on Biology at Guy's Hospital; has been Examiner in Zoology and Comparative Anatomy, University of London, and of Morphology at Oxford; now Examiner in the University of New Zealand; naturalist to 'Challenger' Expedition Commission, 1882-84; author of 'Worm' in Ninth Edition of 'Ency. Brit.,' 'Animal Coloration,' 'Text-book of Zoogeography,' 'A Monograph of the Oligochæta,' 'Structure and Classification of Birds.' (F. E. B.)

**BELL, Charles Frederic Moberly;** asst. manager of 'The Times'; formerly correspondent of 'The Times' in Egypt; author of 'Khedives and Pashas,' 'Egyptian Finance,' 'From Pharaoh to Fellah,' etc. (C. F. M. B.)

**BELL, Dr Louis,** Boston, U.S.A.; author of 'The Elements of Practical Electricity,' 'Power Distribution for Electric Railroads,' 'Electric Power Transmission,' etc. (L. BL.)

**BELL, Malcolm;** author of 'Rembrandt,' 'Sir E. Burne-Jones,' etc. (M. BE.)

**BELLAIRS, Carlyon;** Lieutenant R.N.; writer of articles on naval subjects. (C. W. BE.)

**BELLINGER, Hon. Charles Byron;** Judge of the U.S. District Court, District of Oregon. (C. B. B*.)

**BELTRAMI, Luca;** architect; author of 'Storia della facciata di St Maria del Fiore in Firenza,' 'La Basilica Ambrosiana primitiva e la ricostruzione compiuta nel secolo IX,' etc. (L. BI.)

**BÉNÉDITE, Léonce;** Conservator, Musée du Luxembourg, Paris; author of 'Alphonse Legros'; editor of 'Bulletin des Musées,' etc. (L. BE.)

**BENSON, Arthur Christopher,** M.A., F.R.Hist. Soc.; Master at Eton College since 1885; author of 'Memoirs of Arthur Hamilton,' 'Archbishop Laud: a Study,' 'Poems,' 'Lyrics,' 'Essays,' 'Lord Vyet and other Poems,' 'Fasti Etonenses,' 'Life of Archbishop Benson,' 'The Professor, and other Poems.' (A. C. BE.)

**BERG, Sigvard Johnson,** A.M.I.C.E., Switzerland. (S. J. B.)

**BERNARD, Rev. John Henry,** D.D.; Fellow of Trin. Coll., Dublin; Archbishop King's Lecturer in Divinity, University of Dublin; member of University Council, 1892; Vice-Warden, Alexandra Coll., Dublin, for higher education of women, 1894; Secretary of Royal Irish Academy, 1899; Commissioner of National Education, Ireland, 1897; part-editor of 'Kant's Critical Philosophy for English Readers,' translator of 'Kant's Kritik of Judgment, joint-author of 'The Literature of the Second Century,' editor of 'The Pilgrimage of St Silvia of Aquitania,' 'The Pastoral Epistles of St Paul,' 'The Works of Bishop Butler, etc. (J. H. BE.)

**BERNSTEIN, Eduard;** German Socialistic politician and writer; late editor of the 'Social Democrat'; author of 'On the History and Theory of Socialism,' 'The Communistic and Democratic-Socialistic Movements in England during the 17th Century,' etc. (E. BN.)

**BERRY, George Andreas,** M.B., F.R.C.S., F.R.S. Edin.; Vice-Pres. Ophthalmological Soc.; author of 'Diseases of the Eye,' 'The Elements of Ophthalmoscopic Diagnosis,' 'Subjective Symptoms in Eye Diseases,' etc. (G. A. BE.)

**BESANT, Sir Walter,** M.A., F.S.A., the late; Secretary Palestine Exploration Fund, 1868-85; Hon. Sec. Palestine Exp. Fund; First Chairman Society of Authors, 1884-85; Chairman Society of Authors, 1887-1892; author of 'Froissart' in Ninth Edition of 'Ency. Brit.,' 'Studies in Early French Poetry,' 'Rabelais,' Lives of 'Coligny,' 'Whittington,' 'Edward Palmer,' and 'Richard Jefferies,' 'London,' 'Westminster,' 'South London,' many Novels with the late James Rice. Novels alone: 'The Revolt of Man,' 'All Sorts and Conditions of Men,' 'Beyond the Dreams of Avarice,' 'The Orange Girl,' etc. (W. BE.)

**BHOWNAGREE, Sir Mancherjee Merwanjee,** K.C.I.E., M.P; State Agent, Bombay, for the territory of Bhavnagar, 1873; author of 'History of the Constitution of the East India Company,' Gujerati translation of 'Her Majesty's Life in the Highlands,' etc. (M. M. BH.)

**'BICKERDYKE, John'** (Charles Henry Cook), M.A.; writer on angling and sporting subjects; President of Thames Re-stocking Association, and the Fly-Fishers' Club, 1899-1900; editor of the angling department of the 'Field'; author of 'Angling in Salt Water,' 'The Book of the All Round Angler,' 'Thames Rights and Thames Wrongs,' 'Days in Thule with Rod, Gun, and Camera,' 'Sea-Fishing,' 'Days of My Life in Water, Fresh and Salt,' 'Wild Sports in Ireland,' 'Letters to Young Sea-Fishers,' etc. ('J. B.')

**BIDWELL, Shelford,** M.A., Sc.D., F.R.S.; barrister; President of Physical Society, England, 1897-99; author of 'Curiosities of Light and Sight,' and numerous memoirs on physical subjects. (S. BI.)

**BINDLOSS, Harold;** Secretary Royal Mersey Yacht Club. (H. BS.)

**BINYON, Laurence;** assistant in the British Museum, Department of Printed Books, 1893; transferred to Department of Prints and Drawings, 1895; author of 'Lyric Poems,' 'Poems,' 'London Visions,' 'The Praise of Life, 'Porphyrion and other Poems,' 'Western Flanders,' 'Odes,' 'Catalogue of English Drawings in the British Museum.' (L. B.)

**BIRD, Christopher John,** C.M.G.; Principal Under Secretary of the Colony of Natal, and a Member of the Civil Service Board. (C. J. BI.)

**BIRDWOOD, Sir George Christopher Molesworth,** M.D., K.C.I.E., C.S.I., LL.D.; special assistant in Revenue and Statistics Department India Office, 1871-99; author of 'Incense' in Ninth Edition of 'Ency. Brit.,' 'Economic Vegetable Products of the Bombay Presidency,' 'The Industrial Arts of India,' 'Report on Old Records of the India Office,' 'First Letter Book of East India Company,' Appendix on the Aryan Fauna and Flora to Max-Müller's 'Biography of Words,' etc. (G. B.)

**BIRKBECK, William John,** M.A., F.S.A.; author of 'Russia and the English Church.' (W. J. BI.)

**BIRKINBINE, John,** M.E.; President of the Franklin Institute and the Pennsylvania Forestry Association; sometime President American Institute of Mining Engineers, and editor 'Journal of Iron Workers.' (J. BI*.)

**BIRRELL, Augustine,** K.C.; Hon. Fellow, Trinity Hall, Cambridge; LL.D. St Andrews (Honorary); Quain Professor of Law, University Coll. London, 1896; M.P. (L.) Fifeshire W., 1889-1900; author of Obiter Dicta, 1884, 1887; Life of Charlotte Brontë, 1885; Res Judicatae, 1892; Men, Women, and Books, 1894; Lectures on the Duties and Liabilities of Trustees, 1896; editor of Boswell's Life of Johnson, 1897; Sir Frank Lockwood, 1898; Collected Essays, 1900. (A. BI.)

**BISHOP, Mrs Isabella L.** (Miss Isabella Bird), F.R.G.S., Hon. F.R.S.G.S.; Hon. Member of Oriental Society, Pekin; first lady Fellow of the Royal Geographical Society; author of 'The Englishwoman in America,' 'Six Months in the Sandwich Islands,' 'A Lady's Life in the Rocky Mountains,' 'Unbeaten Tracks in Japan,' 'The Golden Chersonese,' 'Journeys in Persia and Kurdistan,' 'Among the Tibetans,' 'Korea and her Neighbours,' 'The Yangtze Valley and Beyond,' 'Pictures from China,' etc. (I. L. B.)

**BLAIR, Andrew A.;** chief chemist of the U.S. Geological Survey, Division of Mining and Geology, Tenth Census of the United States; author of 'The Chemical Analysis of Iron,' etc. (A. A. B.)

**BLAKE, Rev. John Frederick,** M.A., F.R.S.; sometime Professor of Natural Science, University College, Nottingham; author of 'British Fossil Cephalopoda,' 'The Geological

Society of London,' 'Astronomical Myths,' 'Yorkshire Lias,' etc. (J. F. Bl.)

**BLAKE, Prof. William Phipps,** Ph B.; Director School of Mines, University of Arizona, and territorial geologist of Arizona; author of 'Geological Reconnaissance of California,' 'Silver Ores and Silver Mines,' etc. (W. P. B.)

**BLÖNDAL, Sigfús,** of the University Library, Copenhagen. (S. Bl.)

**BLOUNT, Bertram,** F.C.S., F.I.C.; consulting chemist to the Crown Agents for the Colonies; Hon. President Cement Section of International Assoc. for Testing Materials, Buda-Pesth. (B. Bl.)

**BLOWITZ, Henri Georges Stephane Adolphe Opper de;** 'The Times' correspondent in Paris; Professor of German at Tours, Limoges, Poitiers, and Marseilles; entered on service of 'The Times,' July 1871; inaugurated constant telegraphic communications and obtained the concession from 9 P.M. to 3 A.M. of a special wire for 'The Times' from 9 May 1874; officer of the Legion of Honour; Doctor of Philosophy; officer of the Institute of France; author of 'Feuilles Volantes,' 'L'Allemagne et la Provence,' 'Le Mariage royal d'Espagne,' 'Une Course à Constantinople.' (de B.)

**BLUNT, Capt. Charles Jasper,** R.A.; Chief Ordnance Officer, Guernsey; served in the Chitral campaign, etc. (C. J. B.)

**BODLEY, John Edward Courtenay,** M.A.; private secretary to President of Local Government Board, 1882-85; secretary to Royal Commission on Housing of the Working Classes, 1884-85; author of 'France': vol. i. 'The Revolution and Modern France,' vol. ii. 'The Parliamentary System,' (French ed. 1901), 'L'Anglomanie et les traditions françaises.' (J. E. C. B.)

**BOLTZMANN, Ludwig;** Professor of Theoretical Physics, University of Vienna; Hon. Member Royal Academy of Sciences, Berlin; author of 'Lectures on the Theory of Gas,' 'Lectures on Maxwell's Theory of Electricity and Light'; editor of 'Maxwell's Physical Forces.' (L. Bo.)

**BONAR, James,** M.A., LL.D.; senior Examiner Civil Service Commission, Westminster; junior Examiner in H.M. Civil Service Commission, 1881; senior Examiner, *ibidem*, end of 1895; President of Section F of British Association, 1898; author of 'Malthus and his Work,' 'Ricardo's Letters to Malthus,' 'Philosophy and Political Economy,' 'Catalogue of Adam Smith's Library' (part), 'Ricardo's Letters to Trower.' (J. B*.)

**BONNEY, Rev. Thomas George,** D.Sc., LL.D., F.R.S.; late Professor of Geology, University Coll. London; Hon. Canon of Manchester; Fellow of St John's Coll. Camb.; Hulsean Lecturer (Camb.), 1884; President Geological Society, 1884-86; Boyle Lecturer, 1890-92; Rede Lecturer (Camb.), 1892; Vice-President Royal Society, 1899; author of 'The Alpine Regions,' 'The Story of our Planet,' 'Charles Lyell and Modern Geology,' 'Ice-Work, 'Volcanoes,' etc. (T. G. B.)

**BOSCO, Augustus;** Professor of Statistics, University of Rome. (A. Bo)

**BOULENGER, George A.,** F.R.S., F.Z.S.; assistant, Dept. of Zoology, Brit. Museum, since 1882; author of numerous works on Zoology. (G. A. B.)

**BOURCHIER, James David,** M.A.; sometime Scholar of King's College, Cambridge; Correspondent of 'The Times' at Athens. (J. D. B.)

**BOURGET, Paul,** poet, critic, and novelist; member of French Academy since 1894; officer of the Legion of Honour, 1895; author of La Vie inquiète, 1874; Edel, 1878; Les Aveux, 1882; Essais de Psychologie, 1883; Nouveaux Essais de Psychologie, 1885; Études et Portraits, 1887; Pastels, 1889; Physiologie de l'Amour moderne, 1890; Sensations d'Italie, 1891; Nouveaux Pastels, 1891; Outre Mer, 1895; L'Irréparable, 1884; Cruelle Enigme, 1885; Un Crime d'Amour, 1886; André Cornélis, 1887; Mensonges, 1887; Le Disciple, 1889; Un cœur de femme, 1890; La Terre Promise, 1892; Cosmopolis, 1892; Un Scrupule, 1894; Un Idylle Tragique, 1896; Voyageuses, 1897; Recommencements, 1897; Complications Sentimentales, 1898; La Duchesse Bleue, 1898; Drames de Famille, 1900; Un Homme d'Affaires, 1900; Le Fantôme. (P. B*.)

**BOURNE, Gilbert Charles,** M.A., D.Sc., F.L.S.; Fellow and Tutor of New Coll. Oxford; assistant to Linacre Professor of Comparative Anatomy, Oxford, 1887-88; Director, Marine Biological Association, United Kingdom, 1889-1890; assistant to Linacre Professor at Oxford, 1892-1900; University Lecturer in Comparative Anatomy, 1898; author of various memoirs on Comparative Anatomy, an 'Introduction to Study of Comp. Anatomy of Animals,' articles Anthozoa and Ctenophora, in Lankester's 'Zoology,' etc. (G. C. B.)

**BOURNE, Henry Eldridge;** Professor of History, College for Women, Western Reserve University, U.S. (H. E. B.)

**BOWER, Frederick Orpen,** Sc.D., F.R.S., F.L.S.; Regius Professor of Botany, University of Glasgow, since 1885; author of 'A Course of Practical Instruction in Botany,' 'Practical Botany for Beginners,' etc. (F. O. B.)

**BOWLEY, A. L.;** author of 'Elements of Statistics,' 'Wages in the United Kingdom in the Nineteenth Century,' etc. (A. L. Bo.)

**BOYD, Charles Walter,** B.A. (Edin.); journalist; sometime private secretary in South Africa to Dr Jameson and Mr Cecil Rhodes. (C. W. B*.)

**BRABROOK, Edward William,** C.B., F.S.A., V.P.S.S., V.P.R.S.L.; V.P. Royal Archæological Institute since 1900; Chief Registrar of Friendly Societies since 1891; President Anthropological Institute, 1895-97; President Folk-Lore Society, 1901; Foreign Associate, Society of Anthropology of Paris, 1901; author of 'Building Societies,' 'Friendly Societies,' 'Savings Banks' in Ninth Edition of 'Ency. Brit.,' 'Provident Societies and Industrial Welfare,' 'History of Royal Society of Literature.' (E. W. B.)

**BRADFORD, John R.,** M.D., D.Sc., F.R.C.P., F.R.S.; member of Senate of University of London; physician to University Coll. Hospital London; Professor of Materia Medica and Therapeutics, University College, London; Professor Supt. of the Brown Institution; author of papers on medical and scientific subjects in Proc. Roy. Soc. and in Transactions of medical societies, etc. (J. R. B.)

**BRÆKSTAD, H. L.;** Anglo-Norwegian journalist; translator of standard Norwegian works. (H. L. B.)

**BRAMWELL, Capt. G. A.;** School of Signalling, Aldershot; Deputy-Assistant-Adjutant-General for signalling. (G. A. Br.)

**BRANNER, John Casper, Prof.,** Ph.D., LL.D.; Geologist, Imperial Geolog. Commission, Brazil, 1875-1877; Agent U.S. Department of Agriculture in Brazil, 1882-83; acting President, Stanford University, U.S.A., 1898-99; Fellow of Geolog. Soc. of London and Société Géologique de France; member of various scientific societies of North and South America; author of numerous publications on Brazil. (J. C. Br.)

**BRANTLY, William Theophilus;** reporter of the Maryland Court of Appeals; ex-secretary of State of Maryland; author of 'Maryland' in Ninth Edition of 'Ency. Brit.,' 'Law of Personal Property.' (W. T. B.)

**BRASSEY, Lord, 1st Baron,** K.C.B., D.C.L.; Knight of St John of Jerusalem; Commander of Legion of Honour, 1889; President Statistical Society, 1879-80; Civil Lord of Admiralty, 1880-83; Secretary to Admiralty, 1883-85; Chairman of Opium Commission; President of the Institution of Naval Architects, 1893-95; Governor of Victoria, 1895-1900; author of 'Work and Wages,' 'Naval Annual,' 'British Navy,' 'British Seamen,' 'British Work and Foreign Wages,' etc. (Br.)

**BRETT, Michael,** Barrister, Middle Temple. (M. Bt.)

**BRICKDALE, C. Fortescue,** Barrister, Lincoln's Inn; author of 'The Law and Practice regarding the Registration of Deeds in the County of Middlesex,' 'Notes on Land Transfer,' 'Registration of Title to Land,' part author of 'The Land Transfer Acts, 1875 and 1897,' etc. (C. F. Br.)

**BRIDGE, Vice-Admiral Sir Cyprian Arthur George,** K.C.B.; Commander-in-Chief, China station; member of Committee on Heavy Guns, 1878; of War Office Committee on Machine Guns, 1879; of Ordnance Committee, 1881; Director of Naval Intelligence, 1889-94; Commander-in-Chief Australian station, 1895-98; author of 'Signals' in Ninth Edition of 'Ency. Brit.' (C. A. G. B.)

**BRIGHTMAN, Rev. Frank Edward,** M.A.; Chaplain Univ. Coll. Oxford, 1884-87; Pusey Librarian, 1884; author of 'What Objections have been made to English Orders?'; editor of 'Liturgies Eastern and Western,' 'The Oxford Library of Practical Knowledge,' etc. (F. E. Br.)

**BRINKLEY, Capt. F.,** R.A.; proprietor and editor of the 'Japan Mail,' Yokohama; edited 'Japan'; translated 'The History of Japan'; compiled 'An Unabridged Japanese and English Dictionary,' etc. (F. By.)

**BROADFOOT, Major William,** R.E.; author of the Badminton 'Billiards'; edited 'Career of Major George Broadfoot, C.B., in Afghanistan and the Punjaub,' etc. (W. Br.)

**BROOME, Lady,** widow of the late Sir F. Napier Broome, Governor of West Australia; author of 'Station Life in New Zealand,' etc. (M. A. B.)

**BROOMHALL, G. J. S.,** editor of 'Corn Trade Year-Book,' etc. (G. J. S. B.)

**BROWNE, Edward Granville,** M.A., M.B.; Fellow of Pembroke College, Cambridge, and Professor of Persian; editor of 'The Episode of the Bab,' etc. (E. G. B.)

**BROWNLOW, Rt. Rev. William Robert** [the late], D.D., M.A., R.C. Bishop of Clifton; provost, and domestic prelate to Pope Leo XIII.; co-editor of 'English Roma Sotterranea'; author of 'Early Christian Symbolism'; Memoirs of Melise Brownlow, Sir James Marshall, and Mother Rose Columba Adams, O.P.; Lectures on Slavery and Serfdom, on Church History, on Sacerdotalism, on the Catacombs, and other Archæological subjects; translation of 'Cur Deus Homo,' and 'Vitis Mystica.' (✠ W. R. B.)

**BRUNTON, Sir Thomas Lauder,** M.D., Sc.D., LL.D. (Edin. and Aberd.), F.R.S.; physician to St Bartholomew's Hospital, London; author of 'The Bible and Science,' 'Text-Book of Pharmacology, Therapeutics, and Materia Medica,' 'Disorders of Digestion,' 'Lectures on the Action of Medicines.' (T. L. B.)

**BRYAN, George Hartley,** Sc.D., F.R.S.; Professor of Pure and Applied Mathematics in the University College of North Wales; Fellow of Peterhouse, 1889-95; gold medal Inst. Naval Architects, 1901. (G. H. Br.)

**BRYANT, Hon. Edgar E.,** LL.D.; Justice of the Circuit Court of Arkansas, 1890-97; author of 'Speeches and Addresses,' etc. (E. E. B.)

**BRYCE, Rt. Hon. James,** P.C., D.C.L., LL.D., F.R.S., M.P.; Regius Professor of Civil Law at Oxford, 1870; Under-Secretary of State for Foreign Affairs, 1886; Chancellor of Duchy of Lancaster (with seat in Cabinet), 1892; President of Board of Trade, 1894; Chairman of Royal Commission on Secondary Education, 1894; member of Senate of London University, 1893; corresponding member of Institute of France, 1891; foreign member of Royal Academies of Turin and Brussels, 1896; corresponding member of Società Romana di Storia Patria, 1885; honorary Fellow of Trinity and Oriel Colleges, Oxford; president of the Alpine Club; author of 'Emperor and Empire,' 'Justinian,' 'Procopius,' 'Theodora,' in Ninth Edition of 'Ency. Brit.,' 'The Holy Roman Empire,' 'The Trade Marks Registration Act,' 'Transcaucasia and Ararat,' 'The American Commonwealth,' 'Impressions of South Africa,' etc. (J. Br.)

**BRYDON, J. M.,** the late; architect; designed various Government Offices, Chelsea Town Hall and Polytechnic, Bath Municipal Buildings, etc. (J. M. By.)

**BUCHANAN, John Young,** M.A., F.R.S.; chemist and physicist of the 'Challenger' Expedition; later, Lecturer in Geography, University of Cambridge; author of 'Lake,' 'Mediterranean,' in Ninth Edition of 'Ency. Brit.' (J. Y. B.)

**BUCKLEY, Rev. James Monroe,** D.D., LL.D.; editor of 'The Christian Advocate' (New York); author of 'Travels in three Continents,' 'Faith Healing,' 'Christian Science and Kindred Phenomena,' 'Supposed Miracles,' etc. (J. M. Bu.)

**BÜRDE, Lieut. Johannes,** late of the German army, 51st Infantry Regiment; author of 'Problems of Applied Tactics, with Solutions,' 'Tactical Problems,' etc. (J. Be.)

**BURDETT, Sir Henry,** K.C.B.; founder and editor of the 'Hospital'; late superintendent of the Queen's Hospital, Birmingham, and of the Seamen's Hospital, Greenwich; late secretary Share and Loan Department, London Stock Exchange; author of 'Burdett's Official Intelligence of British, American, and Foreign Securities,' 'The National Debt,' 'Local Taxation in England and Wales,' 'The Patriotic Fund,' 'Hospitals and Asylums of the World,' 'The Relative Mortality of Large and Small Hospitals,' 'Burdett's Hospitals and Charities, a Year-book of Philanthropy,' 'Hospitals and the State,' 'Unhealthiness of Public Institutions,' 'A Practical Scheme for Old Age Pensions,' 'The Registration of Nurses,' 'The Nursing Profession, how and where to Train,' 'Housing of the Poor,' etc. (H. Bt.)

**BURN, Rev. A. E.,** B.D.; Examining Chaplain to the Bishop of Lichfield; author of 'The Athanasian Creed,' 'An Introduction to the Creeds and to the Te Deum,' etc. (A. E. B.)

**BURNSIDE, Rev. Frederick,** M.A.; Hon. Canon St Albans; Rural Dean of Hertford; Hon. editor of the 'Official Year-Book of the Church of England'; compiler of 'The Official Parochial Register of Church Services,' etc. (F. Bu.)

**BURNSIDE, William,** M.A., F.R.S.; Professor of Mathematics, Royal Naval College, Greenwich. (W. Bu.)

**BURROUGHS, John,** author of 'Wake Robin,' 'Signs and Seasons,' 'Birds and

Poets,' 'Fresh Fields,' 'Whitman: A Study,' etc. (J. Bu.)

**BURROWS, Rev. Winfrid Oldfield,** M.A.; Vicar of Holy Trinity, Leeds; formerly Principal of Leeds Clergy School and Tutor of Christ Church, Oxford. (W. O. B.)

**BURTON, Clarence Monroe,** LL.D.; author of 'Life of Cadillac, founder of Detroit,' 'Revisited Landmarks of Detroit,' etc. (C. M. B.)

**BURTON, William,** F.C.S.; author of Cantor Lectures on 'Material and Design in Pottery,' etc. (W. B*.)

**BUTLER, Alfred Joshua,** M.A.; Fellow of Brasenose College, Oxford; author of 'Tyrol' in Ninth Edition of 'Ency. Brit.' (A. J. B.)

**BUTLER, Prof. Nicholas Murray,** Ph.D.; Pres. Columbia University, New York; author of 'The Meaning of Education.' etc.; editor of the 'Educational Review' and of the 'Great Educators' series. (N. M. B.)

## C

**CABLE, George Washington,** A.M., D.L.; author of 'New Orleans' in Ninth Edition of 'Ency. Brit,' 'Old Creole Days,' 'The Grandissimes,' 'Dr Sevier, 'John March, Southerner,' etc. (G. W. Ca.)

**CAILLARD, Sir Vincent Henry Penalver,** K.B.; Assistant Commissioner for England on Montenegrin Frontier Commission, 1879; on Arab Tabia Commission 1879; attached to Sir Beauchamp Seymour, Naval Demonstration, Dulcigno, 1880; service for Intelligence Department, 1882; attached Headquarters Staff Egyptian Campaign, 1882; appointed President Ottoman Public Debt Council, 1883; and Financial Representative of England, Holland, and Belgium in Constantinople; medal and bronze star, Egyptian campaign; Grand Cordons Medjidie and Osmanie; gold medals of Liakat and Nishan-i-Imtiaz; Grand Cordon of Ordre pour le mérite civile. (V. H. P. C.)

**CALLENDAR, Hugh Longbourne,** LL.D., F.R.S.; Professor of Physics, Royal Coll. of Science, London; Professor of Physics, M'Gill Coll. Montreal, 1893-98. (H. L. C.)

**CAMP, Walter,** Newhaven, U.S.A., author of 'Book of College Sports,' 'American Football,' etc. (W. Ca.)

**CAMPBELL, J. G. D.,** M.A.; H.M.'s Inspector of Schools; educational adviser to the King of Siam, 1899-1901. (J. G. D. C.)

**CAMPBELL, Rev. Lewis,** M.A., LL.D.; emeritus Professor of Greek, University of St Andrews; Hon. Fellow of Balliol Coll. Oxford; Gifford Lecturer, St Andrews, 1894-95; author of 'Plato,' 'Sophocles' in Ninth Edition of 'Ency. Brit.,' 'The Christian Ideal,' part 'Life of James Clerk-Maxwell,' 'Sophocles in English Verse,' 'Aeschylus in English Verse,' 'Guide to Greek Tragedy'; edition of 'Plato's Republic' (with late Professor Jowett), 'Life of Benjamin Jowett' (with E. Abbott), 'Religion in Greek Literature,' 'Letters of B. Jowett' (with E. Abbott), 'The Nationalization of the Old English Universities.' (L. C.)

**CARLYLE, E. I.,** M.A., F.R.Hist.Soc.; Fellow of Merton College, Oxford; assist. editor to the 'Dictionary of National Biography.' (E. I. C.)

**CAROE, William Douglas,** M.A., F.S.A.; Architect to Ecclesiastical Commission, to the Dean and Chapter of Canterbury, etc.; Fellow and Member of the Council R.I.B.A.; part author of 'Sefton.' (W. D. C.)

**CARSON, Howard A.,** formerly chief engineer of the Metropolitan (Greater Boston, U.S.A.) Sewerage Commission and now chief engineer of the Boston Transit Commission; in charge of the building of the Boston Subway and the East Boston Tunnel; sometime President of the Boston Society of Civil Engineers. (H. A. C.)

**CARTER, Albert Charles Robinson;** assistant editor of 'The Year's Art,' 1887; editor, 1894; editor of 'The Year's Music,' 1898; contributor to 'The Art Journal' since 1889; art critic of 'Manchester Courier'; art critic for 'Pall Mall Gazette'; writer of 'The Art Annual, 1900, on War Artists.' (A. C. R. C.)

**CARVER, Thomas Gilbert,** M.A., K.C.; author of 'On the Law relating to the Carriage of Goods by Sea.' (T. G. C.)

**CASE, Thomas,** M.A.; Waynflete Professor of Moral and Metaphysical Philosophy, Oxford; Fellow of Magdalen; formerly Fellow and Tutor of B.N.C., and C.C.C.; author of 'Materials for History of Athenian Democracy from Solon to Pericles,' 'Realism in Morals,' 'Physical Realism,' 'St Mary's Clusters.' (T. Ca.)

**CASTLE, Egerton,** M.A., F.S.A.; author of 'Schools and Masters of Fence,' 'Consequences,' 'English Book-Plates,' 'The Light of Scarthey,' 'The Jerningham Letters,' 'The Pride of Jennico,' 'The Bath Comedy,' 'Young April,' 'Marshfield the Observer,' 'The Secret Orchard,' etc. (E. Ca.)

**CHADWICK, Capt. French Ensor,** in command of U.S. cruiser 'New York,' flagship N. Atlantic Squadron; Chief of Staff of Rear-Admiral Sampson in the Spanish-American War. (F. E. Ch.)

**CHALMERS, Mackenzie Dalzell,** C.S.I., M.A.; assistant parliamentary counsel to Treasury, England; counsel to Board of Trade; Judge of County Courts, 1884; acting Chief Justice, Gibraltar, 1893; Commissioner of Assize, 1895; member of the Statute Law Committee, and Board of Faculty of Law of Oxford; law member of the Viceroy's Council in India; author of contributions to 'Dictionary of Political Economy and 'Encyclopædia Britannica,' 'Digest of the Law of Bills of Exchange,' 'Digest of the Law of Sale,' etc. (M. D. Ch.)

**CHAMBERLAIN, Hon. Joshua Lawrence,** A.M., LL.D.; Brigadier-General in the U.S. Civil War; Governor of Maine, 1866-71, and President of Bowdoin College, 1871-83; author of 'Maine' in Ninth Edition of 'Ency. Brit.,' 'Maine: Her Place in History,' 'American Ideals,' etc. (J. L. C.)

**CHANEY, Henry James,** Superintendent Standards Department Board of Trade; Secretary to Royal Commission on Standards 1867-70; represented Great Britain at International Conference on the Metric System, 1901; author of 'Treatise on Weights and Measures.' (H. J. C.)

**CHANNING, Edward,** Ph.D.; Professor of History, Harvard University; author of 'History of the United States,' 'Town and County Government in the English Colonies of North America,' 'Narragansett Planters,' etc.; collaborator with the late Dr Justin Winsor on the 'Narrative and Critical History of America.' (E. Ch.)

**ANUTE, Octave,** late President American Society of Civil Engineers; honorary member Institution of Civil Engineers, Great Britain; author of 'Kansas City Bridges,' 'Progress in Flying Machines,' etc. (O. C.)

**CHAPMAN, Alfred,** M.I.C.E.; designer and constructor of sugar machinery. (A. Ch.)

**CHARLES, Rev. Robert Henry,** M.A., D.D.; Professor of Biblical Greek, Trin. Coll. Dublin; author of 'Book of Enoch,' translated from the Ethiopic and edited 'Ethiopic Text of Book of Jubilees, edited from four MSS.,' 'Book of the Secrets of Enoch,' 'Apocalypse of Baruch,' translated from the Syriac and edited 'The Assumption of Moses,' 'The Doctrine of a Future Life,' 'Jowett Lectures for 1898-99.' (R. H. C.)

**CHATAWAY, James Vincent,** M.L.A., the late; Secretary for Agriculture, Queensland. (J. V. C.)

**CHIROL, Valentine;** B.Lit. University of Paris; foreign editor of 'The Times'; author of 'The Far Eastern Question,' ''Twixt Greek and Turk,' etc. (V. C.)

**CHISHOLM, G. G.,** M A., B.Sc.; author of 'The Commerce of the British Empire,' joint-author of 'Europe' in Stanford's 'Compendium of Geography and Travel'; edited Longman's 'Gazetteer of the World.' (G. G. C.)

**CHISHOLM, Hugh,** B.A.; formerly scholar C.C.C., Oxford; Barrister-at-Law of the Middle Temple; assistant editor of the 'St James's Gazette,' 1892-97; editor, 1897-1900. Contributor to 'Fortnightly Review,' 'National Review,' 'The Times,' 'Standard,' etc.; Joint-editor of the New Volumes of the 'Encyclopædia Britannica.' (H. Ch.)

**CHREE, Charles,** M.A., Sc.D., LL.D., F.R.S.; Fellow of King's College, Camb.; Superintendent Observatory Department, National Physical Laboratory. (C. Ch.)

**CHRISTY, S. B.,** Ph.B.; Professor of Mining and Metallurgy and Dean of the Faculty of the College of Mining, University of California. (S. B. C.)

**CHURCH, Arthur Herbert,** M.A., D.Sc., F.R.S., F.S.A.; Professor of Chemistry, Royal Academy of Arts; Professor of Chemistry in the Royal Agricultural Coll. Cirencester; Lecturer, Cooper's Hill; President of Mineralogical Society, 1898-1901; author of 'Guano,' 'Hemp,' 'Irrigation,' in Ninth Edition of 'Ency. Brit.,' 'Precious Stones,' 'English Earthenware,' 'English Porcelain,' 'The Laboratory Guide,' 'Food Grains of India,' 'Food,' 'Josiah Wedgwood,' 'Colour,' etc. (A. H. C.)

**CHURCH, Col. George Earl;** Member of the Council Roy. Geog. Soc.; President of the Geog. Section, British Association, 1898; author of 'South America, an outline of its Physical Geography,' etc. (G. E. C.)

**CIST, Henry Martyn,** A.M., Cincinnati, U.S.A.; author of 'Army of the Cumberland,' 'Life of Major-General George H. Thomas'; editor of 20 Annual Reports of the Society of the Army of the Cumberland. (H. M. C.)

**CLARK, Charles Hopkins,** editor of 'Hartford Courant,' Conn., U.S.A. (C. H. Cl.)

**CLARK, George A.,** B.L.; Secretary to the Leland Stanford Junior University; Secretary of the U.S. Fur Seal Commission, 1896-1898. (G. A. C.)

**CLARKE, Caspar Purdon,** C.I.E.; Director of Art Museum, South Kensington; late keeper of Art Collections and Assistant Director. (C. P. C.)

**CLARKE, Colonel Sir George Sydenham,** K.C.M.G., F.R.S.; Governor of Victoria, Australia, since 1901; served Egyptian expedition, 1882; Sudan expedition, 1885; Suakin, in Intelligence Department and as Assistant Political Officer; Secretary Colonial Defence Committee; Secretary to Royal Commission on Navy and Army Administration; Superintendent Royal Carriage Factory, 1894-1901; member of Committee on War Office Reorganization, 1900-1901; author of 'Practical Geometry and Engineering Drawing,' 'The Principles of Graphic Statics,' 'Plevna,' 'Fortification Past, Present, and Future,' 'The Navy and the Nation,' 'Imperial Defence,' 'Russia's Sea-power,' etc. (G. S. C.)

**CLAUSEN, George,** A.R.A., R.W.S.; medals: Paris 1889, Chicago 1893, Brussels 1897, Paris 1900. (G. Cl.)

**CLAUSON, Captain John Eugene,** R.E., B.A. London; Secretary Colonial Defence Committee, War Office, London. (J. E. C.)

**CLAYDEN, Peter William,** the late; President Inst. Journalists, London; a President International Congress of the Press, Antwerp, 1894; English member International Bureau of Press; Treasurer, Institute of Journalists' Orphan Fund; author of 'Scientific Men and Religious Teachers,' 'England under Lord Beaconsfield,' 'Early Life of Samuel Rogers,' 'Rogers and his Contemporaries,' 'England under the Coalition,' etc. (P. W. C.)

**CLERC, F. L.,** Denver, Colorado, U.S.A. M. Amer. Soc. of Mining Engineers. (F. L C.)

**CLERK, Dugald,** M.I.C.E.; author of 'The Theory of the Gas Engine,' 'Notes on Motive Power Inventions,' etc. (D. Cl.)

**CLIFFORD, Hugh Charles,** C.M.G.; British Resident, Pahang; nominated by Colonial Office to post of Governor North Borneo and Labuan under Chartered Company, 1900; Resident, Pahang, 1901; Acting Resident, Negri Sembilan, Sept. 1901; author of 'In Court and Kampong, 'Studies in Brown Humanity,' 'Since the Beginning,' 'In a Corner of Asia,' joint author with Sir Frank Swettenham of a Dictionary of the Malay Language. (H. Cl.)

**CLODD, Edward;** author of 'The Childhood of the World,' 'The Childhood of Religions,' 'Jesus of Nazareth,' 'Myths and Dreams,' 'Story of Creation,' 'Story of Primitive Man,' 'Primer of Evolution,' 'Pioneers of Evolution,' 'Tom Tit Tot, an Essay on Savage Philosophy in Folk-Tale,' 'Grant Allen,' 'Story of the Alphabet,' etc. (E. Cl.)

**COBHAM, C. Delaval,** M.A., B.C.L.; British Commissioner, Larnaca, Cyprus; editor of 'Bibliography of Cyprus,' and 'Excerpta Cypria'; translator of Mariti's 'Travels in Cyprus.' (C. D. C.)

**COCKBURN, Hon. Sir John Alexander,** K.C.M.G., M.D.; Fellow King's College, London; Mayor of Jamestown, S. Australia; member of House of Assembly, S. Australia; Minister of Education, 1885-87; Premier and Chief Secretary, 1889-90; Chief Secretary, 1892; Minister of Education and Agriculture, 1893-98; one of the representatives of South Australia at the Federal Conferences in 1890, 1891, 1897, and 1898; Agent-General for South Australia to 1901. (J. A. Co.)

**COGHLAN, T. A.,** A.M.I.C.E.; Government Statistician of New South Wales; author of 'The Mining Industry of New South Wales,' 'A Statistical Account of the Seven Colonies of Australasia'; has also written on the Agriculture, Fauna, and Timber Resources of New South Wales. (T. A. C.)

**COLCLOUGH, John George,** B.A.; late Secretary of the British Chamber of Commerce, Paris; author of 'Ulster,' 'The Law of Contract,' 'Twenty-five Years of Anglo-French Trade,' etc. (J. G. C.)

**COLE, Alan S.;** Asst. Sec. (Art) Board of Education; Ex. for Art, S. Kensington; author of 'Ancient Needle Point and Pillow Lace,' 'Tapestry and Embroidery,' etc.; and editor 'Studies from the Museums,' various descriptive catalogues of Tapestry, Embroidery, Lace, and Egyptian textiles at S. Kens. Mus., etc. (A. S. C.)

**COLLINS, Rev. William Edward,** M.A.; Professor of Ecclesiastical History, King's

Coll., London; Examining Chaplain to the Bishop of St Albans; author of 'The English Reformation and its Consequences,' 'The Nature and Force of the Common Law,' 'Unity, Catholic and Papal,' etc. (W. E. C.)

**COLOMB, Sir John Charles Ready,** K.C.M.G., M.P.; author of 'Protection of Commerce in War,' 'Imperial Strategy,' 'The Distribution of our War Forces,' 'Colonial Defence and Colonial Opinions,' 'The Defence of Great and Greater Britain,' 'Naval Intelligence and Protection of Commerce,' 'The Use and Application of Marine Forces,' 'Imperial Federation, Naval and Military,' 'British Defence,' etc. (J. C. R. C.)

**COLVIN, Sir Auckland,** K.C.S.I., K.C.M.G., C.I.E.; Grand Cordons of Osmanieh and Medjidieh; Comptroller-Gen. Egypt; Financial Adviser to Khedive; Financial member of Viceroy's Council, India; Lieut.-Gov. North-West Provinces and Oudh; author of 'John Russell Colvin,' etc. (A. Co.)

**COLYAR, H. A. de;** of the Middle Temple, Barrister-at-Law; author of 'Law of Guarantees.' (H. A. DE C.)

**COMSTOCK, Brig.-Gen. Cyrus Ballon;** U.S.A., retired; Board of Engineers for Fortifications, U.S. Army; chief engineer, Army of the Potomac, 1862-63; President of the Mississippi River Commission; author of 'Primary Triangulation of the U.S. Lake Survey.' (C. B. C.)

**CONATY, Right Rev. Bishop Thomas James,** S.T.D., J.C.D.; Rector of the Catholic University of America. (✠ T. J. C.)

**CONWAY, Sir William Martin,** M.A.; Slade Professor of Fine Arts, Cambridge; Professor of Art, Univ. Coll. Liverpool, 1885-88; Hon. Sec. Art Congress, 1888-90; President of the Alpine Club; author of 'Dawn of Art in the Ancient World,' a series of Climbers' Guide-books to the Pennine and Lepontine Alps, etc., 'Climbing and Exploration in the Karakoram-Himalayas,' 'The Alps from End to End,' 'The First Crossing of Spitsbergen,' 'With Ski and Sledge over Arctic Glaciers,' 'The Bolivian Andes.' (W. M. C.)

**COOK, Theodore Andrea,** M.A., F.S.A.; author of 'Old Touraine,' 'Rouen,' 'A History of the English Turf,' joint-author of 'Ice-Sports.' (T. A. Co.)

**COOKE, Charles Wallwyn Radcliffe-,** B.A.; author of 'A Treatise on the Agricultural Holdings (England) Act,' 'Four Years in Parliament with Hard Labour,' 'A Book about Cider and Perry'; President, National Association of English Cider-makers. (C. W. R. C.)

**COOLIDGE, Rev. William Augustus Brevoort,** M.A., F.R.G.S.; Fellow of Magdalen College, Oxford; Professor of English History, St David's College, Lampeter, 1880-81; Corresponding Member of the Swiss Hist. Society, 1891; author of 'Jura,' 'Switzerland' (History, Geography, and Statistics), 'Tell,' 'Valais,' 'Zurich' in Ninth Edition of 'Ency. Brit.'; joint author of 'Guide du Haut Dauphiné,' 'Guide to the Central Alps of the Dauphiny,' 'Guide to the Lepontine Alps,' 'The Mountains of Cogne,' 'The Adula Alps,' 'The Range of the Tödi,' 'Guide to Grindelwald,' 'Guide to Switzerland'; editor of 'Alpine Journal,' 1880-89. (W. A. B. C.)

**COPEMAN, Sydney Monckton,** M.A., M.D.; Medical Inspector, Local Government Board; Member of the Council Epidemiological Society; author of 'Vaccination: its Natural History and Pathology,' 'Bacteriology of Vaccine Lymph,' etc. (S. M. C.)

**CORRADINI, Enrico;** late editor of 'La Naziona,' Florence; author of 'La Civia Romanzo,' etc. (E. Co.)

**COTTON, James Sutherland,** M.A.; Hon. Secretary of the Egypt Exploration Fund; late editor of 'The Academy,' London; Fellow and Lecturer of Queen's Coll. Oxford; author of 'Warren Hastings' in Ninth Edition of 'Ency. Brit.,' 'Decennial Report on the Moral and Material Progress of India,' 'India,' 'Elphinstone,' 'Quinquennial Report on Education in India'; editor of 'Paterson's Practical Statutes,' 'The Official Gazetteer of India.' (J. S. Co.)

**COX, General Jacob Dolson,** LL.D., the late; Governor of the State of Ohio (1866-67); U.S. Secretary of the Interior (1869-70); Major-General U.S. Volunteers in the Civil War; Brigade-Commander under General Sherman in the Atlanta campaign; author of 'Atlanta: the March to the Sea,' 'Battle of Franklin,' etc. (J. D. Co.)

**CRACKANTHORPE, Montague Hughes,** K.C., D.C.L.; late member General Council of the Bar and Council of Legal Education; late Chairman Incorporated Council of Law Reporting; Honorary Fellow St John's Coll. Oxford, representative of General Council of Bar at International Congress of Advocates, Brussels, 1897; representative of the same Council at International Congress of the Société de Législation Comparée, Paris, 1900; acting Chairman of the International Commission on Criminal Sentences; author of many legal, social, and political articles. (M. H. C.)

**CRAIES, W. F.;** Barrister, Inner Temple; edited 'A Collection of Statutes relating to Criminal Law,' A Treatise on the construction and effect of Statute Law,' 'The Laws of Insurance,' etc. (W. F. C.)

**CRANE, Walter,** A.R.W.S.; silver medal, Paris, 1889; silver medal, Society of Arts; gold medal, Munich, 1895; first and present President Arts and Crafts Ex. Society (England), 1888; member of Council of Art, Board of Education, and examiner in Design; Hon. Member Dresden Academy of Fine Arts; appointed British Commissioner for the Turin International Exhibition of Decorative Art, 1902; Director of Design, Manchester Municipal School of Art, from 1893-96 (resigned); Hon. Art Director, Reading College, 1898; Principal of the Royal College of Art, South Kensington, 1898-99 (resigned); author and illustrator of 'Baby's Opera,' 'Baby's Banquet,' 'The Sirens Three,' 'Flora's Feast,' 'Queen Summer,' 'Claims of Decorative Art,' 'Renascence, 1891,' 'Decorative Illustration of Books,' 'Spenser's Fairie Queene,' 'The Shepherd's Calendar,' 'Line and Form,' 'A Masque of Days,' etc. (W. CR.)

**CRAWFORD, Francis Marion;** author of many novels, including 'Mr Isaacs,' and 'Saracinesca'; and of 'Ave Roma Immortalis, 'Life of Pope Leo XII.,' 'Constantinople,' etc. (M. CR.)

**CREAK, Capt. Ettrick William,** R.N., C.B., F.R.S.; late Superintendent of Compasses, Hydrographic Department, Admiralty, London. (E. W. C.)

**CREIGHTON, Charles,** M.A., M.D. Aberdeen; author of 'History of Epidemics in Britain,' 'Jenner and Vaccination,' etc. (C. C.)

**CREWE, Earl of,** P.C., M.A., F.S.A.; President of the Literary Fund; assist. priv. sec. to Sec. for Foreign Affairs, 1883-84; Lord-Lieut. of Ireland, 1892-95; author of 'Stray Verses,' articles on Ireland, etc. (C.)

**CRIMP, Santo,** M.I.C.E; the late; author of 'Sewage Disposal Works'; joint author of 'Tables and Diagrams for use in designing sewers and water mains,' etc. (S. CR.)

**CRITCHELL, James Troubridge;** London Correspondent of the 'Brisbane Courier,' 'North Queensland Herald,' etc.; author of 'Preliminary Enquiry into the Markets of the European Continent,' 'Guide to Queensland,' etc. (J.T.CR.)

**CROOKES, Sir William,** F.R.S.; Past President of the Chemical Society, Great Britain; Past President of the Institution of Electrical Engineers; editor of 'Chemical News,' President of the British Association for the Advancement of Science, 1898; editor of 'Quarterly Journal of Science'; Professor of Chemistry, Training Coll., Chester, 1855; author of 'Assaying' in Ninth Edition of 'Ency. Brit.'; 'Select Methods in Chemical Analysis,' 'Manufacture of Beetroot-Sugar in England,' 'Handbook of Dyeing and Calico-Printing,' 'Dyeing and Tissue Printing,' 'Kerl's Treatise on Metallurgy,' with Ernst Rohrig, 'Wagner's Chemical Technology,' 'Auerbach's Anthracen and its Derivatives,' 'Ville's Artificial Manures,' 'A Solution of the Sewage Question,' 'The Profitable Disposal of Sewage,' 'The Wheat Problem,' etc. (W. C.)

**CROSS, Charles Robert,** B.Sc.; Professor of Physics and Director of Rogers Laboratory, Massachusetts Institute of Technology; Director of Rumford Committee, American Academy of Arts and Sciences. (C. R. CR.)

**CROZIER, Capt. T. H.,** R.A.; Professor of Artillery, Ordnance College, Woolwich. (T. H. C.)

**CRUMP, Charles George,** B.A.; of H.M. Record Office; editor 'The History of the Life of Thomas Ellwood,' 'The Works of Walter Savage Landor,' etc. (C. G. CR.)

**CUNDALL, F.;** Sec. and Librarian, Institute of Jamaica; author of 'Studies in Jamaica History,' 'The Story of the Life of Columbus and Discovery of America'; edited 'Bibliotheca Jamaicensis,' etc. (F. CU.)

**CUNNINGHAM, J. T.,** M.A.; late Fellow of University Coll., Oxford; lecturer for Fisheries, Tech. Instruction Com. of Cornwall; late Asst. Professor of Natural History, Edinburgh; also Naturalist to Marine Biological Assoc. of the U.K.; author of 'Treatise on Common Sole,' 'Marketable Marine Fishes of the British Isles,' 'Sexual Dimorphism,' etc. (J. T. C.)

**CURRAN, Rev. J. Milne;** author of 'Geology of Sydney and the Blue Mountains,' 'A Contribution to the Geology and Petrography of Bathurst,' etc. (J. M. CU.)

## D

**DABNEY, Charles William,** Ph.D.; Pres. Univ. of Tennessee; assistant U.S. Secretary Agriculture, 1893-97, etc. (C. W. D.)

**DABNEY, Richard Heath,** A.M., Ph.D.; Professor of Historical and Economical Science, University of Virginia; author of 'The Causes of the French Revolution,' 'John Randolph: a Character Sketch.' (R. H. D.)

**DALBY, W. Ernest,** M.A., B.Sc., M.I.C.E., M.I.M.E., Assoc. M.I. Nav. Architects; Professor of Mechanical Engineering and Applied Mathematics, City and Guilds Technical College, Finsbury. (W. E. D.)

**DALE, T. F.;** author of 'The Game of Polo, part-editor of 'Riding and Polo.' (T. F. D.)

**DALL, Hon. William Healey,** A.M.; naturalist, U.S. National Museum; author of 'Alaska and its Resources,' 'Tribes of the Extreme North-west,' etc. (W. H. D.)

**DALLAS, J. M. M.;** late Secretary of the Edinburgh Draughts Club. (J. M. M. D.)

**DANNREUTHER, Edward,** Professor Royal Coll. Mus.; author of 'Musical Ornamentation,' 'Liszt's Études,' 'Richard Wagner.' (E. DA.)

**DARWIN, George Howard,** M.A., LL.D., D.Sc., F.R.S.; Plumian Professor of Astronomy and Experimental Philosophy, Cambridge; Fellow of Trin. Coll Camb.; author of 'Tides,' in Ninth Edition of 'Ency. Brit.' 'Reports to B.A on Harmonic Analysis of Tidal Observations,' 'Memoirs on the Effects of Tidal Friction on the Earth and on the Moon,' Phil. Trans. Roy. Soc., 'The Tides and Kindred Phenomena in the Solar System,' etc. (G. H. D.)

**DARWIN, Leonard, Major,** late R.E.; Intelligence Dept. War Office, 1885-90; served on several scientific expeditions, including Transit of Venus of 1874 and 1882; author of 'Bi-metallism.' (L. D.)

**DAVENPORT, Cyril James H.,** F.S.A.; British Museum; silver medal Society of Arts, 1900; binding editor to the Anglo-Saxon Review; author of 'The English Regalia,' 'Royal English Bookbindings,' 'Cantor Lectures on Decorative Bookbindings,' 'English Embroidered Bookbindings,' 'Life of T. Berthelet.' (C. D.)

**DAVEY of Fernhurst, Lord,** D.C.L., F.R.S.; Lord of Appeal in Ordinary; Solicitor-General, 1886; Lord Justice of Appeal, 1893. (D.)

**DAVIDS, T. W. Rhys,** LL.D., Ph.D.; Secretary and Librarian Royal Asiatic Society; Professor of Pali and Buddhist Literature, Univ. Coll. London; author of 'Buddhism,' 'Jains,' 'Lamaism,' in Ninth Edition of 'Ency. Brit.,' 'Buddhism,' 'Buddhist Birth Stories,' 'Buddhist Suttas from the Pali,' 'Hibbert Lectures,' 1881, etc. (T. W. R. D.)

**DAVIDSON, William Leslie,** M.A., LL.D.; Professor of Logic and Metaphysics, Aberdeen University; author of 'English Words Explained,' 'Theism as grounded in Human Nature,' 'A Philosophical Centenary: Reid and Campbell,' 'Christian Ethics.' (W. L. D.)

**DAVIES, A. Llewelyn,** B.A.; Barrister, Inner Temple; Assistant Reader in Common Law under the Council of Legal Education. (A. LL. D.)

**DAVIES, Henry Walford,** Mus. Doc. (Camb.), A.R.C.M. (Lond.); organist and director of the choir, Temple Church, London; formerly organist and choirmaster, St Anne's, Soho; teacher of counterpoint, R.C.M., 1895. (H. W. D.)

**DAVIS, John Patterson,** Ph.D., A.M.; assistant in History and Economics, University of Michigan, 1894-1895; now Attorney-at-Law, Nampa, Idaho; author of 'The Union Pacific Railway,' etc. (J. P. D.)

**DAVIS, William Morris,** Professor Physical Geography, Harvard University; author of 'Physical Geography' and numerous scientific publications. (W. M. D.)

**DAWKINS, William Boyd,** M.A., D.Sc., F.R.S., F.S.A., F.G.S., A.M.I.C.E.; Professor of Geol. and Palæontology in Owens College, Manchester; geologist on Geological Survey of Great Britain, 1861-69; author of 'Cave' in Ninth Edition of 'Ency. Brit.,' 'Cave Hunting,' 'Early Man in Britain,' 'British Pleistocene Mammalia.' (W. B. D.)

**DAWSON, George Mercer,** LL.D., F.R.S., the late; Director Geological Survey of Canada; Geologist and Naturalist to H.M. North American Boundary Commission, 1873-75; one of

H.M. Behring Sea Commissioners, 1891, and under the Behring Sea Joint Commission Agreement, 1892; author of numerous scientific and technical reports printed by the Canadian Government, and scientific and other papers. (G. M. D.)

**DAY, Lewis F.**; English Designer and Art Lecturer; Med. Paris Exhibition (1900); Examiner for Art, Board of Education; author of 'Windows—Stained and Painted Glass,' 'The Anatomy of Pattern,' 'The Distribution of Ornamental Design,' 'Nature in Ornament,' etc. (L. F. D.)

**DAYOT, Armand**; Inspector of Fine Arts, Ministry of Fine Arts, France; author of 'Un siècle d'art,' 'La Révolution Française, d'après des peintures, sculptures, etc.,' 'Les maîtres de la caricature Française au XIXe siècle,' etc. (A. DA.)

**DEACON, George Frederick,** M.I.M.E.; Member of Council of Institution of Civil Engineers, London; investigated schemes for water-supply of Liverpool; projected the Vyrnwy scheme; carried out part of it in conjunction with the late Thomas Hawksley; President Association of Municipal and County Engineers, 1878; President Engineering Section Sanitary Institute, 1894; President Mechanical Science Section, British Association, Toronto, 1897. (G. F. D.)

**DEANS, Richard Storry,** LL.B.; Barrister-at-Law, Gray's Inn. (R. S. D.)

**DENNING, W. F.,** F.R.A.S.; Gold Medal, R.A.S.; President Liverpool Ast. Society, 1877-78; author of 'Telescopic Work for Starlight Evenings,' 'The Great Meteoric Shower,' etc. (W. F. D.)

**DE VILLIERS, John Abraham J.**; British Museum. (J. A. J. DE V.)

**DE VINNE, Theodore Low,** printer and typographist, New York; head of the firm of Theodore L. de Vinne and Co.; author of 'Printers' Price List,' 'Invention of Printing,' 'Historic Types,' etc. (T. L. DE V.)

**DEWAR, James,** M.A., Hon. LL.D. (Glasgow, St Andrews, Edin.), D.Sc. (Victoria), F.R.S., F.R.S.Ed., F.I.C., F.C.S.; Professorial Fellow of Peterhouse, Camb.; Jacksonian Professor of Experimental Philosophy, Cambridge; Fullerian Professor of Chemistry, Royal Institution, London; Vice-President of the Royal Society; a Director of the Davy-Faraday Research Laboratory; President British Association for 1902; co-inventor with Sir Frederick Abel of cordite; late member of the Government Explosives Committee; author of 'Alum,' etc. in Ninth Edition of 'Ency. Brit.,' numerous papers contributed to the proceedings of the Royal Societies of London and Edinburgh, the Royal Institution, the British Association, the Chemical Society, etc. (J. DR.)

**DIBDIN, Charles,** F.R.G.S., A.V.I.; Knight of St John of Jerusalem in England; Hon. Corresponding Member of Institutions de Prévoyance, France; Secy. of the Royal National Lifeboat Institution, England; Hon. Secy. of the Civil Service Lifeboat Fund. (C. DI.)

**DIBDIN, Lewis Tonna,** K.C., D.C.L. (Durham), F.S.A.; author of 'Church Courts,' 'City Livery Companies,' 'Brewer's Endowment and Establishment,' 'Monasticism in England,' 'Hanson's Death Duties.' (L. T. D.)

**DICEY, Edward,** C.B., B.A.; editor of 'The Observer' (London), 1870-89; author of 'Rome in 1860,' 'Cavour,' 'The Morning Land,' 'England and Egypt,' 'Victor Emmanuel,' 'Bulgaria, the Peasant State,' 'The Story of the Khedivate,' etc. (E. D.)

**DICKEY, Rev. Charles A.,** D.D.; President of the Presbyterian Hospital in Philadelphia; Moderator of the General Assembly of the Presbyterian Church in the U.S., 1900. (C. A. D.)

**DICKSON, Henry Newton,** B.Sc., F.R.S.E., F.R.G.S.; late Vice-President Royal Meteorological Society; Lecturer in Physical Geography, Oxford; author of 'Meteorology: the Elements of Weather and Climate,' etc. (H. N. D.)

**DIXON, Capt. J. Whitly,** R.N.; conservator of the river Humber; late Staff Commander of the Medway Fleet Reserve; author of 'Mariner's Compass in an Iron Ship,' etc. (J. W. D.)

**DOBSON, George**; Petersburg; author of 'Russia's Railway Advance and Central Asia,' etc. (G. D.)

**DOBSON, Henry Austin,** Principal, H.M. Board of Trade, to 1901; author of 'Hogarth' in Ninth Edition of 'Ency. Brit.'; 'Proverbs in Porcelain,' 'Old-World Idylls,' 'At the Sign of the Lyre,' 'Collected Poems,' 'Thomas Bewick and his Pupils,' Lives of Fielding, Steele, Goldsmith, Horace Walpole, William Hogarth, 'Four Frenchwomen,' 'Eighteenth Century Vignettes,' 'A Paladin of Philanthropy,' etc. (A. D.)

**DODD, Lieut.-Col. John Richard,** M.B., F.R.C.S., R.A.M.C.; Medical Officer, Royal Arsenal, Woolwich. (J. R. D.)

**DOUGLAS, James,** LL.D.; member and Vice-President Am. Inst. of Mining Engineers; member Am. Philosoph. Soc., Am. Geolog. Soc., Society of Arts, London, etc.; formerly Professor of Chemistry, Morrin College, Quebec; author of 'Canadian Independence,' 'Imperial Federation and Annexation,' numerous technical articles and reports, etc. (J. DS.)

**DOUGLAS, Robert Kennaway,** Keeper of Oriental Printed Books and MSS. at the British Museum; Professor of Chinese, King's Coll. London; appointed China Consular Service, 1858; retired, and appointed assistant in charge of Chinese Library, British Museum, 1865; author of 'Canton,' 'China,' 'Jenghiz Khan,' 'Manchuria,' etc., in Ninth Edition of 'Ency. Brit.,' 'The Language and Literature of China,' 'Confucianism and Taoism,' 'China,' 'A Chinese Manual,' 'The Life of Li Hung-Chang,' 'China.' (R. K. D.)

**DOUGLASS, William Tregarthen,** M.I.C.E., M.I.M.E., M.I.E.E.; late Resident Engineer to the Trinity House; Con. Eng. to Govts. of W. Australia, N. S. Wales, Victoria, Cape of Good Hope, etc.; erected the Eddystone, Bishop Rock Lighthouses, etc.; author of 'The New Eddystone Lighthouse,' 'On the More Efficient Lighting of Estuaries and Rivers,' etc. (W. T. D.)

**DOWSON, J. Emerson,** M.I.C.E., M.I.M.E.; Inventor of the Dowson Gas Plant; part author of 'Tramways,' 'Decimal Coinage,' etc. etc. (J. E. DO.)

**DREYER, John Louis Emil,** Director Armagh Observatory; assist. Astronomer at Dublin University Observatory, 1878-82; author of 'Observatory,' 'Sextant,' 'Time,' 'Transit Circle,' in Ninth Edition 'Ency. Brit.,' 'Second Armagh Catalogue of 3300 Stars,' 1886, 'New General Catalogue of Nebulæ and Clusters of Stars,' 'Tycho Brahe'; co-editor 'Copernicus: an International Journal of Astronomy,' 1881-84. (J. L. E. D.)

**DRIESCH, Hans A. E.,** Ph.D. Jena; Stazione Zoologica, Naples; author of 'Analytical Theory of Organic Development,' 'Biology,' etc. (H. A. E. D.)

**DRIVER, Rev. Samuel Rolles,** D.D., D.Litt.; Regius Professor of Hebrew, and Canon of Christ Church, Oxford; member of Old Testament Revision Company; author of 'Isaiah,' 'Notes on the Hebrew Text of the Books of Samuel,' 'An Introduction to the Literature of the Old Testament,' various commentaries; joint-editor of the 'Holy Bible, with various renderings and readings from the best authorities,' 'A Hebrew and English Lexicon of the Old Testament.' (S. R. D.)

**DUFF, Rt. Hon. Sir Mountstuart Elphinstone Grant,** P.C., M.A., D.L., G.C.S.I., F.R.S.; Under-Secretary of State for India, 1868-74; Under-Secretary for the Colonies, 1880-81; Governor of Madras, 1881-86; Member of Senate University of London, 1891; President Royal Geographical Society, 1889-93; President Royal Historical Society, 1892-99; author of 'Miscellanies, Political and Literary,' 'Memoir of Sir H. S. Maine,' 'Ernest Renan,' 'Memoir of Lord de Tabley,' 'Notes from a Diary.' (M. G. D.)

**DUFFIELD, William Bartleet**; of the Inner Temple, Barrister-at-Law. (W. B. DU.)

**DU FIEF, J.**; Secrétaire, Société Royale Belge de Géographie, Bruxelles; author of 'Atlas du Belgique,' 'Les decouvertes maritimes des Portugais au XVe siècle,' 'Les Expeditions Belges au Katenga,' etc. (J. DU F.)

**DUNCAN, Louis,** Ph.D.; sometime President of the American Institute of Electrical Engineers, and Associate Professor of Electricity, Johns Hopkins University, Baltimore. (L. DU.)

**DUNCAN, P.**; Secretary's Department, Inland Revenue Office, London. (P. D.)

**DUNNING, William Archibald,** Ph.D.; Professor of History, Columbia University, New York; member of The American Historical Association; author of 'Essays in Reconstruction,' etc.; editor 'Political Science Quarterly.' (W. A. D.)

**DUTT, Romesh Chunder,** C.I.E.; Lecturer Indian History, Univ. Coll. London; Fellow of the Calcutta Univ.; Divisional Commissioner, 1894 and 1895, being the only native of India who attained that position in the last century; author of a series of historical and social novels in Bengali, and a translation of the Rig Veda and other Sanscrit religious works into that language; in English, 'Civilization in Ancient India,' 'Lays of Ancient India,' 'Maha-bharata,' condensed into English verse, 'Ramayana,' condensed into English verse, 'England and India, 1785-1885'; 'Famines in India.' (R. C. D.)

**DYER, Sir William Turner Thiselton-,** M.A., B.Sc., LL.D., Ph.D., K.C.M.G., C.M.G., C.I.E., F.R.S.; Director, Royal Gardens, Kew; Fellow, University of London, 1887-90; V.P.R.S. 1896-97; joint-author of 'Biology' in Ninth Edition of 'Ency. Brit.,' 'Flora of Middlesex,' edited English edition of Sachs' 'Text-book of Botany,' 'Flora Capensis,' etc. (W. T. T.-D.)

## E

**EARDLEY-WILMOT, Rear-Admiral Sydney M.,** R.N.; author of 'The British Navy, Past and Present,' 'The Next Naval War,' 'Our Flags: Their Origin, Use, and Traditions,' 'The Development of Navies during the Last Half Century,' etc. (S. M. E.-W.)

**EATON, Fred. A.**; Secretary to the Royal Academy, London; edited Thausing's 'Albert Durer: His Life and Works.' (F. A. E.)

**EDGINGTON, Charles,** M.A.; President Oxford University Speed Skating Club; holder since 1898 of the world's speed record for the hour (19 m. 348 yds.). (C. E.)

**EDGEWORTH, Francis Ysidro,** M.A.; D.C.L.; Professor of Political Economy, Oxford, Fellow of All Souls' Coll. Oxford; Fellow of King's Coll. London; editor of the 'Economic Journal'; author of 'Mathematical Psychics,' etc. (F. Y. E.)

**EDWARDS, William Seymour,** Attorney and Counsellor-at-law, U.S.A.; author of 'Coals and Cokes in West Virginia.' (W. S. E.)

**EGERTON, H. E.**; author of 'A Short History of British Colonial Policy,' 'Sir Stamford Raffles,' 'Essays on Christ's Hospital,' etc. (H. E. EG.)

**ELIOT, Charles William,** LL.D., D.C.L.; President of Harvard University; author of 'American Contributions to Civilization,' 'Educational Reform,' etc. (C. W. E.)

**ELIOT, Whately,** M.I.C.E.; conducted survey of the coast of New Zealand; late Engineer to Peterhead Harbour Board; Resident Engineer Eastham section of the Manchester Ship Canal; Superintendent Civil Engineer, Keyham Dockyard Extension, etc. (W. E.)

**ELLINGTON, E. B.,** M.I.C.E.; Member of the Council M.E.; Member of the Société des Ingénieurs Civils de France; Chief Engineer London and Liverpool Hydraulic Power Companies, etc.; inventor of numerous improvements in hydraulic machinery. (E. B. E.)

**ERNST, Gen. Oswald Herbert**; Brigadier-General U.S.A.; member of the U.S. Isthmian Canal Commission; Engineer in charge of Western River Improvements, 1878-86, and of Harbour Improvements on Texas Coast, 1886-89; Superintendent U.S. Military Academy, 1893-98; author of 'Manual of Practical Military Engineering,' etc. (O. H. E.)

**EVANS, Hon. Henry Clay**; U.S. Commissioner of Pensions, Washington. (H. C. E.)

**EVERETT, Commander Allan F.,** R.N.; Signal School, H.M.S. 'Victory,' Portsmouth. (A. F. E.)

**EVERETT, Joseph David,** M.A., D.C.L., D.Sc., F.R.S.; late Professor of Natural Philosophy, Queen's Coll. Belfast; Assist. to Professor of Mathematics, Glasgow, 1864-67; author of 'Centimètre-Gramme-Second System of Units,' English edition of 'Deschanel's Physics,' 'Elementary Text-Book of Physics,' 'Outlines of Natural Philosophy.' (J. D. E.)

**EWART, James Cossar,** M.D., F.R.S.; Regius Professor of Natural History, Edinburgh; Professor Natural History, Aberdeen, 1878-82; member Fishery Board for Scotland; author of 'The Locomotor System of the Echinoderms' (with the late G. J. Romanes), 'On the Progress of Fish Culture in America,' 'On Whitebait,' 'On the Preservation of Fish,' 'The Development of the Limbs of the Horse.' (J. C. E.)

**EWING, James Alfred,** M.A., B.Sc., F.R.S., M.I.C.E.; Professor of Mechanism and Applied Mechanics, Cambridge; Fellow of King's College, Cambridge; Professor of Mechanical Engineering at the Imperial University, Tokyo, Japan, 1878-83; author of 'Pneumatic Despatch,' 'Seismometer,' 'Sewerage,' 'Siemens,' 'Steam Engine,' 'Strength of Materials' in Ninth Edition of 'Ency. Brit.,' 'Treatise on Earthquake Measurement,' 'Magnetic Induction in Iron and other Metals,' 'The Steam Engine and other Heat Engines,' etc. (J. A. E.)

**EXETER, Bishop of, Right Rev. Herbert Edward Ryle,** D.D., B.A.; Warburton Lecturer 1899-1903; Fellow King's College, Cambridge, 1881; Divinity Lecturer at

Emmanuel College, Cambridge, 1881-84; at King's College, 1882-86; Principal of St David's College, Lampeter, 1886-88; Professorial Fellow of King's College, Cambridge, 1888; examining chaplain to late Bishop of St Asaph, 1887-89, and to Bishop of Ripon, 1889; Hon. Canon of Ripon, 1895; Chaplain to the Queen, 1898-1901; Hulsean Professor of Divinity, Cambridge University, 1887-1901, and President of Queens' College, Cambridge, 1896-1901; author of 'The Canon of the Old Testament,' 'The Early Narratives of Genesis,' 'Commentary on Ezra and Nehemiah,' 'Philo and Holy Scripture,' etc. (H. E. R.)

## F

**FAIRBAIRN, Andrew Martin,** M.A., D.D., LL.D.; Principal Mansfield Coll. Oxford; Principal of Airedale Coll. 1877-1886; Chairman of Congregational Union of England and Wales, 1883; Member of Royal Commission on Secondary Education, 1894-95; author of 'Arminius,' 'Independents,' in Ninth Edition of 'Ency. Brit.,' 'Studies in the Life of Christ,' 'The City of God,' 'Religion in History and in Modern Life,' 'Catholicism, Roman and Anglican,' 'The Philosophy of the Christian Religion,' etc. (A. M. F.)

**FAIRBROTHER, William Henry,** M.A., Lecturer in Philosophy, Lincoln College, Oxford; author of 'Philosophy of Thomas Hill Green.' (W. H. F$^x$.)

**FAIRLIE, John A.,** Ph.D.; Asst. Prof. of Administrative Law, Univ. of Michigan; author of 'Municipal Government.' (J. A. Fa.)

**FARMER, John Bretland,** M.A., F.R.S.; Professor of Botany, Royal College of Science, London; Demonstrator of Botany, University of Oxford, 1887-92; Fellow of Magdalen College, Oxford, 1889; Assistant Professor of Biology, 1892-95; author of 'Memoirs, chiefly Botanical and Cytological.' (J. B. F.)

**FARRAR, Very Rev. Frederic William,** D.D., F.R.S.; Dean of Canterbury; Hulsean Lecturer at Cambridge; Bampton Lecturer at Oxford; Chaplain to the Speaker of the House of Commons, 1890-95; author of 'Jesus Christ' in Ninth Edition of 'Ency. Brit.,' 'The Life of Christ,' 'The Life of St Paul,' 'The Early Days of Christianity,' 'Darkness and Dawn,' 'The Bible, its Meaning and Supremacy,' etc. (F. W. F.)

**FAUNCE, W. H. P.,** A.M., D.D.; President of Brown University, Providence, R.I. (W. H. P. F.)

**FAUR, G.,** of the Egyptian Hall, London. (G. Fa.)

**FERGUSON, J.;** editor of the 'Ceylon Observer,' 'Tropical Agriculturist,' etc.; author of 'Handbook to Ceylon,' manuals on Coffee, Tea, Gold, Gems, etc. (J. F.)

**FERRERO, Baron Augusto;** editor of 'La Tribuna,' Rome; author of 'Nostalgie d'Amore'; edited 'From Florence to Rome: A Political Diary of 1870-71,' etc. (A. Fe.)

**FFOULKES, Miss C. Jocelyn;** translator of Morelli's 'Italian Painters,' etc. (C. J. F.)

**FIDLER, H.;** Civil Engineer, head of Technical Staff Department of Civil Engineer-in-Chief, Admiralty; editor of 'A Manual of Construction,' etc. (H. F.)

**FIELD, Capt. A. Mostyn,** R.N.; F.R.A.S., F.R.G.S., F.R.Met.S.; has worked for the Hydrographic Survey in various parts of the world. (A. M. F*.)

**FILON, Pierre Marie Augustin;** agrégé ès lettres; French Critic; tutor to the late Prince Imperial; literary editor of the 'Revue Bleue'; author of 'Le Mariage de Londres,' 'Histoire de la Littérature Anglais,' 'English Profiles,' and works on the French and English drama. (A. Fi.)

**FISHER, Alexander;** English teacher and specialist in the art of enamelling; author of technical articles in the 'Magazine of Art,' the 'Studio,' etc. (A. Fi*.)

**FISHER, George Park,** D.D., LL.D.; Professor of Ecclesiastical History, Yale; author of 'The Reformation,' 'History of the Christian Church,' 'The Colonial Era,' etc. (G. P. F.)

**FISKE, John,** LL.D., the late; author of 'Discovery of America,' 'American Revolution,' 'The Mississippi Valley in the Civil War,' 'Cosmic Philosophy,' etc. (J. Fi.)

**FITCH, Charles H.,** in charge of the Indian Territory Section, U.S. Geological Survey. (C. H. F.)

**FITCH, Sir Joshua Girling,** M.A., LL.D.: Chief Inspector of Training Colleges, retired 1894; H.M. Inspector of Schools, 1863; Chevalier of the Legion of Honour; Governor of St Paul's School, London, and Girton College, Cambridge; author of 'Lectures on Teaching,' 'The Arnolds and their Influence on English Education,' 'Educational Aims and Methods.' (J. G. F.)

**FITZGERALD, Vice-Adml. Charles Cooper Penrose;** Superintendent, Pembroke Dockyard; second in command of the China Station, 1898-1899; author of 'Boat Sailing,' 'Life of Sir George Tryon.' (C. C. P. F.)

**FITZGERALD, J. D.** (J. D. F.)

**FITZMAURICE-KELLY, James;** corresponding member of the Spanish Academy; author of 'A History of Spanish Literature,' 'The Life of Miguel de Cervantes Saavedra,' etc. (J. F.-K.)

**FLEMING, C. J. N.,** B.A.; Scottish International Football Player; member of Committee of Scottish Rugby Football Union. (C. J. N. F.)

**FLEMING, John Ambrose,** M.A., D.Sc., F.R.S.; Pender Professor of Electrical Engineering, Univ. College, London; Fellow of Univ. Coll. London; author of 'Treatise on the Alternate Current Transformer,' 'Electric Lamps and Electric Lighting,' 'Magnets and Electric Currents,' 'A Handbook for the Electrical Laboratory and Testing Room.' (J. A. F.)

**FOOTE, Arthur De Wint;** Superintendent of North Star Mining Company, California; Member of the American Society of Civil Engineers. (A. De W. F.)

**FORBES, Dr H. O.,** LL.D., F.R.G.S.; Director of Museums, Liverpool; author of 'A Naturalist's Wanderings in the Eastern Archipelago,' etc. (H. O. F.)

**FORD, Worthington Chauncey,** Public Library, Boston, U.S.A.; Chief of Bureau of Statistics, U.S. Department of State, 1885-89, and of Bureau of Statistics, U.S. Treasury Department, 1893-98; author of 'American Citizen's Manual,' etc. (W. C. F.)

**FORD, W. J.,** M.A.; author of 'A Cricketer on Cricket.' (W. J. F.)

**FORTIER, Alcée,** Litt.D.; Professor of Romance Language, Tulane University, New Orleans; sometime President of the Modern Language Association of America, and of the American Folk-Lore Society; President of the Louisiana Historical Society since 1894; author of 'Louisiana Studies,' 'Louisiana Folk Tales,' etc. (A. Fo.)

**FOSTER, Clement Le Neve,** B.A., D.Sc., F.R.S.; Professor of Mining at Royal School of Mines, London; Examiner in Mining for the Board of Education; Geological Survey of Great Britain, 1860-65; H.M. Inspector of Mines, 1873-1901; author of 'Mining' in Ninth Edition of 'Ency. Brit.,' 'Ore and Stone Mining,' etc. (C. L. N. F.)

**FOSTER, Hon. John Watson,** LL.D.; ex-U.S. Minister to Mexico, Russia, and Spain; U.S. Secretary of State 1892-93, and Agent of the United States in the Behring Sea Arbitration. (J. W. Fo.)

**FOSTER, Sir Michael,** D.C.L., D.Sc., LL.D., K.C.B., F.R.S., M.P.; Professor of Physiology, Cambridge; secretary R.S.; President British Ass., 1899; author of 'Physiology' in Ninth Edition of 'Ency. Brit.,' 'Text-Book of Physiology,' 'Lectures on History of Physiology'; joint-editor of 'Scientific Memoirs of Thomas Henry Huxley,' etc. (M. F.)

**FOWLER, G. H.,** Ph.D. Leipsic; late Hon. Secretary, Marine Biological Association, Plymouth; edited 'The Hydromedusa,' and 'The Leptomedusa,' Marshall's 'The Frog,' Erichson's 'Scientific Progress in Entomology.' (G. H. Fo.)

**FOX, Francis,** M.I.C.E.; author of 'On the Results of Trials of Varieties of Iron Permanent Way,' and various papers on 'Ventilation, Tunnelling,' etc. (F. Fo.)

**FOX, Major;** head of London Salvage Corps. (F. J. F.)

**FRANKLIN, Fabian,** Ph.D.; editor of 'Baltimore News,' Baltimore, U.S.A.; formerly Professor of Mathematics, Johns Hopkins University. (F. Fr.)

**FRANTZ, Henri;** art critic, 'Gazette des Beaux Arts,' Paris. (H. Fr.)

**FREAM, William,** LL.D., F.G.S. F.L.S., F.S.S.; Lecturer on Agricultural Entomology, Edin. Univ.; author of 'Elements of Agriculture,' 'Soils and their Properties,' 'The Complete Grazier,' etc. (W. Fr.)

**FREEMANTLE, Commander S.,** R.N.; part author of 'Nautical Terms and Phrases in French and English,' etc. (S. Fr.)

**FRERE, Rev. Walter Howard,** M.A.; Superior of the Community of the Resurrection; author of 'A New History of the Book of Common Prayer,' 'Notes on the Early History of the Use of Incense'; editor 'Bibliotheca Musico-Liturgica,' 'The Marian Reaction,' etc. (W. H. F.)

**FRY, Rt. Hon. Sir Edward,** B.A., D.C.L., LL.D., F.R.S., F.S.A., F.L.S.; Judge of High Court, Chancery Division, 1877-83; Lord Justice of Appeal, 1883-92; Fellow University of London and Univ. Coll. London; Hon. Fellow of Balliol Coll. Oxford; presided over the Royal Commission on the Irish Land Acts, 1897-98; author of 'Quakers' in Ninth Edition of 'Ency. Brit.,' 'The Specific Performance of Contracts,' 'British Mosses,' 'James Hack Tuke,' etc. (E. F.)

**FULTON, Robert Burwell,** A.M., LL.D.; Chancellor of the University of Mississippi; author of 'Mississippi, State' in Ninth Edition of 'Ency. Brit.' (R. B. F.)

## G

**GADOW, Hans Friedrich,** Ph.D., Hon. M.A. Cambridge, F.R.S.; Strickland Curator and Lecturer on Zoology, Cambridge; British Museum, Natural History Department, 1880-82; author of 'In Northern Spain,' 'A Classification of Vertebrata,' 'Aves in Bronn's Animal Kingdom,' 'Amphibia and Reptiles,' and papers in Royal Society Philosophical Transactions and other scientific periodicals. (H. F. G.)

**GALLWEY, Lt.-Col. Henry Lionel,** C.M.G, D.S.O.; Deputy Commissioner and Consul, Niger Coast Protectorate; Acting Consul-General, 1896-98, Oil Rivers Protectorate; in command of a Haussa company during operations in Benin country, including capture of Benin City, 1897, etc. (H. L. G.)

**GAMBLE, F. W.,** editor of 'Junior Course of Practical Zoology,' 'Flatworms and Mesozoa,' etc. (F. W. Ga.)

**GANNETT, Henry;** Chief Geographer U.S. Geological Survey; Chief Geographer 10th, 11th, and 12th U.S. Censuses; author of 'Idaho,' etc., in Ninth Edition of 'Ency. Brit.,' 'Dictionary of Altitudes,' 'Statistical Atlas of the U.S.,' etc. (H. G*.)

**GARCKE, Emile,** M.I.E.E., F.S.S.; Manager of the Brush Electrical Engineering Co.; Chairman Elect. Sect. London Chamber of Commerce, 1884-88; Member of Council, Tramways and Light Railways Assoc.; author of 'Manual of Electrical Undertakings,' joint-author of 'Factory Accounts.' (E. Ga.)

**GARDNER, Ernest Arthur;** Yates Professor of Archæology, University College, London; Director of British School of Archæology at Athens, 1887-95; author of 'Handbook of Greek Sculpture,' 'Journal of Hellenic Studies,' many articles on Greek art, archæology, and excavations, from 1882; joint-editor of the 'Journal of Hellenic Studies' since 1897. (E. Gr.)

**GARDNER, J. Starkie,** English Iron Worker and Expert; author of 'English Enamels,' 'Ironwork,' 'Armour in England,' etc. (J. S. G.)

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**HOGARTH, David George,** M.A., Fellow of Magdalen College, Oxford; explored Asia Minor, 1887, 1890, 1891, 1894; excavated at Paphos in Cyprus, 1888; appointed by Egypt Exploration Fund, 1893; Special Correspondent for 'The Times' in Crete and Thessaly, 1897; Director, British School at Athens, 1897-1900; Director, Cretan Exploration Fund, 1899; author of 'A Wandering Scholar in the Levant,' 'Philip and Alexander of Macedon,' 'The Nearer East,' etc. (D. G. H.)

**HOLDEN, Prof. Edward Singleton,** Sc.D., LL.D.; Director of the Lick Observatory, 1887-97; Member National Academy of Sciences; Associate Royal Astronomical Society of London, Astronomical Society of France, etc.; author of 'Astronomy for Students,' 'Life of Sir Wm. Herschel,' 'Nebula of Orion,' etc. (E. S. H.)

**HOLDICH, Col. Sir Thomas Hungerford,** R.E. (retired), K.C.I.E., C.B.; Abyssinia, 1867; Afghan War, 1878-80; also served on political duty with Afghan Boundary Commission, 1884-86; Supt. Frontier Surveys, India, 1892-98; Asmar Boundary Commission, 1894; Pamir Commission, 1895; as H.M. Commissioner for Perso-Beluch Boundary in 1896; author of 'Kandahar,' in Ninth Edition of 'Ency. Brit.,' 'The Indian Borderland,' various papers on military surveying, etc. (T. H. H*.)

**HOLLAND, Hon. Sydney,** LL.D.; President of the Life Saving Society of England; Chairman of the London Hospital; Knight of Grace of the Order of St John of Jerusalem. (S. H*.)

**HOLLINGSHEAD, John,** staff of 'Household Words,' under Charles Dickens; staff of Cornhill Magazine, under W. M. Thackeray,

'Good Words,' under Dr Norman Macleod, 'Daily News,' etc.; founded Gaiety Theatre, 1868; Theatrical Licensing Reform, 1866 and 1892; Copyright Reform, 1874; author of 'Plain English,' 'Underground London,' 'Ragged London,' 'According to My Lights,' etc. (J. HD.)

**HOLROYD, Charles,** F.R. Soc. Painter Etchers; Keeper National Gallery of British Art (Tate Gallery); assistant to Professor Legros, Slade School of Art, for four years; author of 'Michael Angelo and His Works,' 'Etchings,' etc. (C. HD.)

**HOOPER, Franklin H.,** A.B.; assistant editor of 'The Century Dictionary.' (F. H. H.)

**HOOPER, Wynnard,** M.A., author of 'Population,' 'Statistics,' 'Suicide,' in the Ninth Edition of the 'Ency. Brit.' (W. Ho.)

**HOPKINSON, S. D.** (S. D. H.)

**HOSE, C.,** LL.D., D.Sc.; Resident in the Boram District, Sarawak; author of 'A Descriptive Account of the Mammals of Borneo,' etc. (C. H.)

**HOUGHTON, A. E.;** Correspondent of the 'Standard' in Spain. (A. E. H.)

**HOUSMAN, Laurence,** author of 'The Writings of William Blake,' 'Arthur Boyd Houghton,' 'Green Arras,' etc.; illustrated 'Goblin Market,' 'The End of Elfintown,' 'The Were Wolf,' '"Jump to Glory" Jane,' 'The Sensitive Plant.' (L. Ho.)

**HOWE, Henry Marion,** A.M.; Professor of Metallurgy, Columbia University, New York; Past President Am. Institute of Mining Engineers; President Jury of Mines and Mining, World's Columbian Exposition; Bessemer Medallist, British Iron and Steel Inst., and Gold Medallist, Franklin Inst. of Philadelphia, 1895; author of 'Metallurgy of Steel,' 'Copper Smelting,' etc. (H. M. H.)

**HOWELL, Hon. Clark;** editor of 'The Constitution,' Atlanta, Georgia. (C. Ho.)

**HOWELL, William H.,** Ph.D., M.D.; Dean of the Medical Faculty and Professor of Physiology, Johns Hopkins University. (W. H. H.)

**HUBBARD, Wilfranc.** (W. HD.)

**HUDSON, James Fairchild,** editor of the 'Pittsburg Dispatch'; author of 'Railways of the Republic,' etc. (J. F. H.)

**HUGHES, Rev. Hugh Price,** M.A.; Pres. Wesleyan Conference, 1898-99; editor of 'Methodist Times'; Past Pres. of National Council of Evangelical Free Churches; author of 'Social Christianity,' 'Ethical Christianity,' etc. (H. P. H.)

**HUGHES, Rupert,** A.M.; formerly assistant editor of the 'Criterion,' New York; author of 'American Composers,' 'Gyges Ring,' etc. (R. HU.)

**HULL, Commander Thomas A.,** R.N., F.R.G.S.; employed in the search for Sir John Franklin, survey of Palestine, Corfu, etc.; late Superintendent of Admiralty charts; author of 'Practical Nautical Surveying'; editor and reviser 'The Pilot's Handbook for the English Channel,' and 'The Practice of Navigation and Nautical Astronomy,' etc. (T. A. H.)

**HUMMEL, J. J.,** F.I.C.; Professor of Dyeing, Yorkshire Coll., Leeds; author of 'The Dyeing of Textile Fabrics.' (J. J. H.)

**HUNT, Rev. William,** M.A.; examiner in History, 1877 to 1880, Oxford; author of 'The English Church, 597 to 1066,' 'The Church of England in the Middle Ages'; editor with E. A. Freeman of 'Historic Towns,' etc. (W. HU.)

**HUNT, Hon. William H.,** Governor of Porto Rico; sometime Justice of the Supreme Court of Montana. (W. H. H*.)

**HUNTER, Sir Robert,** M.A.; Solicitor to the Post Office; author of 'The Preservation of Open Spaces and of Footpaths and Other Rights of Way.' (R. H*.)

**HUNTER, Walter,** M.I.C.E., M.I.M.E.; engineering director of the Grand Junction Water Works Co., and joint engineer of the Staines Reservoir Joint Committee. (W. H*.)

**HUTCHINSON, Horatio Gordon,** B.A.; amateur golf champion, 1886-87; author of 'Golf' in Badminton Library, 'Creatures of Circumstance,' 'The Book of Golf and Golfers,' 1899. (H. G. H.)

**HUTTON, Rev. Arthur Wollaston,** M.A.; Rector of Spridlington, 1873-76; received into Roman Catholic Church by Dr Newman, 1876; resumed clerical functions in the Church of England, 1898; author of 'Our Position as Catholics in the Church of England,' 'The Anglican Ministry,' 'Cardinal Manning'; edited Arthur Young's 'Tour in Ireland,' 1892, Maitland's 'Essays on the Reformation,' Newman's 'Lives of the English Saints,' etc. (A. W. HU.)

## I

**IDE, Hon. Henry Clay,** Member of U.S. Philippine Commission; formerly U.S. Commissioner to Samoa, and later Chief Justice of Samoa. (H. C. I.)

**ILBERT, Sir Courtenay Peregrine,** K.C.S.I., C.I.E.; Clerk of the House of Commons; formerly Parl. Counsel to the Treasury, 1899-1902; Legal Member of Council of Governor-General of India, 1882-86; Assistant Parl. Counsel to the Treasury, 1886-99; Member of Statute Law Committee; author of 'The Government of India,' 'Legislative Method and Forms.' (C. P. I.)

**INAMA-STERNEGG, Karl Theodor von;** Professor of Political Science, Vienna; President of the Austrian Royal Statistical Central Commission; author of 'Outlines of Germanic Philology,' 'Economy,' etc. (K. T. I.-S.)

**IRVINE, William Fergusson;** Hon. Sec. Record Society of Lanc. and Chesh., author of 'Notes on the Ancient Parish of Bidston'; editor 'Liverpool in King Charles II.'s Time,' etc. (W. F. I.)

## J

**JACKS, Rev. L. P.** (L. P. J.)

**JACKSON, Lieut.-Col. Louis,** R.E.; late instructor in Fortification, R.M.A., Woolwich; instructor in Fortification and Military Engineering, School of Military Engineering, Chatham; Assoc. Memb. of Ordnance Committee, etc. (L. J.)

**JACOB, Francis,** M.I.E.E., F.P.S. Lond.; chief electrician to Messrs Siemens Bros. and Co. (F. JA.)

**JAMES, Edmund Janes,** A.M., Ph.D.; President North-Western University; late Professor of Public Administration and Director of the Extension Division, University of Chicago; past Pres. Am. Acad. of Political and Social Science; author of 'Our Legal Tender Decisions,' 'The Education of Business Men,' etc. (E. J. J.)

**JAMES, Lionel;** War Correspondent of 'The Times' in South Africa. (L. J*.)

**JAMIESON, George,** C.M.G.; Director of the Pekin Syndicate and Yangtse Valley Company; Consul and Judge of Supreme Court, Shanghai, 1891; Consul-Gen., 1897-99; author of various papers on the Revenue and Statistics of China; prize essay on Bimetallism. (G. J.)

**JEBB, Sir Richard Claverhouse,** Litt.D., D.C.L., LL.D., M.P.; Regius Professor of Greek, Camb.; Hon. Professor Ancient History, Roy. Acad., since 1898; Fellow and Lecturer of Trinity College, 1863; Public Orator of the University, 1869; Professor of Greek, University of Glasgow, 1875-89; Lecturer at Johns Hopkins University, Baltimore, 1892; Member of Royal Commission on Secondary Education, 1894; of Royal Commission on Irish University Education, 1901; Member of Consulting Committee of Board of Education, 1900; Fellow of London University, 1897; Member of London University Commission, 1898; Bampton Lecturer, 1899; author of 'Aristophanes,' 'Demosthenes,' 'Euripides,' etc., in Ninth Edition of 'Ency. Brit.,' 'Sophocles,' 'Electra' in Catena Classicorum, 'Ajax,' 'Characters of Theophrastus,' 'Attic Orators,' 'Modern Greece,' 1880; 'Bentley,' 'Sophocles,' with Critical Notes, Commentary, and Translation; 'Humanism in Education,' etc. (R. C. J.)

**JEFFERSON, Joseph,** LL.D.; actor; author of 'Autobiography,' etc. (J. J*.)

**JEKELFALUSSY, Józef von Jekel- und Margitfalva,** Dr. Juris, the late; Director-General of the Royal Hungarian Statistical Bureau; Member of the Royal Hungarian Academy of Sciences; edited 'The Millennium of Hungary and its People,' etc. (J. JE.)

**JENKS, Jeremiah Whipple,** Ph.D.; Professor of Political Science, Cornell University; Member of the U.S. Committee to investigate Trusts; author of 'Henry C. Carey,' 'Road Legislation for the American State,' and numerous magazine contributions in Germany, England, and the United States. (J. W. J.)

**JENKYNS, Sir Henry,** the late, K.C.B.; Parliamentary Counsel to Treasury. (H. JE.)

**JERVIS-SMITH, Rev. Frederick J.,** M.A., F.R.S.; University Lecturer in Mechanics; Millard Lecturer, Trinity College, Oxford; Member of Com. on Explosions, Home Office, 1895-96; received Medal French Exhibition for Dynamometer; silver medal Inventions Exhibitions for Integrator. (F. J. J.-S.)

**JEUNE, Rt. Hon. Sir Francis Henry,** K.C.B., K.B.; appointed a Judge of the High Court, 1891; President of Probate, Divorce, and Admiralty Division; Judge-Advocate-Gen., 1892. (F. H. J.)

**JEUNE, Lady;** contributor to leading reviews and magazines; author of 'Lesser Questions,' etc. (M. J.)

**JOHNSTON, Sir Harry Hamilton,** G.C.M.G., K.C.B.; Special Commissioner, Commander-in-Chief and Consul-General for Uganda Protectorate; explored Portuguese West Africa and River Congo, 1882-83; commanded Scientific Expedition of Royal Society to Mt. Kilimanjaro, 1884; H.M. Vice-Consul in Cameroons, 1885; Acting Consul in Niger Coast Protectorate, 1887; Consul for province of Mozambique, 1888; expedition to Lakes Nyasa and Tanganyika (founding of the British Central Africa Protectorate), 1889; author of 'River Congo,' 'Kilimanjaro,' 'History of a Slave,' 'Life of Livingstone,' 'British Central Africa,' etc. (H. H. J.)

**JORDAN, David Starr,** Ph.D., LL.D.; President of Leland Stanford Junior University; sometime Assistant to the U.S. Fish Commission, and Professor of Zoology, and President of Indiana University; Commissioner and Expert for the United States to investigate the Fur Seal Question, 1896-97; author of 'Vertebrate Animals of Northern U.S.,' 'Fisheries of North and Middle America,' 'Factors of Organic Evolution,' etc. (D. S. J.)

**JORDAN, Richard;** Draughts Champion of Scotland, 1896, and of the World since 1896. (R. J.)

**JUDSON, Harry Pratt,** A.M., LL.D.; Professor of Political Science, and Dean of the Faculties of Arts, Science, and Literature, University of Chicago; author of 'Europe in the Nineteenth Century,' 'Growth of the American Nation,' etc. (H. P. J.)

## K

**KAN, C. M.;** Professor of Geography, University of Amsterdam; author of 'Holland' in Ninth Edition of the 'Ency. Brit.,' 'A History of Discoveries in the Indian Archipelago,' editor 'The International Colonial Review,' etc. (C. M. K.)

**KARAGEORGEVITCH, Bojidar, Prince;** artist and art critic. (B. K.)

**KEANE, Augustus Henry,** F.R.G.S.; Emeritus Professor of Hindustani, Univ. Coll. London; late Vice-President Anthrop. Institute; author of 'Kirghiz,' 'Soudan,' 'Somali,' 'Yoruba,' etc., in Ninth Edition of 'Ency. Brit.' Stanford's 'Asia,' 'Africa,' 'Ethnology,' 'Man, Past and Present,' etc. (A. H. K.)

**KELSEY, C. H.,** President of the Title Guaranty and Trust Company, New York. (C. H. K.)

**KELTIE, John Scott,** F.S.S., F.S.A. (Scot.), LL.D. St Andrews; Secr. Royal Geog. Soc.; Knight of Swedish Order of North Star, 1898; Hon. Memb. Geographical Societies of Paris, Berlin, Rome, Brussels, Amsterdam, Geneva, Lisbon, Buda-Pest, Philadelphia, etc.; for several years sub-editor of 'Nature'; inspector of geographical education, R.G.S., 1884; Librarian R.G.S., 1885; President Geographical Section, Brit. Ass., 1897; author of 'Finland,' 'Sir John Franklin,' etc., in Ninth Edition of 'Ency. Brit.,' 'History of Scottish Highlands and Clans,' 'Applied Geography,' 'The Partition of Africa'; editor of 'Statesman's Year Book' since 1880; editor of the 'Geographical Journal'; joint-editor of 'World's Great Explorers' Series, and 'The Systematic Atlas.' (J. S. K.)

**KEMPE, Harry Robert,** A.M.I.C.E., M.I.E.E.; principal technical officer, Postal Telegraph Dept., England; author of 'Handbook of Electrical Testing,' 'The Electrical Engineer's Pocket Book,' 'The Engineer's Year Book,' etc. etc. (H. R. K.)

**KENNEDY, Sir Charles Malcolm,** K.C.M.G., C.B.; Head of Commercial Department, Foreign Office, 1872-93; Lecturer on International Law, Univ. Coll. Bristol; Commissioner in the Levant, 1870-71; at Paris, 1872-86; Plenipotentiary, Treaty of the Hague, 1882; author of 'Kennedy's Ethnological and Linguistic Essays' (editor), 'Diplomacy and International Law.' (C. M. K*.)

**KENNEDY, Hon. Sir William Rann;** Judge of the King's Bench Division of the High Court of Justice; Fellow, and afterwards Hon. Fellow of Pembroke Coll. Camb. (W. R. K.)

**KEYNES, John Neville,** M.A., D.Sc.; University Lecturer in Moral Science, Cambridge, 1884; Member of the Council of the Senate of the University of Cambridge; author of 'Studies and Exercises in Formal Logic,' 'Scope and Method of Political Economy.' (J. N. K.)

**KHNOPFF, Fernand:** chevalier de l'ordre de Leopold, de St Michel de Bavière; Vice-Pres. de Cercle artistique et littéraire de Bruxelles, etc. (F. K*.)

**KIDD, Benjamin;** formerly of Inland Revenue Department; author of 'Social Evolution,' 1894 (translations: German, 1895; Swedish, 1895; French, 1896; Russian, 1897; Italian, 1898; Czech, 1900; Danish, 1900); The Control of the Tropics, 1898. (B. K*.)

**KIRK, Edward C.,** D.D.S.; Dean of the Department of Dentistry, and Professor of Clinical Dentistry, University of Pennsylvania; Member of the National Dental Association and the American Academy of Dental Science; editor of 'The American Text-book of Operative Dentistry,' and of 'The Dental Cosmos' Magazine. (E. C. K.)

**KNIGHT, Major John G. D.,** Corps of Engineers, U.S.A., A M.; Commandant U.S. Engineer School; in charge of U.S. Engineer Depot, 1895-1901, of Torpedo Defence, E. entrance N.Y. Harbour, 1898-1901; on Board of U.S. Torpedo System, 1896-1901. (J. G. D. K.)

**KNOTT, Cargill Gilston,** D.Sc.; Lecturer on Applied Mathematics, Edinburgh University; Assistant to Professor of Natural Philosophy, Edinburgh University, 1879-83; Prof. of Physics, Imperial University, Japan, 1883-91; conducted Magnetic Survey of Japan, 1887; awarded Keith Prize (Roy. Soc. Edin.) for work on magnetic strains, 1897; author of 'Ice,' 'Pneumatics,' in Ninth Edition of 'Ency. Brit.,' 'Physics,' etc. (C. G. K.)

**KNOWLING, Richard John,** D.D.; Professor of New Testament Exegesis in King's College, London, 1894; Fellow, 1899; Examiner for Hall-Houghton Prizes at Oxford, 1897, and in Theology at Durham, 1895-96; Select Preacher at Cambridge, 1895; author of 'Witness of the Epistles,' 'Acts of the Apostles,' etc. (R. J. K*.)

**KOREN, John;** author of 'Economic Aspects of the Liquor Problem,' etc. (J. K.)

**KRAUS, Professor Dr F. X.,** the late; Professor of Ecclesiastical History at the University of Freiburg in Bresigau. (F. X. K.)

**KROPOTKIN, Prince Peter Alexeivitch;** Gold Medal of Russian Geographical Society, 1864; crossed North Manchuria from Transbaikalia to the Amur, 1864; Secretary to Physical Geography Section of Geographical Society; author of 'Lithuanians,' 'Njni-Novgorod,' 'Nova Zembla,' 'Poland,' 'Siberia,' 'Tomsk,' 'Warsaw,' etc., in Ninth Edition of 'Ency. Brit.,' 'General Sketch of the Orography of East Siberia,' 'In Russian and French Prisons,' 'Recent Science in Nineteenth Century,' 'The State, its Part in History,' 'Memoirs of a Revolutionist.' (P. A. K.)

## L

**LABBE, Alphonse,** Docteur ès sciences; chief of the Laboratory of Zoology, University of Paris; author of 'La Cytologie expérimentale,' 'Recherches zoologiques et biologiques sur les parasites du sang des vertèbres,' etc. (A. L*.)

**LAMB, Horace,** M.A., LL.D., F.R.S.; Chairman of Convocation, and of the General Board of Studies, Victoria University; Professor of Mathematics, Owens Coll., Victoria Univ., Manchester; member of Council of the Royal Society, 1894-96; President of the Manchester Literary and Philosophical Society, 1899-1901; Fellow and Assistant Tutor, Trinity Coll., Camb., 1872-75; Professor of Mathematics, University of Adelaide, 1875-85; author of 'Motion of Fluids,' 'Hydrodynamics,' 'Infinitesimal Calculus.' (H. Lb.)

**LANE-POOLE, Stanley,** M.A., Litt.D.; Professor of Arabic at Trin. Coll. Dublin; employed in Coin Department of British Museum, 1874-92; sent by Government on archæological missions to Egypt, 1883, and Russia, 1886; employed by Egyptian Government on archæological research at Cairo, 1895-97; corr. member of the Imperial Russian Archæological Society; lecturer at the Royal Institution, 1900; author of 'Catalogue of the Oriental andIndian Coins in the British Museum,' 'Lord Stratford de Redcliffe,' 'E. W. Lane,' 'Saladin,' 'Histories of the Moors in Spain,' 'Turkey,' 'The Barbary Corsairs,' 'The Mahommedan Dynasties,' 'The Mogul Emperors,' 'Egypt in the Middle Ages,' 'Egypt,' 'The Art of the Saracens of Egypt,' 'Cairo,' etc., edited 'Lane's Arabic Lexicon,' 'Arabian Society in the Middle Ages,' 'Life of General Chesney.' (S. L.-P.)

**LANESSAN, J. M. A. de;** Agr. de la faculté de Médicine; French Minister of Marine; formerly Governor-General of Indo-China; author of 'La Tunisie,' 'L'expansion coloniale de la France,' 'L'Indo-Chine française,' 'Du Protoplasme végétal,' 'La Matière, la Vie et les êtres vivants.' (J. M. A. de L.)

**LANG, Andrew,** M.A., LL.D.; Hon. Fellow of Merton Coll., Oxford; author of 'Apparitions,' 'Ballad,' 'Family,' 'Molière,' in Ninth Edition of 'Ency. Brit.,' 'Oxford,' 'Helen of Troy,' 'Custom and Myth,' 'Myth, Ritual, and Religion,' 'Life, Letters, and Diaries of Sir Stafford Northcote,' 'Pickle the Spy,' 'The Book of Dreams and Ghosts,' Translations of 'Odyssey' (with Professor Butcher), and 'Iliad' (with Myers and Walter Leaf); 'The World's Desire' (with Rider Haggard), 'The Making of Religion,' 'The Companions of Pickle,' 'A History of Scotland from the Roman Occupation,' 'Prince Charles Edward,' 'Magic and Religion,' 'The Mystery of Mary Stuart,' etc. (A. L.)

**LANG, W. H.,** M.B., D.Sc.; lecturer in botany, Queen Margaret's Coll., Glasgow; author of 'Memoirs on Morphology,' 'The Development of the Higher Cryptogams,' etc. (W. H. L.)

**LANKESTER, Edwin Ray,** M.A., LL.D., F.R.S.; Hon. Fellow of Exeter Coll., Oxford; Correspondent of the Institute of France; Director of the Natural History Department of the British Museum; Fullerian Professor of Physiology and Comparative Anatomy in the Royal Institution of London, 1898-1900; Fellow and Lecturer, Exeter Coll., 1872; Professor of Zoology and Compar. Anat. Univ. Coll., London, 1874-90; Regius Professor Natural History, Edinburgh, 1882; Linacre Professor of Comparative Anatomy, Oxford, 1891-1898; Royal Medallist Royal Society, 1885; Vice-President Royal Society, 1896; Founder (1884), President (1892) Marine Biological Association (Plymouth Laboratory); Correspondent of the Institute of France; Corr. Mem. Imp. Acad. Sciences, St Petersburg; For. Mem. Royal Bohemian Society of Sciences, of the New York Academy of Sciences, of the Academy of the Lincei of Rome, of the Royal Belgian Academy, and of the Academy of Sciences of Philadelphia; editor since 1869 of 'Quarterly Journal of Microscopical Science'; author of 'Hydrozoa,' 'Mollusca,' 'Mussel,' 'Polyzoa,' 'Protozoa,' 'Vertebrata,' 'Zoology,' in Ninth Edition of 'Ency. Brit.,' 'A Monograph of Cephalaspidian Fishes,' 'Comparative Longevity,' 'Developmental History of the Mollusca,' 'Degeneration,' 'The Advancement of Science,' 'Zoological Articles'; joint-editor of 'Scientific Memoirs of Thomas Henry Huxley.' (E. R. L.)

**LARMOR, Joseph,** M.A., D.Sc., Sec. R.S.; Fellow of St John's Coll., Camb.; University Lecturer in Mathematics; Professor of Natural Philosophy, Queen's Coll., Galway, and in the Queen's University in Ireland, 1880-1885, and formerly Fellow of the Royal University; Examiner in Mathematics and Natural Philosophy in the Univ. of London; lately President of the Cambridge Philosophical Society; Treasurer of the London Mathematical Society; author of 'Æther and Matter,' and various Memoirs on Mathematics and Physics. (J. L*.)

**LAUGHTON, John Knox,** M.A.; Professor Modern History, King's Coll., London; Secretary of the Navy Records Society; served in Baltic during the Russian War, 1854-55; in China, 1856-59; afterwards in Mediterranean and Channel; Mathematical and Naval Instructor, Royal Naval College, Portsmouth, 1866-73; also at Greenwich, and lecturer on Meteorology, 1873-85; Pres. R. Met. Soc. 1882-1884; Honorary Fellow, Caius College, Cambridge, 1895; author of 'Farragut,' 'Fitzroy,' in Ninth Edition of 'Ency. Brit.,' 'Physical Geography in its Relation to the Prevailing Winds and Currents,' 'Studies in Naval History,' 'Nelson and his Companions in Arms,' 'Life of Henry Reeve,' 'Sea Fights and Adventures,' 'Letters and Despatches of Lord Nelson,' 'Defeat of the Spanish Armada.' (J. K. L.)

**LAWRENCE, Rt. Rev. William,** D.D., S.T.D.; Bishop of Massachusetts; sometime Professor of Homiletics and Pastoral Theology, and Dean Episcopal Theological School, Cambridge, U.S.A.; author of 'Life of Amos A. Lawrence,' 'Proportional Representation in the House of Clerical and Lay Delegates,' 'Visions and Service.' (W. L.)

**LAYARD, George S.;** English art writer; author of 'Charles Keene,' 'Mrs Lynn Linton,' 'Portraits of Cruikshank by Himself,' 'Tennyson and his Pre-Raphaelite Illustrators,' etc. (G. S. L.)

**LECLÈRE, Léon;** Professor of Universal History and History of Philosophy, University of Brussels. (L. L.)

**LEE, Sidney,** B.A., Litt.D.; editor of Dictionary of National Biography and Supplement; Clark Lecturer in English Literature, Trin. Coll., Cambridge, 1901; author of 'Stratford-on-Avon from the Earliest Times to the Death of Shakespeare,' 'Lord Herbert of Cherbury's Autobiography, with a continuation of his Life,' 'A Life of William Shakespeare.' (S. L.)

**LEE-WARNER, Sir William,** K.C.S.I., M.A.; Secretary in the Political and Secret Departments of the India Office; Fellow of the University of Bombay; entered Indian Civil Service, 1869; political agent at Kolhapur; Under-Secretary in Foreign Office of India; Secretary to the Government of Bombay in Political and Judicial Departments; Chief Commissioner of Coorg and Resident in Mysore; additional member of the Viceroy's Council; served on Education Commission, the Financial Commission, etc.; author of 'The Protected Princes of India,' 'The Citizen of India.' (W. L.-W.)

**LEGGE, J. G.;** Chief Inspector of Reformatory and Industrial Schools, Home Office. (J. G. L.)

**LEGGE, Robin H.;** editor of 'Music in the Nineteenth Century.' (R. H. L.)

**LEONARD, Rt. Rev. Abiel,** A.M., S.T.D.; Bishop of the Diocese of Salt Lake. (A. Le.)

**LEVEY, George Collins,** C.M.G.; London Correspondent of 'Melbourne Age'; editor and proprietor of 'Melbourne Herald,' 1863-68; editor and contributor to 'Melbourne Age,' 1869-81; Secretary to Commissioners for Victoria at the Exhibitions in London, Paris, Vienna, Philadelphia, Melbourne, 1873, 1876, 1878, 1880-81; Executive Commissioner, Amsterdam, 1883; Secretary Royal Commission, Hobart Exhibition, 1894-95; Secretary Colonial Adelaide Exhibition, 1887; Committee of Royal Commission to Paris Exhibition, 1900; member of Board of Advice to Agent-General of Victoria; author of 'Handbook to Australasia,' 'Australian Encyclopædia.' (G. C. L.)

**LEWES, Vivian B.,** F.I.C., F.C.S.; Professor of Chemistry, Royal Naval College; Chief Superintending Gas Examiner to the Corporation of the City of London. (V. B. L.)

**LEWIS, Charlton T.,** Ph.D.; President N.Y. Prison Association, N.J. State Charities Aid Association; Chairman of Commission to revise Penal Laws of New Jersey; Lecturer on Life Insurance, Harvard and Columbia Universities, and on Principles of Insurance, Cornell University; author of 'History of Germany,' Essays, Addresses, etc. (C. T. L.)

**LEYLAND, John;** writer on naval questions. (J. Ld.)

**LIAS, Rev. John James,** M.A.; Professor of Modern Literature, St David's Coll., Lampeter, 1871-1880; examining chaplain to Bishop of Llandaff, 1887-98; Chancellor of Llandaff Cathedral; author of 'Science in Relation to Miracles,' 'The Nicene Creed,' 'A Plea for Rationality in Ceremonial,' etc. (J. J. L*.)

**LIDDELL, F. F.,** M.A.; Fellow of All Souls College, Oxford; Barrister, Lincoln's Inn; editor of 'Manual of Military Laws.' (F. F. L.)

**LIGHTFOOT, T. B.,** M.I.C.E., M.I.M.E.; author of 'The Mechanical Refrigeration of Air,' 'Preservation of Food by Cold,' etc. (T. B. L.)

**LILLIE, Arthur;** champion Grand National Croquet Club, 1872; author of 'Croquet,' 'Croquet Up to Date,' etc. (A. Li.)

**LITTLEJOHN, Henry Harvey,** M.B., B.Sc., F.R.C.S. Ed.; Lecturer in Medical Jurisprudence, School of Medicine of the Royal College of Physicians and Surgeons of Edinburgh. (H. H. L.)

**LLOYD, Lt.-Col. E. M.,** R.E.; author of 'Vauban, Montalembert, Carnot: Engineer Studies,' etc. (E. M. L.)

**LLOYD, Henry Demarest,** author of 'Wealth against Commonwealth,' 'Labor Co-partnership,' etc. (H. D. L*.)

**LOCH, Charles Stewart,** B.A.; Secretary to the Council of the London Charity Organization Society since 1875; Member Royal Commission on Aged Poor, 1893-95; Dunkin Trust Lecturer, Manchester College, Oxford, 1896; Vice-President Royal Statistical Society, 1894, 1895, 1897, 1901; author of 'Charity Organization,' 'Old Age Pensions and Pauperism.' (C. S. L.)

**LOCOCK, Col. Herbert,** C.B.; retired Colonel of Royal Engineers; Assist. Director of Works at Headquarters, 1881-86; Depy. Inspector-General of Fortifications at Headquarters, 1887-96. (H. Lo.)

**LODGE, Oliver Joseph,** F.R.S., D.Sc., LL.D.; Principal of the University of Birmingham; Professor of Physics, University Coll., Liverpool, 1881-1900; author of 'Elementary Mechanics,' 'Modern Views of Electricity,' 'Pioneers of Science,' 'Signalling without Wires,' etc. (O. J. L.)

**LORD, J. K.,** Professor of the Latin Language and Literature, Dartmouth College,

N.H.; author of 'New Hampshire' in Ninth Edition of 'Ency. Brit.' (J. K. L*.)

**LOUIS, Prof. Henry,** The Durham College of Science, Newcastle-upon-Tyne, England; author of 'A Handbook of Gold Milling,' etc. (H. L*.)

**LOUIS, Paul;** French statistician; staff of the 'Revue Blanche.' (P. L.)

**LOVE, Augustus E. H.,** M.A., F.R.S.; Sedleian Professor of Natural Philosophy, Oxford, since 1899; Fellow of St John's Coll., Camb; University Lecturer in Mathematics. (A. E. H. L.)

**LOW, A. P.;** of the Geological Survey of Canada; author of 'Report on the Exploration in the Labrador Peninsula,' etc. (A. P. Lo.)

**LOW, Hon. Seth,** LL.D.; Mayor of New York City; formerly President of Columbia University; Mayor of Brooklyn, 1881-85; President of the Archæological Institution of America. (S. L*.)

**LOW, Sidney James,** M.A., L.C.C.; Lecturer on History, King's College, 1883-86; editor of the 'St James's Gazette,' 1888-97; co-editor of the 'Dictionary of English History'; author of contributions to 'Nineteenth Century,' 'Fortnightly Review,' 'National Review,' etc. (S. J. L.)

**LOWE, Major F. M.,** R.A.; Senior Experimental Officer, Shoeburyness, 1884; Asst. Inspector, Army Inspection Dept., 1888; Gunnery Instructor, Brit. N. America, 1893; Gunnery Instructor, Coast Defence School, and Asst. Superintendent of Experiments at Shoeburyness. (F. M. L*.)

**LUGARD, Brig.-Gen. Sir Frederick John Dealtry,** K.C.M.G., C.B., D.S.O.; High Commissioner of Northern Nigeria; served Afghan War, 1879-1880; Soudan Campaign, 1885; Burma Campaign, 1886-1887; commanded expedition against slave traders on Lake Nyassa, 1888; employed by British East African Company; in command of Exploration of the Sabakhi, and Administrator of Uganda, 1889-92; employed by Royal Niger Company, 1894-95; West Charterland, 1896-97; H.M. Commissioner for Hinterland of Nigeria and Lagos, 1897-99; Commandant of West African Frontier Force, 1897-99; author of 'Our East African Empire.' (F. D. L.)

**LUMMIS, Charles Fletcher,** editor of the 'Land of Sunshine' magazine, Los Angeles, California; author of 'The Right Hand of the Continent' (California), and numerous publications dealing with the western and south-western States; formerly editor of the Los Angeles 'Daily Times.' (C. F. L.)

**LUNGE, George,** Ph.D.; Professor of Technical Chemistry at the Polytechnic, Zurich; author of 'Acid and Alkali Manufacture,' etc. (G. L.)

**LUSHINGTON, Sir Franklin,** M.A., the late; Chief Police Magistrate for London; author of 'Wagers of Battle.' (F. L*.)

**LYALL, Sir Alfred Comyn,** K.C.B., G.C.I.E., Hon. D.C.L. Oxford, and LL.D. Cambridge; Member of Council of Secretary of State for India since 1888; Lieut.-Gov. North-West Provinces, India, 1882-87; author of 'British Dominion in India,' 'Asiatic Studies,' 'Life of Warren Hastings.' (A. C. L.)

**LYDEKKER, Richard,** B.A., F.R.S., F.G.S., F.Z.S.; Geological Survey of India, 1874-82; author of 'Geology of Kashmir,' 'Catalogues of Fossil Mammals, Reptiles, and Birds in British Museum,' 'Phases of Animal Life,' 'Royal Natural History,' 'A Manual of Palæontology' (with late Professor A. Nicholson), 'The Great and Small Game of Europe, N. and W. Asia, and America,' 'Descriptions of South American Fossil Animals.' (R. L*.)

**LYNES, G. B.,** A.M.; sub-editor of the New Volumes of 'Ency. Brit'; formerly literary editor of the 'Baltimore News,' and instructor in History and Acting Librarian, Union College, Schenectady, N.Y.; author of 'A Syllabus of Modern European History,' etc. (G. B. L.)

**LYONS, H. G.;** Major R.E.; Director of the Survey Department, Egypt; editor of 'A Handbook of Travellers in Egypt;' author of 'Report on the Island and Temples of Philæ,' etc. (H. G. L.)

## M

**MACALISTER, Alexander,** M.A., M.D., D.Sc., LL.D., F.R.S., F.S.A.; Member of Senate of Royal University of Ireland; Professor of Anatomy, Cambridge University, since 1883; Fellow of St John's College; Professor of Zoology, University of Dublin, 1869; Professor of Anatomy and Chirurgery, Dublin, 1877; author of 'Phrenology,' 'Physiognomy,' 'Stigmatization,' in Ninth Edition of 'Ency. Brit.,' 'Introduction to Animal Morphology,' 'Morphology of Vertebrate Animals,' 'Text-Book of Human Anatomy,' etc. (A. Ma.)

**MacALISTER, Donald,** M.A., M.D., B.Sc., F.R.C.P., Fellow and Senior Tutor of St John's Coll., Camb.; University Lecturer in Medicine; Physician to Addenbrooke's Hospital; Univ. Memb. and Business Chairman General Medical Council; Chairman of British Pharmacopœia Committee; Examiner in Medicine, Univ. Birmingham, and R. Coll. Physicians, London; Hon. President International Congress of Hygiene, Madrid, 1898; Lecturer in Natural Philosophy, St Bartholomew's Hospital, 1879; Goulstonian Lecturer, Royal College of Physicians, 1887; first Croonian Professor, 1888; Thomson Lecturer, Aberdeen, 1889; Examiner Victoria Univ. 1896-98; author of 'Ziegler's Pathological Anatomy,' 'Nature of Fever,' 'Advanced Study and Research in Cambridge,' 'The Practitioner' (with editorial committee), 'The British Pharmacopœia,' etc. (D. M*.)

**MACAULAY, W. H.,** M.A.; Fellow and Lecturer of King's Coll., Cambridge; late University Lecturer in Applied Mechanics, Cambridge. (W. H. M.)

**MacCOLL, D. S.,** M.A.; painter; art critic of the 'Saturday Review.' (D. S. M.)

**MacCORMAC, Sir William,** Bt., the late; President of the Royal College of Surgeons, 1896-1901; Serjeant-Surgeon to King Edward VII. (W. MacC.)

**MACDONELL, John,** C.B., LL.D.; Master of the Supreme Court; author of 'The Law of Master and Servant,' etc. (J. M†.)

**MACFARLANE, J.;** formerly assistant, British Museum. (J. M'F.)

**MACGREGOR, Sir William,** K.C.M.G., C.B., M.D. Aberdeen, B.Sc. Camb., LL.D. Aberdeen; Governor of Lagos; Resident Surgeon and Resident Physician Glasgow Royal Infirmary, and Royal Lunatic Asylum, Aberdeen; Assistant Government Medical Officer, Seychelles, 1873; Surgeon Civil Hospital, Port Louis, Mauritius, 1874; Chief Medical Officer, Fiji, 1875; late Receiver-General and Administrator of the Government, and Acting High Commissioner and Consul-General for the Western Pacific; Administrator of British New Guinea, 1888; Lieut.-Governor, 1895. (W. M'G.)

**MACKAY, T.;** author of 'Methods of Social Reform.' (T. M*.)

**M'KENDRICK, John Gray,** M.D., LL.D. (Hon. Aberdeen), F.R.S., F.R.S. Edin., F.R.C.P.; Professor of Physiology Glasgow University; Examiner in Physiology University of London, Victoria University, and University of Birmingham; formerly Examiner in Univ. of Oxford and Camb.; Fullerian Professor of Physiology at Royal Inst. of Great Britain; one of the lecturers in connexion with the Gilchrist Trust; has served on the Council of the Royal Society; member of Council of Royal Society of Edinburgh; President of Physiological Section of British Association; author of 'Narcotics,' 'Sleep,' 'Smell,' 'Stammering,' 'Stereoscope,' 'Taste,' 'Touch,' 'Voice,' 'Vascular System,' in Ninth Edition of 'Ency. Brit.,' 'Animal Physiology,' 'A Text-Book of Physiology,' 'Life in Motion, or Muscle Nerve,' 'Physiology,' 'Life of Helmholtz,' etc. (J. G. M.)

**M'LAUGHLIN, Andrew Cunningham,** A.M., LL.B.; Professor of American History, University of Michigan; author of 'History of Higher Education in Michigan,' 'Civil Government in Michigan,' 'Lewis Cass,' etc. (A. C. M.)

**MACMAHON, Major Percy Alexander,** R.A., Sc.D., F.R.S.; Professor of Artillery, Woolwich; President of London Mathematical Society, 1894-96; accompanied Government Expedition to observe eclipse of sun, Norway, 1896; author of numerous papers on Pure Mathematics, etc. (P. A. M.)

**McMASTER, John Bach,** Ph.D., Litt.D.; Professor American History, University of Pennsylvania; author of 'A History of the People of the United States.' (J. B. McM.)

**McMILLAN, Walter G.,** F.C.S., M.I.M.M.; Sec. Inst. Elect. Engineers; late lecturer on Metallurgy, Mason Coll., Birmingham; author of 'A Treatise on Electro-Metallurgy,' part author of 'Metals,' translator of 'Electric Smelting and Refining.' (W. G. M.)

**MACMORRAN, Alexander,** K.C., A.M.I.C.E.; became editor of 'Justice of the Peace,' 1879, and has so continued; author of editions of 'Lumley's Public Health,' works on 'The Public Health (London) Act, 1891,' the 'Local Government Act, 1888,' the 'Local Government Act, 1894,' the 'London Government Act, 1899,' 'Poor Law Orders,' 'Poor Law Statutes,' etc. (A. M'M.)

**MAC MUNN, Charles Alexander,** M.A., M.D., F.C.S., F.R.M.S.; Hon. Pathologist and Physician, Wolverhampton General Hospital; author of 'The Spectroscope in Medicine,' 'Outlines of Clinical Chemistry,' etc. (C. A. MacM.)

**M'CORMICK, William Symington,** M.A.; Professor of English Literature at University College, Dundee; author of 'Lectures on Literature,' joint-editor of the Globe 'Chaucer,' etc. (W. S. M.)

**McCRADY, Edward,** President of the Historical Society of South Carolina; author of 'History of South Carolina under the Proprietary Government,' and 'History of South Carolina under the Royal Government.' (E. McC.)

**M'Vey, Frank L.,** Ph.D.; Assistant Professor of Political Science, University of Minnesota. (F. L. M.)

**MacWILLIAM, Robert,** Professor at Gill Coll., Somerset East, Cape Colony. (R. M'W.)

**MAGNUS, Sir Philip;** Superintendent of Technological Examinations and Secretary of Examinations Department, City and Guilds of London Institute; organising Director and Secretary of City and Guilds of London Institute, 1880-88; member Royal Commission on Technical Instruction, 1881-84; is Member of the Senate and Fellow of the London University; Vice-President and Fellow of College of Preceptors; Member of the Mathematical and Physical Societies; author of 'Technical Education' in Ninth Edition of 'Ency. Brit.,' 'Lessons in Elementary Mechanics,' 'Hydrostatics and Pneumatics,' 'Industrial Education.' (P. M*.)

**MAITLAND, Frederic William,** LL.D., D.C.L. (Oxford, Glasgow, Cracow); Professor of English Law, Cambridge; Reader of English Law at Cambridge, 1884; Corresponding Member of Roy. Prussian Academy; author of 'Justice and Police,' 'Bracton's Note-Book,' 'History of English Law' (with Sir F. Pollock), 'Domesday Book and Beyond,' 'Township and Borough,' 'Canon Law in England,' etc. (F. W. M.)

**MAITLAND, J. A. Fuller,** M.A., F.S.A.; musical critic of 'The Times'; author of 'Life of Robert Schumann,' 'Masters of German Music,' 'The Musician's Pilgrimage,' Spitta's 'Life of Bach' (joint-translation with Mrs C. Bell); edited the Appendix to Grove's 'Dictionary of Music and Musicians,' 'English County Songs' (with Miss L. E. Broadwood), 'The Fitzwilliam Virginal Book' (with W. B. Squire). (J. A. F. M.)

**MANSON, Edward;** Barrister, Middle Temple; author of 'Law of Trading Companies,' 'The Law of Debentures and Debenture Stock,' 'Practical Guide to Company Law,' etc. (E. Ma.)

**MANSON, James Alexander;** sub-editor of the New Volumes of the 'Ency. Brit.'; dramatic critic, 'Weekly Dispatch,' 1890-92; literary editor of the 'Daily Chronicle,' 1891; author of 'In Memoriam edition of Burns's Poetical Works,' 'Valour for Victoria,' 'Sir Edwin Landseer' (Makers of British Art Series), etc. (J. A. M.)

**MARKBY, Sir William,** K.C.I.E., D.C.L.; Fellow of All Souls College, Oxford, and of Balliol College; judge of High Court, Calcutta, 1866-78; Reader in Indian Law, Oxford, 1878-1900; author of 'Lectures on Indian Law,' 'Elements of Law considered with Reference to General Principles of Jurisprudence.' (W. Ma.)

**MARKHAM, Sir Clements Robert,** K.C.B., F.R.S.; President of the Royal Geographical Society, of the International Geographical Congress, 1894-99, and of the Hakluyt Society, and of the Geographical, Elizabethan, and Royal Society Clubs; entered the Navy in 1844; served in the Arctic Expedition of 1850-51; geographer to the Abyssinian Expedition; Assistant Secretary in the India Office, 1867-77; author of 'Geography' (historical), 'Peru,' 'Polar Regions,' in Ninth Edition of 'Ency. Brit.'; 'Life of the Great Lord Fairfax,' 'The Fighting Veres,' 'History of Peru,' 'History of Persia,' 'History of the Abyssinian Expedition,' Lives of Columbus, John Davis, and Major Rennell, 'The Paladins of Edwin the Great'; edited volumes for the Hakluyt Society, the Navy Records Society, the Roxburghe Club, etc. (C. R. M.)

**MARSHALL, George M.,** Ph.B.; Professor of English Language and Literature, University of Utah. (G. M. M.)

**MARTEL, Major C. P.,** R.A.; Sec. to the Ordnance Committee; late Professor of Artillery, Ordnance Coll. (C. P. M.)

**MARTIN, T. C.;** editor of 'Electrical World and Engineer,' New York. (T. C. M.)

**MARTIN, Capt. W. R.,** R.N.; author of 'A Treatise on Navigation and Nautical Astronomy,' etc. (W. R. M*.)

**MARZIALS, Frank Thomas;** Accountant-General of the Army since 1898; entered War Office during Crimean war; author of 'Lives of Dickens and Victor Hugo,' collaborating also in the 'Life of Thackeray,' 'Life of Gambetta,' etc. (F. T. M.)

**MASKELYNE, J. Nevil;** of the Egyptian Hall, London; author of 'Sharps and Flats.' (J. N. M.)

**MASON, Otis Tufton,** A.M., Ph.D.; Curator Ethnology, U.S. Nat. Museum, Washington; author of 'The Hupa Indians,' 'Woman's Share in Primitive Culture,' 'Cradles of the North American Indians,' 'The Antiquities of Guadeloupe,' etc. (O. T. M.)

**MATHEWS, George Ballard,** M.A., F.R.S.; late Professor of Mathematics, University Coll. of Wales; formerly Fellow of St John's Coll., Cambridge; author of 'A Treatise on Bessel Functions' (part), 'Theory of Numbers,' etc. (G. B. M.)

**MATTHEWS, Brander,** LL.B., D.C.L., A.M.; Professor of English, Columbia University; author of 'French Dramatists of the Nineteenth Century,' 'Introduction to the Study of American Literature,' 'Aspects of Fiction and Other Ventures in Criticism,' etc. (B. M.)

**MATTHEWS, George Edward,** A.B.; editor of 'The Buffalo Express,' Buffalo, N.Y. (G. E. M.)

**MAURICE, Maj.-Gen. Sir John Frederick,** K.C.B.; commanded Woolwich District, 1895-1901; Ashanti Campaign, 1873-74; South Africa, 1879; Zulu Campaign, 1880; Egyptian Expedition, 1882; Intelligence Dept. War Office; Sudan, 1884; A.Q.M.G.; Nile, 1885; Professor of Military History, Staff College, Aldershot, 1892-93; commanding R.A., Colchester, 1893-95; Maj.-Gen., Dec. 1895; author of 'War,' in Ninth Edition of 'Ency. Brit.,' 'Life of Frederick Denison Maurice,' 'Hostilities without Declaration of War,' 'Balance of Military Power in Europe,' 'War,' 'National Defences.' (J. F. M*.)

**MAUS, Octave;** editor of 'L'Art Moderne,' Brussels. (O. M*.)

**MAXWELL, William H.,** A.M.I.C.E.; Borough and Waterworks Engineer, Tunbridge Wells Corporation; author of 'The Removal and Disposal of Town Refuse,' 'Destructors and Steam Production,' etc. (W. H. MA.)

**MAYO-SMITH, Richmond,** Ph.D., the late; Professor of Political Economy, Columbia University, New York; author of 'Emigration and Immigration,' 'Sociology and Statistics,' etc. (R. M.-S.)

**MEAD, Hon. Elwood:** in charge of Irrigation Investigations, U.S. Department of Agriculture. (E. M*.)

**MEAKIN, Budgett,** author of 'The Moorish Empire,' etc. (B. M*.)

**MEISSAS, Gaston;** memb. Société de Géographie; author of 'Marseilles,' and (part) of 'Paris,' in the Ninth Edition of the 'Ency. Brit.,' 'Grands Voyageurs de notre Siècle,' etc. (G. ME.)

**MERCATELLI, Luigi,** late war correspondent in Abyssinia of 'La Tribuna.' (L. ME.)

**MERRIFIELD, Webster,** LL.D.; President and Professor of Political Economy, State University of North Dakota. (W. MS.)

**MERRILL, Hon. Frederick James Hamilton,** Ph.D.; Director of N.Y. State Museum, Albany, N.Y., N.Y. State Geologist; Fellow Am. Ass. Adv. Science and Geol. Soc. of America; Member Am. Inst. Mining Engineers, Am. Soc. of Naturalists, Nat. Geol. Soc., etc. (F. J. H. M.)

**MIDDLETON, R. E.,** M.I.C.E., M.I.M.E.; Fellow of the Sanitary Inst., Fellow of Surveyors' Inst., etc.; late Engineer-in-Charge of Surveying of Forth Bridge; Instructor in Surveying, Central Tech. Coll., S. Kensington; Lecturer on Waterworks, Engineering and Sewage, Univ. Coll., London; part author of 'A Treatise on Surveying,' etc. (R. E. M.)

**MIJATOVICH, Chedomille;** Senator of the kingdom of Servia since 1875; Envoy Extraordinary and Minister Plenipotentiary of the King of Servia to the Court of St James, 1895-1900; transferred to Constantinople, 1900; Minister of Finance and Commerce of Servia, 1873; Minister of Foreign Affairs and Finance, 1880; Servian Minister to the Court of St James, 1884; Servian Plenipotentiary for the conclusion of peace with Bulgaria, 1886; Member of Royal Servian Academy of Science; corresponding member of South Slavonic Academy; hon. member of Royal Hist. Soc. London; author of several publications in Servian on Political Economy, Finances, History of Commerce, and History of Servia in Fifteenth Century; novels—'Rayko of Rasina,' 'Ikoniya, the Mother of the Vezier,' etc., 'Constantine the last Emperor of the Greeks,' 'Ancestors of the House of Orange.' (C. MI.)

**MILL, Hugh Robert,** D.Sc. (Edin.), LL.D. (St Andrews), F.R.S.G.S., F.R.G.S., F.R.Met.Soc.; Director of British Rainfall Organization, and editor of 'Symons' Meteorological Magazine' since 1901; Hon. Corresponding Member of the Geographical Societies of Paris, Berlin, Amsterdam, Budapest, Brisbane, and Philadelphia; Recorder of Section E, British Association, 1893-99; President, Section E, 1901; British Delegate to International Conference on the Exploration of the Sea, at Christiania, 1901, author of 'Rainband,' 'Rain-gauge,' 'Thermometer,' 'Whirlpool,' in Ninth Edition of 'Ency Brit.,' 'Realm of Nature,' 'The Clyde Sea Area,' 'The English Lakes,' 'Hints on the Choice of Geographical Books,' 'New Lands,' 'The International Geography,' etc. (H. R. M.)

**MILLINGEN, Alexander Van,** M.A.; Robert College, Constantinople; author of 'Byzantine Constantinople,' etc. (A. VAN M.)

**MILMAN, Sir Archibald John Scott,** K.C.B., the late; Clerk of the House of Commons 1900, retired 1902; entered service of House of Commons in 1857; promoted Second Clerk Assistant, 1870; Clerk Assistant, 1886-1900. (A. J. S. M.)

**MILNE, John,** F.R.S., F.G.S.; twenty years employed by Japanese Govt. as geologist and mining engineer; established the Seismic Survey of Japan; designer of seismographs and instruments to record vibrations on railways, etc.; author of 'Earthquakes,' 'Seismology,' 'Crystallography,' etc. (J. MI.)

**MILTON, James Tayler,** M.I.C.E.; Chief Engineer Surveyor, Lloyd's Register of Shipping; Member of Inst. of Naval Architects and of the Iron and Steel Inst., etc. (J. T. MI.)

**MINCHIN, E. A.,** M.A., F.Z.S.; Jodrell Professor of Zoology and Comparative Anatomy, Univ. Coll., London; late Fellow of Merton Coll., Oxford; late Lecturer Comp. Anatomy, Oxford; late Lecturer in Biology, Guy's Hospital; author of 'Sponges,' etc. (E. A. M.)

**MITCHELL, Hugh;** of Gibraltar; Barrister-at-Law, Inner Temple. (H. M*.)

**MITCHELL, Peter Chalmers,** D.Sc., M.A., F.Z.S.; Lecturer on Biology at the London Hospital Medical College; University Demonstrator in Comparative Anatomy, and assistant to Linacre Professor at Oxford, 1888-91; Lecturer on Biology at Charing Cross Hospital, 1892-94; at London Hospital, 1894; examiner in Biology to the R.C.P. 1892-96; author of 'Outlines of Biology,' 'The Biological Problem of To-day' (translated), 'Thomas Henry Huxley,' etc. (P. C. M.)

**MONCKTON, Lionel;** composer, and musical critic to the 'Daily Telegraph.' (L. M.)

**MONKHOUSE, William Cosmo,** the late Assistant Secretary (Finance) Board of Trade; served on several Departmental Committees and Committee on the Mercantile Marine Fund, 1894-96; author of 'The Christ upon the Hill,' 'A Question of Honour,' 'The Earlier English Water-Colour Painters,' 'The Italian Pre-Raphaelites,' 'British Contemporary Artists,' etc. (C. MO.)

**MONTAGU, Sir Samuel;** head of the banking firm of Samuel Montagu and Co., London; member of Gold and Silver Commission, 1887-90; author of magazine articles on Finance, Decimal Currency, Weights and Measures, etc. (S. M.)

**MOORE, Hon. John Bassett,** LL.D.; Professor International Law and Diplomacy, Columbia University, New York; author 'Extradition and Inter-State Rendition,' 'International Arbitrations,' etc. (J. B. M*.)

**MORENO, Dr Francesco P.;** donor and director of the La Plata Museum, Buenos Aires; repr. in Great Britain of the Argentine in connexion with Chilian Argentine Boundary Dispute; author of 'La Plata,' etc. (F. P. M.)

**MORFILL, William Richard,** M.A.; Professor of Russian and the other Slavonic languages, Oxford; Curator of the Taylor Institution, Oxford; author of 'Russia' (History and Literature) in Ninth Edition of 'Ency. Brit.' (W. R. M.)

**MORSE, John Torrey,** Jr.; sometime Lecturer on History, Harvard University; author of biographies of Alexander Hamilton, Abraham Lincoln, John Quincy Adams, Thomas Jefferson, etc., and of 'The Life and Letters of Oliver Wendell Holmes.' (J. T. MO.)

**MORTON, Hon. Julius Sterling** (the late); sometime U.S. Secretary of Agriculture and President of Nebraska State Historical Society. (J. S. M*.)

**MOSCA, Gaetano;** Professor of Constitutional Law, Turin, Italy. (G. MO.)

**MOSCHINI, V.;** Mayor of Padua. (V. MO.)

**MOTT, Frederick Walker,** M.D., B.S. Lond., F.R.C.P., F.R.S.; Physician to Out-Patients, Charing Cross Hospital; Pathologist to the London County Asylums; Croonian Lecturer, Royal College of Physicians, 1900. (F. W. MO.)

**MUIR, John,** A.M., LL.D.; U.S. Explorer and Naturalist; discoverer of the Muir glacier, Alaska; author of 'The Mountains of California' and of numerous articles on the natural history of the Pacific Coast, Alaska, etc.; Editor 'Picturesque California.' (J. MU*.)

**MUIR, Robert,** M.A., M.D., C.M.; Professor of Pathology, University of Glasgow; Examiner in Pathology, Oxford; senior assistant to the Prof. of Pathology, Edinburgh, and Pathologist to Edinburgh Royal Infirmary, 1892; Lecturer on Pathological Bacteriology, Edinburgh, 1894; Professor of Pathology, St Andrews, 1898-99; author of 'Manual of Bacteriology' (with Dr J. Ritchie), 'Scientific Papers,' etc. (R. MU*.)

**MUNRO, Wilfred H.;** A.M., Professor of European History, Brown University, R.I. (W. H. MU.)

**MURPHY, Shirley Forster,** M.D., M.R.C.S.; Medical Officer of Health, Administrative County of London; Corresp. Mem. Soc. Sweden, and of Roy. Soc. Hygiene, Italy; author of 'Infectious Disease and its Prevention,' editor of 'Our Homes and How to make them Healthy,' etc. (S. F. M.)

**MURRAY, Sir George Herbert,** K.C.B.; Secretary to the Post Office since 1899; entered Foreign Office, 1873; transferred to Treasury, 1880; private secretary to Mr Gladstone and Earl of Rosebery when Prime Minister; Chairman Board of Inland Revenue, 1897-99. (G. H. M.)

**MUTHER, Dr Richard,** Professor of Art History, University of Breslau; author of 'The History of Modern Painting,' 'The Oldest German Picture Bibles,' 'Gothic and Early Renaissance Illustrations of German Books,' 'A Century of French Painting,' etc. (R. MR.)

**MYRES, J. L.;** Student and tutor of Christ Church, Oxford; author of 'A Catalogue of the Cyprus Museum.' (J. L. M.)

## N

**NAIRNE, Rev. Alexander,** M.A.; Professor of Hebrew and Old Testament Exegesis in King's Coll., Lond.; Fellow of Jesus Coll., Cambridge, 1887-93; Vice-Principal of Clergy Training School, 1887-89. (A. N*.)

**NANSEN, Fridtjof,** D.Sc., LL.D., D.C.L., Ph.D.; went to Greenland Sea, 1882; curator in Natural History Museum, Bergen; went across Greenland, 1888-89; curator Museum of Comparative Anatomy, Christiania University; made his North Pole Expedition, in which he reached the highest latitude until then attained (86 deg. 175 m.), 1893-96; Prof. of Zoology, Christiania University; author of 'Across Greenland,' 'Eskimo Life,' 'Farthest North,' 'The Norwegian North Polar Expedition,' 'Scientific Results,' etc. (F. N.)

**NASH, James Okey,** M.A., of the Community of the Resurrection. (J. O. N.)

**NATHAN, Major F. L.,** R.A.; Superintendent of the Royal Gunpowder Factory, Waltham Abbey. (F. L. N.)

**NATHAN, Major Matthew,** C.M.G., R.E.; Governor of Gold Coast; served in Nile Expedition, 1885; Lushai Expedition, 1889; Sec. Col. Defence Com. 1895-1900; administered Government Sierra Leone, 1899. (M. N.)

**NELSON, William Rockhill,** Editor-in-Chief of the 'Kansas City Star,' Kansas City, Mo. (W. R. N.)

**NEWCOMB, Prof. Simon,** Ph.D., LL.D., D.Sc., D.Nat.Phil.; Superintendent U.S. Nautical Almanac; Foreign Mem. Royal Society, London; Assoc. Institute of France, etc.; author of 'Moon' in Ninth Edition of 'Ency. Brit.,' 'Popular Astronomy,' etc.; editor of 'American Journal of Mathematics.' (S. N.)

**NEWELL, Frederick Haynes;** Hydrographer of the U.S. Geol. Survey; author of 'Agriculture by Irrigation,' 'Hydrography of the United States,' etc. (F. H. N.)

**NEWSOM, George Ernest,** M.A.; Vice-Principal of King's College, London. (G. E. N.)

**NEWTON, Henry G.,** M.A., LL.B.; Referee in Bankruptcy, New Haven, Conn. (H. G. N.)

**NISBET, C.** (C. N.)

**NORTON, Charles Eliot,** LL.D.; Professor of the History of Art, Harvard; Dante scholar and translator; author of 'Church Buildings in the Middle Ages'; editor of 'Letters of James Russell Lowell,' 'Correspondence of Carlyle and Emerson,' 'Writings of George William Curtis,' etc. (C. E. N.)

**NORTON, Professor Richard N.;** American School of Archæology, Rome. (R. N. N.)

**NOTTER, Col. J. Lane,** M.A., M.D., R.A.M.C., F.C.S.; late Prof. of Military Hygiene, Netley; author of 'The Theory and Practice of Hygiene,' etc. (J. L. N.)

## O

**O'DONOGHUE, Freeman M.,** F.S.A.; Assistant Keeper of Prints, British Museum; author of 'Catalogue of the Collection of Playing Cards bequeathed to the British Museum by Lady Charlotte Schreiber,' 'A Descriptive and Classified Catalogue of the Portraits of Queen Elizabeth,' etc. (F. M. O'D.)

**O'NEILL, Æneas;** Assistant Correspondent of 'The Times,' Vienna. (Æ. O'N.)

**ORDE-BROWNE, Capt. C.,** the late; author of 'Armour and its Attack by Artillery,' 'Short Notes on Field Batteries,' 'Ammunition for Rifled Ordnance,' etc. (C. O.-B.)

**OWEN, Capt. C. R. B.,** R.A.; late Professor of Artillery, Ordnance College; Assist. Superintendent, Roy. Carriage Dept., Woolwich Arsenal. (C. R. B. O.)

**OWEN, Edmund,** M.B. Lond., F.R.C.S.; Senior Surgeon to St Mary's Hospital, London, and Consulting Surgeon to the Children's Hospital, Great Ormond Street; Member of the Council, and late Member of the Court of Examiners of Royal College of Surgeons; Examiner in Surgery at the Universities of Cambridge and of London; Knight of Grace of the Order of St John of Jerusalem; Corresponding Member of the Imperial Medical Military Academy of St Petersburg, of the Canadian Medical Association, and of the Association of American Orthopædic Surgeons; Hon. Surgeon to the Royal Society of Musicians; late President of the Medical Society of London; author of 'A Manual of Anatomy for Senior Students,' 'The Surgical Diseases of Children.' (E. O.)

## P

**PAGET, Sir John R.,** Bart., LL.B., K.C.; Gilbart Lecturer on Banking. (J. R. P*.)

**PAGET, Stephen,** F.R.C.S.; Surgeon to West London Hospital; Surgeon to Throat and Ear Department, Middlesex Hospital; author of 'The Surgery of the Chest,' 'John Hunter,' 'Ambroise Paré and his Times,' Experiments on Animals,' 'Memoirs and Letters of Sir James Paget.' (S. P.)

**PALGRAVE, Robert Harry Inglis,** F.R.S.; editor of 'Economist,' 1877-83; author of 'The Local Taxation of Great Britain and Ireland,' 'Notes on Banking in Great Britain and Ireland, Sweden, Denmark, and Hamburg,' 'An Analysis of the Transactions of the Bank of England for the years 1844-72,' 'Bank Rate in England, France, and Germany, 1844-1878'; editor of 'Dictionary of Political Economy.' (R. H. I. P.)

**PAPILLON, Rev. Thomas Leslie,** M.A.; late Fellow of Merton Coll. and of New Coll., Oxford; author of 'A Manual of Comparative Philology'; editor Dean Bradley's 'Aids to Writing Latin Prose,' etc. (T. L. P.)

**PARKIN, George Robert,** LL.D., C.M.G.; Principal of Upper Canada College, Toronto, Canada; author of 'Imperial Federation,' 'Round the Empire,' 'The Great Dominion,' 'Life and Letters of Edward Thring.' (G. R. P.)

**PARSONS, William Barclay:** Chief Engineer of the Underground Railway, New York City. (W. B. P.)

**PASCO, Hon. Samuel;** Member of the Nicaragua Canal Commission, United States Senator from the State of Florida, 1887-99. (S. PA.)

**PATON, Diarmid Noël,** M.D., B.Sc., F.R.C.P. Ed.; Superintendent of Research Laboratory of Royal College of Physicians, Edinburgh, 1889; Lecturer on Physiology, School of Medicine of Royal Colleges, Edinburgh, 1886; Biological Fellow of Edinburgh University, 1884; Member of the Royal Commission on Salmon Fisheries; author of many papers on Physiological subjects. (D. N. P.)

**PAUL, Alfred Wallis,** C.I.E., B.A.; late Scholar of Wadham College, Oxford; Indian Civil Service (retired): Political Officer Sikkim Expedition; British Commissioner under Anglo-Chinese Convention of 1890; Deputy Commissioner of Darjeeling. (A. W. P.)

**PEACH, Capt. E.,** Indian Staff Corps; author of 'Tactics—Savage Warfare,' etc. (E. P.)

**PEARSON, Karl,** M.A., LL.B., F.R.S.; Professor of Applied Mathematics and Mechanics, University College, London; Gresham Professor of Geometry, 1892-94; Darwin Medal Royal Society, 1898; author of 'Grammar of Science,' 'Enlarged Grammar of Science,' 'The Chances of Death, and other Studies in Evolution,' 'The Ethic of Freethought,' 'Die Fronica, a History of the Mediæval Portraits of Christ,' etc. (K. P.)

**PELSENUR, PAUL,** D.Sc. (Brussels); cor. member of the Royal Belgian Academy of Science; member of the Belgian Committee of Mariculture; Professor in the Normal School, Ghent; lecturer, Brussels University; author of 'Introduction à l'Étude des Mollusques,' 'Report on the Pteropoda,' 'The Anatomy of the Deep-Sea Mollusca,' etc. (P. P.)

**PEMBREY, Marcus Seymour,** M.A., M.D.; Lecturer in Physiology, Guy's Hospital Medical School. (M. S. P.)

**PENDEREL-BRODHURST, James George Joseph;** editor of 'Land,' 1881-83, assistant editor of 'St James's Gazette,' 1888-93, editor of 'St James's Budget,' 1889-98; author of 'The Life and Times of King Edward VII.,' part author of 'The Royal River and Abbeys and Churches of England and Wales.' (J. G. J. P.-B.)

**PENNELL, Joseph,** artist; author of 'A Canterbury Pilgrimage,' 'An Italian Pilgrimage,' 'Two Pilgrims' Progress,' 'Our Sentimental Journey through France and Italy,' 'Pen Drawing and Pen Draughtsmen,' 'Our Journey to the Hebrides,' 'The Stream of Pleasure,' 'The Jew at Home,' 'Play in Provence,' 'Modern Illustration,' 'The Illustration of Books,' 'The Work of Charles Keene,' 'Lithography and Lithographers.' (J. P*)

**PERSHING, James H.,** A.B.; Lecturer on International Law in the University of Denver, and Professor of Medical Jurisprudence in Gross Medical College, Denver. (J. H. PE.)

**PETERSON, Frederick,** Ph.D., M.D.; President New York Neurological Society and President of the Board of Managers of Craig Colony for Epileptics, Chief of Clinic, Department of Neurology, Columbia University. (F. P*.)

**PETRIE, William Matthew Flinders,** D.C.L., Litt.D., LL.D., Ph.D.; Edwards Professor of Egyptology, University Coll. London; surveying British remains, 1875-80; excavating in Egypt, 1880-1901; author of 'Pyramid,' 'Weights and Measures,' in Ninth Edition of 'Ency. Brit.,' 'Stonehenge,' 'Pyramids and Temples of Gizeh,' 'Season in Egypt,' 'Racial Portraits,' 'Historical Scarabs,' 'Ten Years' Digging,' 'History of Egypt,' 'Tel el Amarna,' 'Egyptian Tales,' 'Decorative Art,' 'Six Temples at Thebes,' 'Religion and Conscience in Ancient Egypt,' 'Syria and Egypt,' 'Royal Tombs of the First Dynasty,' 'Royal Tombs of the Earliest Dynasties,' etc. (W. M. F. P.)

**PFEIL, Count Joachim Von,** one of the founders of German East Africa; sometime resident in Bismarck Archipelago; author of 'The Founding of the Boer States,' 'Studies and Observations in the South Seas,' etc. (J. VON P.)

**PHELAN, Hon. James Duval;** Mayor of San Francisco, 1896-1901. (J. D. P.)

**PHILLIMORE, George Grenville,** M.A., B.C.L.; Barrister-at-Law of the Middle Temple. (G. G. P*.)

**PHILLIMORE, Sir Walter George Frank,** Bt., D.C.L., LL.D.; Judge of the King's Bench Div.; author of 'Book of Church Law,' 2nd ed. of 'Phillimore's Ecclesiastical Law, 3rd ed. of vol. iv. of 'Phillimore's International Law.' (W. G. F. P.)

**PHILLIPS, R. W.,** M.A., D.Sc., F.L.S.; Professor of Botany in the University Coll. of North Wales; author of 'Memoirs on the Physiology of Plants,' 'Morphology of the Algæ,' etc. (R. W. P.)

**PHILLPOTTS, Col. A. H. C.,** R.A. (A. H. C. P.)

**PINCHOT, Gifford,** B.A.; Forester of the U.S. Department of Agriculture, Special Lecturer in the Forest School, Yale Univ.; author of 'The White Pine.' (G. P.)

**PITMAN, Charles Murray;** stroke of the Oxford Eight, 1893 95. Author of articles on Rowing. (C. M. P.)

**PITT, Walter,** M.I.C.E., M.I.M.E.; Member of the Committee of International Maritime Conference (London), etc. (W. P*.)

**POLLEN, John Hungerford,** M.A.; Examiner for Art, South Kensington; Fellow of Merton Coll., Oxford; Professor of Fine Arts in Catholic University of Dublin; Cantor Lecturer, Society of Arts, 1885; author of 'Carving,' 'Filigree,' 'Furniture,' in Ninth Edition of 'Ency. Brit.,' 'Ancient and Modern Furniture and Woodwork,' 'Ancient and Modern Gold- and Silver-smiths' Work, 'The Trojan Column,' etc. (J. H. P.)

**POLLOCK, Sir Frederick,** Bt., LL.D., D.C.L.; Corpus Professor of Jurisprudence, Oxford; editor of the Law Reports from 1895; Fellow Trin. Coll., Camb. [illegible] member Institute of France, [illegible] Professor of Jurisprudence, University Coll., London, 1882-83; Professor of Common Law in the Inns of Court, 1884-90; member Royal Labour Commission, 1891-94; author of 'Sword,' 'Tort' in Ninth Edition of 'Ency. Brit.,' 'Principles of Contract,' 'The Law of Torts,' 'Digest of the Law of Partnership,' 'The Land Laws,' 'History of English Law,' 'Spinoza, Life and Philosophy,' 'A First Book of Jurisprudence,' 'The Etchingham Letters,' 1899 (with E. Fuller Maitland). (F. Po.)

**POORE, George Vivian,** M.D.; Professor of Medicine and Clinical Medicine, University College, London; medical attendant to late Prince Leopold, Duke of Albany, 1870-71; and Prince of Wales, 1872; [illegible] for professional services to the Princess Thyra, Duchess of Cumberland, 1872; Physician University Coll. Hospital, 1876; Secretary-General of Sanitary Congress, 1891, etc.; author of 'Essays on Rural Hygiene,' 'A Treatise on Medical Jurisprudence.' (G. V. P.)

**PORTER, W. Haldane,** B.A.; Barrister, Middle Temple; Chancellor's English Essay, Oxford, 1893. (W. H. Po.)

**POST, George B.;** Architect; Member of the Am. Society of Civil Engineers. (G. B. P.)

**POTTER, Rt. Rev. Henry Codman,** D.D., LL.D; Bishop of the Diocese of New York; author of 'The Church and Her Children, 'The Scholar and the State,' etc. (H. C. P.)

**POULTON, Edward Bagnall,** M.A., D.Sc.; Hon. LL.D. Princeton, F.R.S.; Hope Professor of Zoology, Oxford; Fellow of Jesus Coll., Oxford; Member of Council of Royal Society, 1897-99; Member of Hebdomadal Council of Oxford; Demonstrator in Anatomical Department of University Museum, 1877-79; Lecturer in Natural Science, and tutor of Keble College, Oxford, 1880-89: Lecturer in Natural Science, Jesus College, Oxford, 1880-88; author of 'The Colours of Animals,' 'Charles Darwin and the Theory of Natural Selection,' many memoirs on Zoological Subjects in the Proceedings and Transactions of the Royal, Linnæan, Zoological, Entomological, and other learned Societies. (E. B. P.)

**POWELL, F. York,** M.A.; Regius Professor of Modern History, Oxford; Student of Ch. Ch., Oxford; author of 'Icelandic Language,' etc., in Ninth Edition of 'Ency. Brit.,' 'Alfred the Great and William the Conqueror,' 'History of England to 1509.' (F. Y. P.)

**POYNTING, John Henry,** D.Sc., F.R.S.; late Fellow of Trin. Coll., Camb.; Professor of Physics and Dean of the Faculty of Science, Birmingham University; author of the Adams Prize Essay (1891) on the 'Mean Density of the Earth,' 'A Text-Book of Physics' (with Professor J. J. Thomson), and various physical papers. (J. H. P*.)

**PRINCE, Hon. L. Bradford,** LL.D.; President of the Bureau of Immigration of the territory of New Mexico, Santa Fé, New Mexico; ex-Governor of the State of New Mexico; President of the New Mex. Hist. Soc.; author of 'New Mexico' in Ninth Edition of 'Ency. Brit.' (L. B. PR.)

**PROCTER, Hon. John Robert,** President U.S. Civil Service Commission, Washington, D.C.; Geologist State of Kentucky, 1880-1893; author of 'Kentucky' in Ninth Edition of 'Ency. Brit.' (J. R. P.)

**PROUT, Major Henry Gosler,** editor of 'The Railroad Gazette,' New York; sometime Governor of the Provinces of the Equator, Africa, and Colonel of Engineers, Army of the Khedive. (H. G. P.)

**PROWSE, Daniel Wodley,** K.C., LL.D., D.C.L.; retired Judge Central District Court of Newfoundland; appointed Judge Central District Court, 1869; Commissioner for the Consolidation of Colonial laws; Chairman Board of Health, 1893-96; author of 'History of Newfoundland,' 'Manual for Magistrates in Newfoundland,' numerous pamphlets and newspaper articles. (D. W. P.)

**PULLAN, Rev. Leighton,** Fellow of St John's Coll., Oxford; author of 'History of

Early Christianity,' 'Lectures on Religion,' etc. (L. P.)

**PURSER, F.,** M.A., M.R.I.A.; Fellow of Trinity Coll., Dublin, and Professor of Natural Philosophy, University of Dublin. (F. Pu.)

**PURSER, J.,** M.A., D.Sc., LL.D., M.R.I.A.; emeritus Professor of Mathematics, Queen's Coll., Belfast. (J. Pu.)

**PUTNAM, George Haven,** A.M., Litt.D.; Head of the publishing House of G. P. Putnam's Sons, N.Y.; led in reorganizing, 1887, the American Copyright League, and was its secretary during the movement for International Copyright which resulted in the Copyright Bill of 1891; Received Cross of the Legion of Honour from France, 1891; author of 'Question of Copyright,' 'Books and their Makers in the Middle Ages,' etc. (G. H. P*.)

**PUTNAM, Hon. Herbert,** Librarian of Congress, Washington, D.C. (H. P.)

**PYLE, Joseph Gilpin;** editor of the 'Post-Intelligencer,' Seattle, Washington; author of 'Minnesota' in Ninth Edition of 'Ency. Brit.' (J. G. P.)

## Q

**QUILLER-COUCH, Arthur Thomas,** B.A.; Lecturer Classics Trin. Coll., Oxford, 1886-87; author of 'Dead Man's Rock,' 'Troy Town,' 'The Splendid Spur,' 'Noughts and Crosses,' 'The Delectable Duchy,' 'Adventures in Criticism,' 'The Oxford Book of English Verse,' 'The Laird's Luck,' finished R. L. Stevenson's uncompleted novel 'St Ives,' etc. (A. T. Q.-C.)

## R

**RADAU, R.;** Membre de l'Académie des Sciences et du Bureau des Longitudes, Paris; writer on Astronomy, etc., part author of 'Géologie d'Ethiopie,' etc. (R. Ra.)

**RAIKES, His Honour Judge Francis William,** LL.D., K.C.; Judge of County Court (Hull); three years in Merchant Service, then passed into Royal Navy first; called to the Bar, 1873; author of 'The New Practice' (with Mr Justice Kennedy); 'Jurisdiction and Practice of County Courts in Admiralty' (with Mr Kilburn), 'Both to Blame,' paper read at Brussels International Law Conference, 1895; and various papers on 'Maritime Law,' translations and editions of the 'Maritime Codes of Europe,' etc. (F. W. Ra.)

**RAMBAUT, Arthur Alcock,** M.A. (Dub. and Oxon.); D.Sc., F.R.S., F.R.A.S.; Radcliffe Observer, Oxford; Assistant Astronomer Trinity College, Dublin, at Dunsink, 1882-92; Andrews Professor of Astronomy in the University of Dublin and Royal Astronomer of Ireland, 1892-97; author of various memoirs and papers on Astronomical subjects. (A. A. R*.)

**RAMSAY, William Mitchell,** D.C.L., LL.D. St And. and Glasgow, Litt.D. Camb.; Professor of Humanity, Aberdeen Univ.; Fellow of Exeter Coll.; Oxford, 1882; Lincoln Coll., Oxford, 1885; Professor of Classical Art in Oxford University, 1885; Levering Lecturer in Johns Hopkins University, Baltimore, 1894; Foreign Member of Austrian Imperial and Royal Archæological Institute, 1900; author of 'Hermes,' 'Illyria,' 'Jupiter,' 'Mysteries,' 'Oracle,' 'Phrygia,' 'Scio,' 'Sicyon,' 'Smyrna,' in Ninth Edition of 'Ency. Brit.,' 'The Historical Geography of Asia Minor,' 'The Church in the Roman Empire,' 'The Cities and Bishoprics of Phrygia,' 'St Paul the Traveller and the Roman Citizen,' 'Was Christ born at Bethlehem?' 'Historical Commentary on Galatians.' (W. M. Ra.)

**RASHDALL, Rev. Hastings,** M.A., D.C.L.; Fellow and Tutor of New College, Oxford; Lecturer in St David's College, Lampeter, 1883; Tutor in the Univ. of Durham, 1884-88; Fellow and Lecturer of Hertford Coll., Oxford, 1888-95; Chaplain and Theological Tutor of Balliol Coll., 1894-95; author of 'The Universities of Europe in the Middle Ages,' 'Doctrine and Development' (with R. S. Rait), 'New College.' (H. Ra.)

**RÁTH, Dr Zoltán;** Professor at the Royal Academy of Law, Kassa, Hungary; late of the Royal Hungarian Statistical Bureau; author of 'Evitzedünk egyenesadó-reformjairól.' (Z. R.)

**RAVENSTEIN, Ernest George;** War Office, Topographical (now Intelligence) Department, 1855-75; Council Royal Statistical Society, 1877-92; President, Section E, Brit. Assoc., 1891; Professor of Geography, Bedford Coll., 1882-83; author of 'The Russians on the Amur,' 'Geographie und Statistik des Britischen Reiches,' 'Vasco da Gama's First Voyage,' 'Map, Equatorial Africa,' 'Systematic Atlas.' (E. G. R.)

**RAYLEIGH, Lord, 3rd Baron,** D.C.L. (Hon. Oxon.), LL.D., D.Sc. (Camb. and Dublin), F.R.S.; Professor of Natural Philosophy, Royal Institution; Scientific Adviser to Trinity House; Cavendish Professor of Experimental Physics, Cambridge, 1879-84; Secretary of Royal Society, 1887-96; author of 'Optics,' 'Wave Theory,' in Ninth Edition of 'Ency. Brit.,' 'Theory of Sound,' numerous scientific papers. (R.)

**REDWOOD, Boverton,** F.R.S.Ed., A.M.I.C.E., M.I.M.E.; Fellow of Inst. of Chem.; V.P. and Mem. of Council and Publication Com., Soc. Chem. Ind.; Fellow of Chem. Geol. and R. Geog. Soc.; D Sc. Ohio Normal University; Mem. of Am. Chem. Soc., and Am. Philosophical Soc. (honorary); Hon. Corres. Mem. Imperial Russian Technical Soc.; Chevalier of the Order of Leopold; Consulting Chemist, with special experience in the technology of petroleum; Adviser on Petroleum to the Home Office; Consulting Adviser to the Corporation of London under the Petroleum Acts; Chemical Adviser to the Oil Trade Section of the London Chamber of Commerce; member of several juries at International Inventions and Health Exhibitions, president of International Jury for lighting appliances and materials at Brussels Exhibition, 1897, and member of Jury, Paris Exhibition, 1900; author of 'Cantor Lectures on Petroleum and its Products,' 'Petroleum: its Production and Use,' 'Report (with Sir Frederick Abel) on Accidents with Mineral Oil Lamps,' 'Report (with Sir Frederick Abel) on the Transport of Petroleum through the Suez Canal,' 'The Transport of Petroleum in Bulk,' articles on the Petroleum Industry, and Lamps in Chemical Technology, 'A Treatise on Petroleum,' 'The Detection and Estimation of Inflammable Gases and Vapours in the Air' (with Professor Clowes), 'Handbook on Petroleum' (with Capt. J. H. Thomson). (B. R.)

**REEVES, Hon. William Pember,** Agent-General for New Zealand; Member of Senate of University of London; edited the 'Canterbury Times,' and the 'Lyttelton Times'; Member of N.Z. Parliament, 1887-96; Minister of Education, Labour, and Justice, 1891-96; resigned position to become Agent-General for colony; author of 'The Long White Cloud, a History of New Zealand,' 'An Introduction to the History of Communism and Socialism,' also volume of New Zealand verse. (W. P. R.)

**REICH, Emil,** Dr. Juris, F.R.Hist.S.; author of 'History of Hungarian Literature,' 'History of Civilization,' 'Græco-Roman Institutions,' 'Historical Atlas of English History,' 'Historical Atlas of Modern History,' etc. (E. Re*.)

**REID, Clement,** F.R.S., F.L.S., F.G.S.; geologist on survey of England and Wales; formerly secretary and recorder to the Geological Section of British Association; author of 'Pliocene Deposits of Britain,' 'Origin of the British Flora,' many contributions to geological journals. (C. R.)

**REID, Sir George,** LL.D.,; President Royal Scottish Academy; author of 'Lithography,' 'Painting,' 'Turner,' in Ninth Edition of 'Ency. Brit.' (G. Re.)

**REID, Hon. Whitelaw,** A.M., LL.D.; editor of the New York Tribune; Ex-U.S. Minister to France; author of 'Greeley,' 'Newspapers,' in Ninth Edition of 'Ency. Brit.' (W. R.)

**RENTON, A. Wood,** LL.B.; Puisne Judge, Mauritius; author of 'Thurlow' in Ninth Edition of 'Ency. Brit.' (A. W. R.)

**RENWICK, I. P. A.,** M.A., LL.B.; assistant editor of the 'Statesman's Year Book.' (I. P. A. R.)

**REYNOLDS, Osborne,** M.A., LL.D. Glasgow, F.R.S., M.I.C.E., Hon. Fellow Queens' Coll., Cambridge; Professor of Engineering, Owens College, Victoria University, Manchester; Fellow of Queens' College, Cambridge, 1877; President, Section G, British Association, 1887; author of upwards of sixty papers on original researches in 'Mechanics and Physics,' in the Philosophical Transactions and Proceedings of the Royal Society, etc. (O. R.)

**RHODES, Hon. Bradford;** editor of 'The Banker's Magazine,' New York. (B. R*.)

**RHODES, James Ford,** LL.D.; author of 'History of the United States from the Compromise to 1850.' (J. F. R.)

**RICHARDS, Robert Hallowell,** Sc.B.; Professor of Mining, Engineering, and Metallurgy, Massachusetts Institute of Technology. (R. H. R.)

**RICHARDSON, Charles Francis,** A.M., Ph.D.; Professor of English, Dartmouth College, N.H.; author of 'History of American Literature,' 'The Choice of Books,' etc., etc. (C. F. R.)

**RICHARDSON, Professor Rufus B.;** director of American School of Classical Studies, Athens. (R. B. R.)

**RICHMOND, Sir William Blake,** R.A., M.A., K.C.B.; Slade Professor at Oxford, 1878-83; President of Society of Miniature Painters, 1899. (W. B. Ri.)

**RICKETTS, Charles,** English printer, artist, and wood-engraver; one of the founders of the Vale Press; decorated 'Early Poems of John Milton,' 'The Poems of Keats,' etc. (C. Ri.)

**RILEY, John Athelstan Laurie,** M.A.; travelled in Persia, 1881; Turkey in Europe, 1883; Persia and Kurdistan, 1884, 1886, 1888; member of the House of Laymen of the Province of Canterbury; member London School Board, 1891-[illegible] of the Monks,' various pamphlets and articles, subjects connected with education, Eastern Christians, and foreign travel. (J. A. L. R.)

**RIPON, Bishop of, Rt. Rev. William Boyd Carpenter,** Hon. D.D. Glasgow, Hon. D.C.L. Oxon.; Knight of the Order of the Royal Crown, Prussia; Hulsean Lecturer, Cambridge, 1878; Bampton Lecturer, Oxford, 1887; Pastoral Lecturer on Theology, Cambridge, 1895; Canon of Windsor, 1882-1884; Hon. Chaplain to the Queen, 1879-83; Chaplain-in-Ordinary, 1883-84; author of 'Commentary on Revelation,' 'Witness of Heart to Christ' (Hulsean Lectures), 'Permanent Elements of Religion' (Bampton Lectures), 'Lectures on Preaching,' 'Christian Reunion,' 'The Great Charter of Christ,' 'A Popular History of the Church of England.' (W. B. R.)

**RISTORI, E. J.,** Assoc.M.Inst.C.E. (E. J. R.)

**ROBERTS, W.;** author of 'Christies',' 'The Book-hunter in London,' etc. (W. R*.)

**ROBERTS-AUSTEN, Sir William Chandler,** K.C.B., D.C.L. (Durham), F.R.S.; Chevalier de la Légion d'Honneur; chemist and assayer to Royal Mint since 1870; Professor of Metallurgy, Royal School of Mines since 1880; President of Iron and Steel Institute; author of 'Gold,' etc., in Ninth Edition of 'Ency. Brit.,' 'An Introduction to the Study of Metallurgy.' (W. C. R.-A.)

**ROBERTSON, Sir George Scott,** K.C.S.I., D C.L.; entered Indian Medical Service, 1878; British Agent in Gilgit; conducted a political mission to Chitral, 1893; besieged in Chitral, during March and April 1895; installed the present ruler of Chitral, September 1895; author of 'The Kafirs of the Hindu Kush,' 'Chitral: The Story of a Minor Siege.' (G. S. R.)

**ROBERTSON, James W.;** Commissioner of Agriculture and Dairying, Ottawa, Canada. (J. W. R.)

**ROBERTSON, John G.;** Lecturer on the English Language, University of Strasburg. (J. G. R.)

**ROBINSON, A. Mary F. (Mme. Duclaux; formerly Mme. Darmesteter),** author of 'Emily Bronte,' 'The End of the Middle Ages,' 'Margaret of Angoulême, Queen of Navarre,' 'Retrospect, and other Poems,' 'Life of Renan,' 'Collected Poems,' 'Marguerites du Temps Passé,' 'Froissart,' 'Grands Ecrivains d'outre Manche,' etc. (A. M. F. D.)

**ROBINSON, Rev. Charles Henry,** M.A.; Hon. Canon of Ripon; Lecturer in Hausa in the University of Cambridge, 1896; travelled in Armenia in order to report to Archbishop of Canterbury on the condition of Armenian Church, 1892; conducted pioneer expedition to Kano, 1893-95; author of 'Hausaland, or Fifteen Hundred Miles through the Central Soudan,' 'Specimens of Hausa Literature,' 'Grammar of the Hausa Language,' 'Dictionary of the Hausa Language,' 'Studies in the Character of Christ,' 'Nigeria, Our Latest Protectorate,' 'Human Nature a Revelation of the Divine.' (C. H. R.)

**ROBINSON, Gerald Philip;** President of the Society of Mezzotint Engravers; late Mezzotint Engraver to Queen Victoria, and appointed same to the King, 1901. (G. P. R.)

**ROBINSON, Rev. Joseph Armitage,** D.D., Ph.D.; Canon of Westminster; Norrisian Professor of Divinity, Cambridge University, 1893-99; author of 'A Collation of the Athos Codex of the Shepherd of Hermas,' 'Appendix to The Apology of Aristides,' 'The Passion of St Perpetua,' 'The Philocalia of Origen,' 'Euthaliana,' 'Unity in Christ.' (J. A. R.)

**ROCKHILL, Hon. William Woodville;** Head of the Bureau of American Republics; sometime First Assistant Secretary of State;

U.S. Commissioner to China, etc.; author of 'Land of the Llamas.' (W. W. R.)

**ROCKWELL, General Alfred P.,** author of 'Fire,' 'Fire Extinction,' in Ninth Edition of 'Ency. Brit.' (A. P. R.)

**ROGERS, Henry Wade,** LL.D.; Lecturer at Yale University; sometime President of North Western University, Evanston, Ills.; Chairman of the World's Congress on Jurisprudence and Law Reform, World's Columbian Exposition; author of 'Expert Testimony, etc. (H. W. R.)

**ROLLS, Hon. C. S.;** pioneer in motor-car travelling. (C. S. R.)

**ROSCOE, Sir Henry Enfield,** Ph.D., LL.D., D.C.L., M.D., F.R.S.; Vice-Chancellor, University of London; Emeritus Professor, Owens College, Victoria University; Member of Royal Commissions on Noxious Vapours, Technical Instruction, Scottish Universities, Secondary Education, and Exhibition of 1851, President of the British Association (Manchester, 1887); President Society of Chemical Industry, 1881; President Chemical Society, 1882; author of 'Lessons in Elementary Chemistry,' 'Treatise on Chemistry,' 'Primer of Chemistry,' 'John Dalton,' 'New View of the Genesis of the Atomic Theory of Chemistry' (with Dr Harden). (H. E. R.)

**ROSEWATER, Victor,** A.M., Ph.D.; managing editor of the Omaha Bee, Omaha, Nebraska; Member Omaha Public Library Bd., Am. Economic Assn., Am. Library Assn., Neb. Historical Society; author of 'Special Assessments: a Study in Municipal Finance.' (V. R.)

**ROSS, H. M.,** B.A.; formerly exhibitioner of Lincoln Coll., Oxford; writer on engineering and scientific subjects; associate editor of the new volumes of the 'Encyclopædia Britannica.' (H. M. R.)

**ROSSETTI, William Michael;** Professional Assistant to Board of Inland Rev. for Estate duty on Pictures and Drawings; author of 'Canova,' 'Correggio,' 'Fiesole,' 'Ghirlandajo,' 'Lippi,' 'Murillo,' 'Perugino,' 'Reni,' 'Rosa,' 'Shelley,' 'Titian,' 'Veronese,' etc., in Ninth Edition of 'Ency. Brit.'; 'Fine Art, chiefly contemporary,' 'Lives of Famous Poets,' 'Life of Keats,' 'Dante G. Rossetti as Designer and Writer,' 'Memoir of Dante G. Rossetti'; editor of 'The Germ,' 1850, of 'Shelley's Poems,' of 'Wm. Blake's Poems,' of 'Poems by Dante and Christina Rossetti,' of 'Ruskin,' 'Rossetti,' 'Præraphaelitism,' of 'Præraphaelite Diaries and Letters,' etc. (W. M. R.)

**ROWLAND, Henry Augustus,** Ph.D., LL.D., F.R.S., the late; Professor of Physics, Johns Hopkins University; recipient of Rumford, Draper and Matteucci medals for scientific discoveries; Hon. Member Inst. of France, etc.; author of 'Screw' in Ninth Edition of 'Ency. Brit.' (H. A. R.)

**RUFFINI, Arthur;** Royal Naval Academy, Leghorn. (A. R*.)

**RUGE, Dr Sophus;** Professor of Geography, University of Dresden; author of 'Map' in Ninth Edition of 'Ency. Brit.,' 'Geschichte des Zeitalters der Entdeckungen,' 'Abhandlungen und Vorträge zur Geschichte der Erdkunde,' 'Christopher Columbus,' etc. (S. R.)

**RUSSELL, Hon. Bertrand Arthur William,** M.A.; Fellow of Trinity College, Cambridge; author of 'German Social Democracy,' 'Essay on the Foundations of Geometry,' 'Philosophy of Leibnitz.' (B. A. W. R.)

**RUSSELL, George William Erskine,** LL.D.; Parliamentary Secretary to the Local Government Board, 1883-85; Under-Secretary of State for India, 1892-94; for the Home Department, 1894-95; author of 'A Monograph on the Rt. Hon. W. E. Gladstone,' 'Letters of Matthew Arnold,' 'Collections and Recollections, 1898.' (G. W. E. R.)

## S

**SACHS, Edwin O.,** A.M.I.C.E.; Chairman of British Fire Prevention Committee; Fellow of the Royal Statistical Society; Associate of the Institution of Naval Architects, etc.; in 1898 he applied electrical power to the working of the stage at Drury Lane; in 1899 he was appointed technical adviser to the Royal Opera, Covent Garden; founded in 1897 the British Fire Prevention Committee, and in 1899 the first independent fire-testing station established in Europe; author of 'Modern Opera Houses and Theatres,' 'Stage Construction,' 'Fires and Public Entertainments.' (E. O. S.)

**ST. JOHN, Molyneux;** Ottawa, Canada. (M. St. J.)

**SAMPSON, Rear-Admiral William Thomas,** LL.D.; in command of U.S. North Atlantic Squadron, battle of Santiago; late Commandant U.S. Navy Yard, Boston, Mass.; Member of International Prime Meridian and Time Conference; U.S. Delegate to International Maritime Conference; Chief of U.S. Bureau of Ordnance, 1893-97. (W. T. S.)

**SAUNDERS, George,** B.A.; Berlin Correspondent of 'The Times'; late Berlin Correspondent of the 'Morning Post,' etc. (G. Su.)

**SAYCE, Rev. Archibald Henry,** M.A., LL.D., D.D.; Fellow of Queen's College, Oxford; Professor of Assyriology, Oxford; Member of O T. Revision Company, 1874-84; Deputy Professor of Comparative Philology, Oxford, 1876-90; Hibbert Lect., 1887; Gifford Lect., 1900-1; author of 'Babylonia,' 'Cyrus,' 'Darius,' 'Grammar,' 'Humboldt,' 'Inscriptions' (Cuneiform and Semitic), 'Lydia,' in Ninth Edition of 'Ency. Brit.,' 'Assyrian Grammar for Comparative Purposes,' 'Translations in Records of the Past,' 1st series; 'Lectures on the Assyrian Language and Syllabary,' 'Babylonian Literature,' 'Introduction to the Science of Language,' 'The Monuments of the Hittites,' 'Fresh Light from the Monuments,' 'The Ancient Empires of the East,' 'Hibbert Lectures on Babylonian Religion,' 'The Hittites,' 'The Races of the Old Testament,' 'The Higher Criticism and the Verdict of the Monuments,' 'The Egypt of the Hebrews and Herodotus,' 'Early History of the Hebrews.' (A. H. S.)

**SCHIDROWITZ, Philip,** Ph.D. Berne; F.C.S. (Great Britain and Germany); Member of Societies of Chemical Industry and of Public Analysts; author (joint) of various papers on Acids, Wine, Analyses, etc. (P. S.)

**SCHILLER, F. C. S.,** M.A.; Fellow and Tutor of C.C.C. Oxford. (F. C. S. S.)

**SCHINDLER, Gen. Sir A. Houtum-,** C.I.E.; general in the Persian army; has resided, as Persian official, and travelled for many years in Persia; author of 'Eastern Persian Irak,' etc. (A. H.-S.)

**SCHLICH, William,** Ph.D., C.I.E., F R.S.; Professor of Forestry, Cooper's Hill Coll.; appointed to the Indian Forest Department, 1866; Conservator of Forests, 1871; Inspector-General of Forests to the Government of India, 1881; organized the first School of Forestry in England at Cooper's Hill, 1885; author of 'A Manual of Forestry.' (W. Sch.)

**SCHLOSS, David,** M.A.; author of works on labour questions. (D. Sch.)

**SCHOULER, James,** LL.D.; Professor School of Law, Boston University, and Lecturer at Johns Hopkins University, Baltimore; author of 'History of the United States under the Constitution' and numerous works on Jurisprudence. (J. Sch.)

**SCHRADER, Franz;** Prix Gay de l'Académie des Sciences; editor of 'L'Année Cartographique,' 'Le Tour du Monde'; author of 'Aperçu de la Structure Géologique des Pyrénées,' etc. (F. Sch.)

**SCHURMAN, Jacob Gould,** D.Sc., LL.D.; President and sometime Professor of Philosophy, Cornell University; Chairman of the U.S. Philippine Commission, 1899; author of 'Kantian Ethics,' 'Ethics of Evolution,' 'Agnosticism and Religion,' etc. (J. G. S*.)

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**SCOTT, Austin,** Ph.D., LL.D.; President Rutgers College and Rutgers Scientific School, New Jersey. (A. Sc.)

**SCOTT, Dukinfield Henry,** M.A., Ph.D., F.R.S.; Honorary Keeper Jodrell Laboratory, Royal Gardens, Kew; Assistant Professor of Botany, Univ. Coll., London, 1882-85; Royal Coll. of Science, London, 1885-92; a General Secretary of the British Association; co-operated with the late Professor W. C. Williamson in his 'Researches on Fossil Plants'; one of the editors of the 'Annals of Botany'; author of 'An Introduction to Structural Botany,' 'Studies in Fossil Botany'; author and joint-author of many botanical papers. (D. H. S.)

**SCOTT, Harold Spencer;** Barrister-at-Law, Lincoln's Inn. (H. S. S.)

**SCOTT, Sir James George,** G.C.I.E.; War Correspondent in Perak, 1875-76; Burma, 1879; Hong Kong, 1883-85; joined Burma Commission in 1886; member of Anglo-Siamese Boundary Commission, 1889-90; Superintendent Northern Shan States, 1891; Chargé d'Affaires in Bangkok, 1893-94; British Commissioner, Mekong Commission, 1894-96; British Commissioner Burma-China Boundary Commission, 1898-1900; author of 'The Burman, His Life and Notions,' 'France and Tongking,' 'Burma,' 'The Upper Burma Gazetteer.' (J. G. Sc.)

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**SCOTT, W. W.;** foreign sub-editor of 'The Times.' (W. W. S*.)

**SCOTT-MONCRIEFF, Sir Colin Campbell,** K C.M.G, C.S.I., LL.D.; Under-Secretary for Scotland; Irrigation Depart. N.W. Provinces; Chief Engineer Burmah; Under-Secretary of State Public Works, Memshy, Cairo, 1883-92; author of 'Irrigation in Southern Europe.' (C. S. M.)

**SCRUTTON, T. E.,** M.A., K.C.; Barrister, Inner Temple; author of 'Law of Copyright,' etc. (T. E. S.)

**SCUDDER, Horace Elisha,** Litt.D., the late; editor of 'The Atlantic Monthly,' 1890-98; author of 'History of the United States,' 'Book of Fables,' 'The Life of James Russell Lowell,' etc. (H. E. S*.)

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**SEWARD, Albert Charles,** M A., F.R.S., F L.S., F R.G.S.; University Lecturer in Botany, Cambridge; Late Fellow of St John's College; Fellow and Tutor in Natural Science at Emmanuel College, Cambridge; author of 'Fossil Plants as Tests of Climate,' 'The Wealden Flora,' 'Fossil Plants for Students of Botany and Geology,' 'The Jurassic Flora,' also various Botanical papers contributed to scientific journals. (A. C. Se.)

**SHADWELL, A.,** M.D.; author of 'Tallerman Treatment by Superheated Dry Air,' 'The London Water Supply,' etc (A. Sl.)

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**SHARP, David,** M.A., M.B., C.M., F.R.S.; Past President of Entomological Society of London; author of 'Aquatic Carnivorous Coleoptera,' 'Insects.' (D. S*.)

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**SHAW, Albert,** Ph.D.; editor of the American 'Monthly Review of Reviews'; author of 'Local Government in Illinois,' 'Municipal Government in Great Britain,' 'Municipal Government in Continental Europe,' etc. (A. Sw.)

**SHAW, Flora L. (Miss);** special correspondent for 'The Times' to South Africa and Australia, Canada and Klondike; author of articles on British colonial questions. (F. L. S.)

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**SHAW, Hon. Leslie Mortier,** LL.D.; Secretary of the U.S. Treasury; formerly Governor of the State of Iowa. (L. M. S.)

**SHAYLOR, J.;** manager to Simpkin, Marshall, and Co. (J. Sh*.)

**SHEARMAN, Montague;** past President O.U.A.C.; joint-author of 'Football: Its History for Five Centuries,' author of 'Athletics and Football.' (M. S.)

**SHEARMAN, Thomas Gaskell,** the late; joint-author of 'Shearman and Redfield on Negligence'; author of 'Natural Taxation,' 'Crooked Taxation,' 'Distribution of Wealth,' 'The Single Tax,' etc. (T. G. S.)

**SHERRINGTON, Charles S.,** M.A., M.D., F.R.S.; Professor of Physiology, Univ. Coll. Liverpool; Member of Council of Royal Society; Late Brown Professor of Pathology, University of London; Lecturer on Physiology, St Thomas's Hospital, London; Croonian Lecturer, Royal Society; Member of the Commission on Asiatic Cholera, 1886; Anglo-American Secretary, International Congresses of Physiology, Liège 1892, Berne 1895, Cam-

bridge 1898, Turin 1901; author of numerous scientific papers to the Royal and other scientific societies, especially on the brain and nervous system. (C. S. S.)

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**SHIPLEY, Arthur Everett,** M.A., F.Z.S.; Fellow, Tutor, and Lecturer at Christ's College, Cambridge; Lecturer on Advanced Morphology of the Invertebrata in the University; Demonstrator of Comparative Anatomy in the University, 1885-94, Fellow of Christ's College, 1887; Member of the Council of the Senate, 1896, author of 'Zoology of the Invertebrata'; author of 'Vine Disease,' 'Wasps,' 'Wheat Pests,' in Ninth Edition of 'Ency. Brit.'; joint-editor and part-author of the 'Cambridge Natural History'; editor of the 'Pitt Press Natural Science Manuals,' Biological Series; part-author of 'A Text-Book on Zoology,' etc. (A. E. S.)

**SHORTER, Clement King**; editor of 'The Sphere'; late editor of the 'Illustrated London News,' the 'Sketch,' and the 'English Illustrated Magazine'; author of 'Charlotte Brontë and Her Circle,' 'Sixty Years of Victorian Literature,' etc. etc. (C. K. S.)

**SIBREE, Rev. James**; for over twenty years a missionary in Madagascar; author of 'Madagascar' in the Ninth Edition of the 'Ency. Brit.,' 'Madagascar and its People,' 'The Great African Island,' 'Madagascar before the Conquest,' etc. (J. Si*.)

**SIMPSON, Alexander Russell,** M.D.; Professor of Midwifery and the Diseases of Women and Children, University of Edinburgh; editor of Sir James Y. Simpson's 'Lectures on Diseases of Women'; author of 'Contributions to Obstetrics and Gynæcology,' and of an 'Atlas of the Frozen Section of a Cadaver in the Genu-pectoral Position' (along with Dr Berry Hart), and many Memoirs. (A. R. S.)

**SIMPSON, Rev. James Gilliland,** M.A.; Principal of Leeds Clergy School; lately Rector of St Paul's, Dundee. (J. G. Si.)

**SIMPSON, Lieut.-Col. W. A.**; Assistant Adjutant-General U.S. War Department; Instructor U.S. Military Academy, West Point, 1883-87. (W. A. S.)

**SINCLAIR, F. G.,** M.A., F.L.S.; author of many biological papers in scientific journals, etc. (F. G. S*.)

**SKINNER, Frank C.**; Principal Examiner and Chief of Classification Division, U.S. Patent Office. (F. C. S.)

**SLOANE, Thomas O'Conor,** Ph.D., A.M.; late Professor Nat. Sc., Seton Hall Coll., South Orange, N.J. (T. O'C. S.)

**SLOANE, William Milligan,** Ph.D., L.H.D., LL.D.; Professor of History, Columbia University, New York; sometime Professor of History in Princeton University, and editor of the 'Princeton Review'; Secretary to George Bancroft in Berlin, 1873-75; author of 'The French War and the Revolution,' 'Napoleon Bonaparte,' etc. (W. M. S.)

**SLOCUM, William F.,** LL.D.; President Colorado College. (W. F. S.)

**SMITH, Benjamin Eli,** A.M.; assistant editor of the 'Century Dictionary'; editor of the 'Century Cyclopædia of Names,' and of the 'Century Atlas.' (B. E. S.)

**SMITH, Hon. Charles Emory**; Postmaster-General, Washington, D.C.; formerly United States Minister to Russia; editor of the 'Philadelphia Press' since 1880. (C. E. S.)

**SMITH, George Barnett,** F.R.G.S.; author of 'Mrs Browning,' in Ninth Edition of 'Ency. Brit.,' 'Shelley,' 'Life of Mr Gladstone,' 'Victor Hugo,' 'The Life of Mr Bright,' 'The Prime Ministers of Queen Victoria,' 'Life and Enterprises of Ferdinand de Lesseps,' 'The Life of Queen Victoria,' etc. (G. B. S.)

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**SMITH, Dr Hugh M.**; in charge of Division of Inquiry respecting Food Fishes, U.S. Commission of Fish and Fisheries. (H. M. S*.)

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**SMYTH, Herbert Warington,** M.A., LL.M., F.G.S., F.R.G.S.; Sec. Mining Dept., Transvaal; Order of the White Elephant, Siam; Sec. Siamese Legation, 1898-1901; author of 'Journey on the Upper Mekong,' 'Five Years in Siam,' etc. (H. W. Sm.)

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**SÖDERBERG, Dr E.**; of the Central Statistical Bureau, Sweden; author of 'Samuel Johan Hedborn,' etc. (E. So.)

**SOULE, R. H.,** B.A., M.E.; sometime General Manager of the Erie R. R. (R. H. So.)

**PIELMANN, Marion H.**; editor of the 'Magazine of Art' since 1887; art critic to 'Daily Graphic' until, in 1891, art editor and part-founder of 'Black and White'; author of 'Works of G. F. Watts, R.A.,' 'Henriette Ronner,' 'History of "Punch,"' 'Millais and his Works,' 'The Unidentified Contributions of Thackeray to "Punch,"' 'John Ruskin,' 'Notes on the Wallace Collection in Hertford House,' 'The Portraits of Geoffrey Chaucer,' 'British Sculpture and Sculptors of To-day.' (M. H. S.)

**SPIERS, R. Phené,** F.S.A., F.R.I.B.A.; Master of the Architectural School and Surveyor of Royal Academy; Associate and Hon. Fellow of King's Coll. London; Past President of Architectural Association; Member of Council Royal Institute of British Architects; Hon. and Corres. Member of the Société Centrale des Architectes, Paris; Sociedad de los Arquitectos, Madrid; edited 'Pugin's Normandy,' 'Fergusson's History of Architecture'; author of 'Architectural Drawing,' 'Architectural Essays on Pierrefonds,' 'Domed Churches in Perigord,' 'Mosqueat Damascus,' etc. (R. P. S)

**SPRING-RICE, Stephen Edward,** C.B.; Principal Clerk H.M. Treasury; Auditor of the Civil List; private secretary to successive Financial Secretaries to the Treasury, 1881-1888, and to Chancellor of the Exchequer, 1886. (S. E. S.-R.)

**SQUIRE, William Barclay,** B.A., F.S.A., F.R.G.S.; Assist. Brit. Museum; Hon. Sec. Purcell Soc.; Joint Hon. Sec. Eng. Com. International Music Society; late musical critic of 'Westminster Gazette,' 'Saturday Review,' and 'Globe' (London); author of various articles on music; and editor of 'Byrd's Masses,' 'The Fitzwilliam Virginal Book,' etc. (W. B. S*.)

**STANTON, Rev. Vincent Henry,** D.D., M.A.; Ely Professor of Divinity, Cambridge, and Canon of Ely; Hulsean Lecturer, 1879; author of 'The Jewish and the Christian Messiah,' 'The Place of Authority in Matters of Religious Belief.' (V. H. S.)

**STATHAM, H. H.**; editor of 'The Builder'; author of 'Architecture for General Readers,' 'Architecture among the Poets.' (H. H. S.)

**STEBBING, Rev. Thomas Roscoe Rede,** M.A., F.R.S., F.L.S., F.Z.S.; Fellow of King's College, London; Fellow of Worcester Coll. Oxford; prepared Report on the Amphipoda of the 'Challenger' Expedition; Chairman of Conference of Delegates, corresponding societies of British Association, 1899, author of 'Translation of Longinus On the Sublime,' 'Essays on Darwinism,' '"Challenger" Reports,' 'Zoology,' 'A History of Crustacea,' etc. (T. R. R. S.)

**STEDMAN, Edmund Clarence,** L.H.D., LL.D.; poet and critic; author of 'Poems,' 'Victorian Poets,' 'Poets of America,' 'The Nature and Elements of Poetry'; editor of 'Library of American Literature,' 'Victorian Anthology,' etc. (E. C. S.)

**STEED, H. WICKHAM**; Correspondent of 'The Times' at Rome. (H. W. S.)

**STEPHEN, Sir Herbert,** Bart., LL.M.; Clerk of Assize for the Northern Circuit; author of 'The Law Relating to Malicious Prosecutions,' 'Prisoners on Oath,' etc. (H. S*.)

**STEPHEN, Leslie,** Litt.D., M.A.; Hon. Fellow of Trin. Hall, Camb.; President of Ethical Society; formerly Fellow and Assistant Tutor, Trin. Hall Coll., and Clark Lecturer in English Literature; editor of Cornhill Magazine, 1871-82; Dictionary of National Biography, 1882-91; author of 'Hours in a Library,' 'History of English Thought in the Eighteenth Century,' 'Essays on Freethinking and Plain Speaking,' 'The Science of Ethics,' 'Life of Henry Fawcett,' 'An Agnostic's Apology,' 'Life of Sir James Fitz-James Stephen,' 'Studies of a Biographer,' 'The English Utilitarians'; edited 'Letters of John Richard Green.' (L. S.)

**STEPHENS, F. G.** one of the Pre-Raphaelite Brotherhood; late art critic of the 'Athenæum'; author of 'Landseer' in Ninth Edition of 'Ency. Brit.,' 'Catalogue of Satires' (Brit. Mus.), 'Artists at Home,' 'George Cruikshank,' 'Memorials of W. Mulready,' 'French and Flemish Pictures,' 'Sir E. Landseer,' 'T. C. Hook, R.A.,' etc. (F. G. S.)

**STERLAND, Miss M. B.**; writer on Ecclesiastical History. (M. B. S.)

**STERLING, Maj.-Gen. John B.**; Egypt, 1882; Sudan and Cyprus, 1885. (J. B. S.)

**STEWART, John Alexander,** M.A., LL.D.; Tutor of Christ Church; White's Professor of Moral Philosophy, Oxford; author of 'The English MSS of the Nicomachean Ethics,' 'Notes on the Nicomachean Ethics.' (J. A. St.)

**STOCK, Eugene**; Editorial Secretary of the Church Missionary Society. (E. St.)

**STOCKMAN, Ralph,** M.D., F.R.C.P.Ed., F.R.S.Ed.; Professor of Materia Medica and Therapeutics, University of Glasgow; assistant in the University of Edinburgh for six years, and afterwards Lecturer on Materia Medica in the School of Medicine. (R S*.)

**STRANGE, Edward Fairbrother**; Assistant Keeper, National Art Library; Assistant, South Kensington Museum, 1889; National Art Library, 1891; author of 'Alphabets: a Handbook of Lettering,' 'Japanese Illustration,' 'Worcester, the Cathedral and City,' and numerous essays on art subjects. (E. F. S.)

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**SWINBURNE, Algernon Charles**; author of 'Beaumont and Fletcher,' 'Congreve,' 'Keats,' 'Landor,' 'Marlowe,' 'Mary' (of Scotland), 'Tourneur,' 'John Webster,' in Ninth Edition of 'Ency. Brit.,' 'The Queen-Mother, and Rosamond,' 'Atalanta in Calydon,' 'Chastelard,' 'Poems and Ballads,' 'William Blake,' 'Songs before Sunrise,' 'Bothwell,' 'Songs of Two Nations,' 'George Chapman,' 'Poems and Ballads' (2nd series), 'A Study of Shakespeare,' 'Mary Stuart,' 'Tristram of Lyonesse, and other Poems,' 'Miscellanies,' 'A Study of Victor Hugo,' 'Locrine,' 'Poems and Ballads' (3rd series), 'Study of Ben Jonson,' 'Studies in Prose and Poetry,' 'Rosamund, Queen of the Lombards,' etc. (A. C. S.)

**SYMONS, Arthur**; author of 'An Introduction to the Study of Browning,' 'Days and Nights,' 'Silhouettes,' 'London Nights,' 'Studies in Two Literatures,' 'The Symbolist Movement in Literature,' 'Images of Good and Evil,' 'Collected Poems.' (A. Sy.)

**SYMONS, H.**; British Museum. (H. Sy.)

## T

**TAIT, Peter Guthrie,** M.A., D.Sc., the late; Professor of Natural Philosophy, Edin.; Sec. Royal Soc., Edin.; Hon. Fellow St Peter's Coll., Cambridge, Professor of Mathematics, Queen's Coll., Belfast, 1854; author of 'Light,' 'Sir W. Rowan Hamilton,' etc., in Ninth Edition of 'Ency. Brit.,' 'Dynamics of a Particle,' 'Quaternions,' 'Thermo-Dynamics,' 'Heat,' 'Light,' etc. (P. G. T.)

**TANSLEY, A. G.,** M.A., F.L.S.; Asst. Professor of Botany, University Coll., London; author of 'Memoirs on the Anatomy of Plants'; editor of 'The New Phytologist,' etc. (A. G. T.)

**TAUSSIG, Frank William,** Ph.D., LL.D.; Professor of Political Economy, Harvard University, and editor of the 'Quarterly Journal of Economics'; author of 'Tariff History of the United States,' 'Wages and Labour,' etc. (F W. T.)

**TAYLOR, Charles,** M.A., D.D., Hon. LL.D. (Harvard); Master of St John's Coll., Cambridge; author of 'Geometrical Conics,' 'The Gospel in the Law,' 'The Teaching of the Twelve Apostles,' etc. (C. T*.)

**TAYLOR, Hon. Hannis,** LL.D.; U.S. Minister to Spain, 1893-97; author of 'The Origin and Growth of the English Constitution.' (H. T*.)

**TCHERTKOFF, V.**; author of 'Christian Martyrdom in Russia'; agent for Count Tolstoy in England. (V. T.)

**TEDDER, Henry Richard,** F.S.A.; Secretary and Librarian of the Athenæum Club; librarian to Lord Acton, 1873-74; one of the organisers and joint-sec. of 1st International Conference of Librarians, 1877; joint hon. sec. of Library Association, 1878-80; hon. treas. of the same, 1889-97, and 1898-1901; President, 1897-98; treas. and sec. Metropolitan Free Libraries' Committee, 1878-80; hon. treas. second International Conference of Librarians, 1897; joint-editor of first three volumes of Transactions of

Library Association, and of Reports of 1st and 2nd International Library Conference; author of 'Libraries,' etc., in Ninth Edition of 'Ency. Brit.,' and of many papers in publications of Library Association, some printed separately, articles in reviews, etc. (H. R. T.)

**TELBIN, William;** English scenic artist; author of 'Scenery,' 'Act Drops,' etc., in 'Magazine of Art,' etc. (W. TE.)

**TEMPLE, Lieut.-Col. Sir Richard Carnac,** Bt., C.I.E.; Knight of Grace; Chief Commissioner, Andaman and Nicobar Islands, and Superintendent, Penal Settlement at Port B[illegible] Afghan Campaign 1878-79; Burmah War, 1887-89; C[illegible] Magistrate, Panjab; Assistant Commissioner, Burmah, and Cantonment Magistrate, Mandalay, 1887; Deputy-Commissioner, 1888; to special duty with Government of India, 1890; Official President, Rangoon Municipality, and Port-Commissioner, Rangoon, 1891; has been member of the Council R. Asiatic Soc.; Asiatic Soc., Beng.; Cor. Member American Philosophical Socy.; Smithsonian Institute; Numismatic Socy. of Philadelphia; edited 'Fallon's Dict. of Hindustani Proverbs,' 'Burnell's Devil-Worship of the Tuluvas'; has been editor and proprietor of the 'Indian Antiquary,' since 1884; founded and edited the 'Panjab (Indian) Notes and Queries,' 1883-87. (R. C. T.)

**THAYER, William Roscoe,** A.M.; editor of 'The Harvard Graduates' Magazine'; author of 'The Dawn of Italian Independence,' 'Poems New and Old,' 'Throne Makers,' etc. (W. R. T.)

**THEOBALD, F. V.,** M.A.; Foreign Member of Association of Economic Entomologists, U.S.; Zoologist to the South-Eastern Agricultural College; Lecturer in Economic Entomology to the Horticultural College, Swanley; author of 'A Text-book of Agricultural Zoology,' 'The Parasitic Diseases of Poultry,' 'British Flies,' 'Insect Life,' etc. (F. V. T.)

**THOMPSON, Sir Edward Maunde,** K.C.B., D.C.L., LL.D., V.P.S.A.; corresponding member of the Institute of France and of the Royal Prussian Academy of Sciences; Director and Principal Librarian, Brit. Museum; Assis. Brit. Mus., 1861; Keeper of the MSS. and Egerton Librarian, 1878; Sandars Reader in Bibliography, Cambridge, 1895-96; editor of 'Chronicon Angliae'; author of 'Miniature,' 'Paleography,' etc., in Ninth Edition of 'Ency. Brit.,' 'Letters of Humphrey Prideaux,' 'Correspondence of the Family of Hatton,' 'Chronicon Adae de Usk, 1377-1404,' 'Diary of Richard Cocks in Japan, 1615-22,' 'Chronicon Galfridi le Baker de Swynebroke, 1303-1356,' 'Adae Murimuth Continuatio Chronicorum, 1303-1347,' 'Robertus de Avesbury de gestis mirabilibus Regis Edwardi Tertii': joint-editor of publications of the Palæographical Society, and of the Facsimile of the Laurentian Sophocles, 'Handbook of Greek and Latin Palæography.' (E. M. T.)

**THOMPSON, Sir Henry,** Bt., F.R.C.S., M.B., London; Surgeon Extraordinary to King of the Belgians; Com. Order of Leopold; Consulting Surgeon to University Coll. Hospital, London, and emeritus Professor of Clinical Surgery; surgeon to University Coll. Hospital, 1863; Professor of Pathology and Surgery, Royal College of Surgeons, 1884; President of the Cremation Society of England; author of 'Practical Lithotrity and Lithotomy,' 'Cremation, or Treatment of the Body after Death,' 'Modern Cremation,' 'Charley Kingston's Aunt,' 'All But,' 'On Food and Feeding,' 'Diet in Relation to Age and Activity,' etc. etc. (H. TH.)

**THOMSON, Basil P.;** Governor of Cardiff Prison; late of the Colonial Service; acted as Prime Minister of Tonga, etc.; author of 'Diversions of a Prime Minister,' 'South Sea Yarns,' etc. (B. P. T.)

**THOMSON, David Croal;** editor of 'The Art Journal'; author of 'The Life and Work of Thomas Bewick,' 'The Life and Work of H. K. Browne ("Phiz"),' 'The Barbizon School of Painters,' 'Corot,' 'Luke Fildes, R.A.,' 'The Tate Gallery,' 'Fifty Years of Art,' 'The Paris Exhibition, 1900.' (D. C. T.)

**THOMSON, Prof. Elihu;** Electrician for the General Electric Company; inventor of electric welding and other important electrical appliances. (E. T.)

**THOMSON, John Arthur,** M.A.; formerly Lecturer on Zoology and Biology, School of Medicine, Edinburgh; Regius Professor of Natural History, Aberdeen University; part-author of 'Evolution of Sex'; author of 'The Study of Animal Life,' 'Outlines of Zoology,' 'The Natural History of the Year,' 'The Science of Life,' etc. (J. A. T.)

**THOMSON, Joseph John,** D.Sc., LL.D. Glasgow and Princeton, Ph.D. Cracow, F.R.S.; Cavendish Professor of Experimental Physics, Cambridge; Fellow of Trinity College; Lecturer Trinity College; Roy. Socs. Upsala and Turin; President of Cambridge Philosophical Society, 1894; President of Section A, British Association, 1896; author of 'A Treatise on the Motion of Vortex Rings,' 'Application of Dynamics to Physics and Chemistry,' 'Recent Researches in Electricity and Magnetism,' 'Elements of the Mathematical Theory of Electricity and Magnetism,' etc. (J. J. T.)

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**THURSFIELD, James Richard,** M.A.; formerly Fellow of Jesus Coll., Oxford; author of 'Peel,' 'The Navy and the Nation,' conjointly with Sir George S. Clarke. (J. R. T.)

**THURSTON, Prof. Robert Henry,** A.M., C.E., LL.D.; Director of Sibley College, and Professor of Mechanical Engineering, Cornell University; sometime President Am. Society Mechanical Engineers; inventor of Testing Machines, etc.; author of 'Manual of the Steam Boiler,' 'History of the Steam Engine,' 'Materials of Engineering,' etc. (R. H. T.)

**THWING, Charles Franklin,** D.D., LL.D.; President Western Reserve University and Adelbert College; author of 'American Colleges,' 'The Reading of Books,' 'Within College Walls,' 'American College in American Life,' etc. (C. F. T.)

**TIEDEMANN, H.;** Anglo-Dutch journalist; ex-President of the Foreign Press Association. (H. TI.)

**TODD (J.), Spencer Brydges,** C.M.G.; Secretary Dept. of Agent-General for Cape of Good Hope in London; Executive Commissioner, Paris, for Universal Exhibition, 1878; appointed by H.R.H. Prince of Wales a member of the International Jury; author of 'The Resident Magistrate at the Cape of Good Hope,' 'Handy Guide to Laws and Regulations at the Cape of Good Hope.' (S. B. T.)

**TREBLE, Rev. Edmund John,** A.K.C.L.; Eng. Chap., Wiesbaden; author of 'Plain Teaching about the Church of England,' etc. (E. J. T.)

**TRENT, William Peterfield,** A.M., LL.D.; Prof. of English, Columbia University, New York; formerly editor of the 'Sewanee Review'; author of 'English Culture in Virginia,' 'Southern Statesmen of the Old Régime,' 'Life of William Gilmore Simms,' 'Robert E. Lee,' etc. (W. P. T.)

**TRIPP, Hon. Bartlett;** late U.S. Minister to Austria; Chief-Justice of the Supreme Court of Dakota Territory, 1885-89. (B. T.)

**TROTTER, Lieut.-Colonel Henry,** C.B.; British Delegate on the European Commission of the Danube, and H.B.M. Consul-General for Roumania; served 1863-75 on great Trigonometrical Survey of India; accompanied mission to Yarkand and Kashgar, 1873-74; special service in China, 1876; additional military attaché at Constantinople during Turko-Russian War, 1877-78; Consul for Kurdistan, 1878-82; military attaché, Constantinople, 1882-89; Consul-General in Syria, 1890-94; has acted as H.M. Chargé d'Affaires at Bucharest; author of various papers contributed to the Royal Geog. Soc. (H. TR.)

**TROUP, Charles Edward,** M.A., C.B.; Principal Clerk in the Home Office since 1896; chairman of Committee on Identification of Habitual Criminals; editor of 'Judicial Statistics of England and Wales'; author of 'The Future of Free Trade.' (C. E. T.)

**TUKE, Sir John Batty,** M.D., D.Sc., F.R.C.P.Ed., F.R.S.Ed., M.P.; Medical Superintendent, Saughton Hall Asylum, Edinburgh; Member of General Medical Council of Registration and Education; Medical Superintendent of Fife and Kinross Asylum, 1865-73; author of 'Aphasia,' 'Hippocrates,' 'Hysteria,' 'Insanity,' in Ninth Edition of 'Ency. Brit.,' 'Morrison Lectures,' 'Insanity of Over-exertion of the Brain.' (J. B. T.)

**TURNER, Cuthbert Hamilton,** M.A.; Fellow of Magdalen College, Oxford; co-editor of the 'Journal of Theological Studies.' (C. H. T.)

**TURNER, Frederick J.,** Ph.D.; Professor of American History, University of Wisconsin; author of 'Wisconsin,' in Ninth Edition of 'Ency. Brit.' (F. J. T.)

**TURNER, Herbert Hall,** D.Sc., F.R.S.; Savilian Professor of Astronomy, Oxford; Fellow of New College, Oxford; member of Senate of Cambridge University; formerly Fellow of Trin. Coll. Camb., and chief assistant Royal Observatory, Greenwich; author of 'Modern Astronomy.' (H. H. T.)

**TYLOR, Edward Burnett,** LL.D., D.C.L., F.R.S.; Professor of Anthropology, Oxford; Keeper of the University Museum since 1883; author of 'Anthropology,' 'Cannibalism,' 'Demonology,' 'Giant,' 'Magic,' etc., in Ninth Edition of 'Ency. Brit.'; 'Anahuac, Mexico and the Mexicans,' 'Researches into the Early History of Mankind,' 'Primitive Culture,' 'Anthropology,' 'The Natural History of Religion.' (E. B. T.)

## U

**UKITA, Goji;** Chancellor of the Japanese Legation, London. (G. U.)

**UNWIN, William Cawthorne,** F.R.S., M.I.C.E.; Hon. Life M.I.M.E.; Hon. Mem. Am. Soc. M.E.; Hon. Assoc. R. I. Brit. Architects; Professor of Civil and Mechanical Engineering, Central Technical College, City and Guilds of London Institute; instructor at Royal School of Naval Architecture and Marine Engineering, Kensington, 1868-72; Professor of Hydraulic Engineering, Royal Indian Engineering College, Cooper's Hill, 1872-85; Professor of Engineering, Central Technical College of the Guilds of London, Kensington, since 1885; President, Section G, British Association, 1892; on the Council of Royal Society, 1894; on the Council Inst. Civil Engineers, 1900; on the Senate London University, 1900; author of 'Hydraulics,' etc., in Ninth Edition of 'Ency. Brit.,' 'Wrought Iron Bridges and Roofs,' 'Machine Design,' 'The Testing of Materials of Construction,' 'The Development and Transmission of Power from Central Stations,' etc. (W. C. U.)

## V

**VAN DYKE, Prof. Henry,** D.D., LL.D.; Professor of English Literature, Princeton University; author of 'The Poetry of Tennyson,' 'Little Rivers,' 'The Gospel for an Age of Doubt,' 'The Toiling of Felix, and other Poems,' etc. (H. VAN D.)

**VAN DYKE, John Charles,** L.H.D.; author of 'History of Painting,' 'Old Dutch and Flemish Masters,' etc. (J. C. VAN D.)

**VASCONCELLOS, Captain Ernesto de;** Secretary of the Committee of Colonial Cartography, Department of Marine and Fisheries, Portugal; Secretary of the Lisbon Geographical Society; author of 'As Colonias Portuguesas,' etc. (E. DE V.)

**VAUGHAN, H.E. Herbert, Cardinal,** D.D., Priest of the Title of SS. Andrew and Gregory on the Coelian Hill; Archbishop of Westminster; Bishop of Salford, 1872-92; author of a large number of pamphlets and letters concerning educational, social, and religious questions, etc. (✠H. E. V.)

**VERDINOIS, Frederigo;** Italian man of letters; translated 'Cantico di Natale' and 'La Piccola Dorrit' from Dickens, Shakespeare's 'Midsummer Night's Dream,' etc. (F. V.)

**VERNON-HARCOURT, Leveson Francis,** M.A., M.I.C.E.; Professor of Civil Engineering at Univ. Coll. London; proceeded to India, 1896, to inspect the river Húgli, reporting to Calcutta Port Commissioners; British Member of Jury for Civil Engineering, Paris Exhibition, 1900; author of 'River Engineering,' 'Water Supply,' in Ninth Edition 'Ency. Brit.,' 'Rivers and Canals,' 'Harbours and Docks,' 'Achievements in Engineering,' 'Civil Engineering as applied in Construction,' etc. (L. F. V.-H.)

**VERWORN, Max,** M.D., Ph.D.; Professor of Physiology, Jena, author of 'Allgemeine Physiologie,' 'Psycho-physiologische Protisten-Studien,' etc. (M. V.)

**VETCH, Col. Robert Hamilton,** R.E., C.B.; employed on defences of Bermuda, Bristol Channel, Plymouth Harbour, and Malta, 1861-1876; Secretary of R.E. Institute, Chatham, 1877-1883; commanded R.E. Submarine Mining Batt., 1884; Assistant Inspector-General of Fortifications at War Office, 1884-89; Deputy Inspector-General of Fortifications and Secretary of the Defence Committee, and of the Joint Naval and Military Committee on Defence, War Office, 1889-94; Chief Engineer in Ireland and Colonel on Staff, 1894-98; author of 'Gordon's Campaign in China,' 'Life of Lieut.-Gen. Sir Gerald Graham'; edited 'The Professional Papers of the Corps of R.E.'; also the 'R.E. Journal,' 1877-84. (R. H. V.)

**VILLARS, Paul;** Knight of the Legion of Honour; and London Correspondent of 'Le Journal des Débats,' 'Le Figaro,' etc.; author of 'Sketches of England,' 'Scotland and Ireland,' etc. (P. V*.)

**VINELLI, Dr Marcello;** editor of 'La Unione Sarda,' Cagliari, Sardinia. (M. VI.)

**VINES, Sydney Howard,** D.Sc. London, M.A., D.Sc. Camb., F.R.S.; President of the

Linnean Society of London; Sherardian Professor of Botany, Oxford; Fellow of Magdalen College; Fellow and Lecturer of Christ's Coll. Cambridge, 1876; Reader in Botany, Cambridge, 1883; Hon. Fellow of Christ's Coll. Cambridge, 1897; author of 'Reproduction,' etc., in Ninth Edition of 'Ency. Brit.,' 'Lectures on the Physiology of Plants,' 'A Student's Text-Book of Botany,' papers in various scientific journals, etc. (S. H. V*.)

## W

**WAALS, J. D. van der**; Doctor of Math. and Physics, Leyden; Professor of Physics, Amsterdam; Gen. Sec. Royal Academy of Sciences, Amsterdam; Cor. Member de l'Académie des Sciences de Paris, etc.; author of 'The Continuity of the Gaseous and Liquid States of Matter,' etc. (J. D. v. D. W.)

**WADSWORTH, S.**, M.A.; Barrister-at-Law, of the Inner Temple and of Lincoln's Inn; joint-editor of the 17th edition of Davidson's 'Concise Precedents in Conveyancing.' (S. WA.)

**WAGER, Harold W. T.**, F.L.S.; formerly Lecturer in Biology, Yorkshire Coll. Leeds; H.M. Inspector of Science Schools; author of 'Memoirs on Cytology and Reproduction of the Lower Organisms,' etc. (H. W*.)

**WAGNER, Dr Hermann**; Professor of Geography in Göttingen University; author of 'Germany (Geography)' in Ninth Edition of 'Ency. Brit.,' 'Lehrbuch der Geographie,' editor 'Geographisches Jahrbuch,' etc. (H. WA.)

**WALDSTEIN, Charles**, Litt.D., Ph.D., L.H.D.; Knight Commander of the Order of the Redeemer; and Ernestine Saxon Order; Fellow of King's College, Cambridge, 1894; member of Council of British Archæological School, Athens, etc.; Lecturer in Classical Archæology in Univ. of Camb., 1880; Director of Fitzwilliam Museum, Camb., 1883-89; Director of American Archæological School, Athens (retaining Readership at Camb.), 1889-1893, retaining Professorship there till 1896; Slade Professor of Fine Art, 1895-1901; author of 'Balance of Emotion and Intellect,' 1878, 'Essays on the Art of Phidias,' 1885, 'The Work of John Ruskin,' 1894, 'The Study of Art in Universities,' 1895, 'The Expansion of Western Ideals' and the 'World's Peace,' 1899, 'The Jewish Question' and the 'Mission of the Jews,' 1899, and numerous reports of excavations and archæological memoirs. (C. W*.)

**WALKER, James**, D.Sc., F.R.S.; Professor of Chemistry, University College, Dundee. (J. WAL.)

**WALKER, Norman**, M.B., F.R.C.P.; Assistant Physician of Edinburgh Infirmary; part author of 'An Introduction to Dermatology.' (N. W.)

**WALLACE, Sir Donald Mackenzie**, K.C.I.E., K.C.V.O.; Private Secretary to Marquesses of Dufferin and of Lansdowne as Viceroys of India, 1884-89; attached to the Czarewitch as political officer during his tour in India and Ceylon, 1890-91; Director of the Foreign Department of 'The Times,' 1891-99; Assist. Private Secy. to H.R.H. the Duke of Cornwall and York during his colonial tour, 1901; member of Institut de Droit International and Officier de l'Instruction Publique of France; joint-editor of New Volumes of 'Encyclopædia Britannica"; author of 'Russia,' 'Egypt and the Egyptian Question,' etc. (D. M. W.)

**WALLACE, William**, M.A., LL.D.; assistant editor of the 'Glasgow Herald'; author of 'Burns and Mrs Dunlop,' 'Scotland Yesterday'; edited 'Chambers's Life and Works of Burns,' etc. (W. WA.)

**WALLIS, John Edward Power**, M.A.; Advocate-General of Madras; Inns of Court Reader in Constitutional Law, 1892-97; author of 'State Trials' for the State Trials Committee, and numerous articles on constitutional law and history. (J. E. P. W.)

**WALPOLE, Sir Spencer**, K.C.B., Hon. LL.D. Edin.; Inspector of Fisheries, 1867; Lieut.-Governor of the Isle of Man, 1882; Secretary to the Post Office, 1893-99; author of 'History of England from 1815,' 'Life of Rt. Hon. Spencer Perceval,' 'Life of Lord John Russell,' 'The Electorate and the Legislature,' 'Foreign Relations,' 'The Land of Home Rule. (S. W.)

**WALTON, Hon. Sir Joseph**, K.C.; Judge of the King's Bench Div.; chairman of the General Council of the Bar, 1899; Recorder of Wigan, 1895-1901; author of 'Practice and Procedure of Court of Common Pleas at Lancaster.' (W.)

**WARD, H. Marshall**, D.Sc., F.R.S, F.L.S., F.R.Hort.S.; Professor of Botany, Cambridge; Fellow of Sidney Sussex College, Cambridge; Hon. Fellow of Christ's College, Cambridge; President of the British Mycological Society; corresponding Member Cryptogamic Society of Scotland; Cryptogamic Botanist to Ceylon Government, 1880-82; Berkeley Fellow, Owens Coll., 1882; Fellow of Christ's Coll., 1883; Professor of Botany in Forest School, Cooper's Hill, 1885-95; author of 'Schizomycetes' in Ninth Edition of 'Ency. Brit.,' 'Timber and some of its Diseases,' 'The Oak,' 'Sachs' Lectures on the Physiology of Plants,' 'Laslett's Timber and Timber Trees,' 'Diseases of Plants,' 'Grasses,' 'Disease in Plants.' (H. M. W.)

**WARD, James**, M.A., LL.D., D.Sc.; Fellow of Trin. Coll. Camb. and Professor of Mental Philosophy, Cambridge; Gifford Lecturer, University of Aberdeen, 1895-97; author of 'Herbart,' 'Psychology,' in Ninth Edition of 'Ency. Brit.,' 'Naturalism and Agnosticism.' (J. W*.)

**WARD, Robert de C.**, A.M.; Instructor in Climatology Harvard University. (R. DE C. W.)

**WATERHOUSE, Major-Gen. James**; Unemployed Supernumerary List, Indian Staff Corps; Vice-President Roy. Phot. Soc.; Hon. Mem. Vienna Phot. Soc. 1901; Indian Ordnance Dept. 1866; Assist. Surveyor-Gen. in charge of photographic operations in the Surveyor-General's Office, Calcutta, 1866-97; took part in the observation of total eclipses, 1871 and 1875, and of transit of Venus, 1874; President of the Asiatic Society of Bengal, 1888-90; awarded Roy. Phot. Soc. Progress Medal, 1890, also Vienna Phot. Soc. Voigtlander Medal, 1895; author of 'The Preparation of Drawings for Photographic Reproduction,' and numerous papers in the 'Bengal Asiatic Society's Journal' and various photographic journals and publications. (J. WA*.)

**WATSON, Alfred Edward Thomas** ('Rapier'); editor of the 'Badminton Library' and 'Badminton Magazine'; musical and dramatic critic of the 'Standard'; edited the 'Illustrated Sporting and Dramatic News,' writing under the signature 'Rapier,' 1880-95; author of 'Sketches in the Hunting Field,' 'Race Course and Covert Side,' 'Types of the Turf,' 'Steeplechasing,' chapters in the Badminton volumes on Hunting, Riding and Driving, Racing and Chasing, 'The Turf,' etc. (A. E. T. W.)

**WATSON, Colonel Charles Moore**, C.M.G., M.A.; Deputy Inspector-General of Fortifications, War Office; served in Sudan under the late Gen. C. G. Gordon, C.B., 1874-1875; A.D.C. to Field-Marshal Sir Lintorn Simmons, G.C.B., 1878-80; employed in Indian Office, 1880-82; special service, Egyptian War, 1882; employed in Egyptian Army, 1882-86, with rank of Pasha (3rd class Osmanieh), Assistant Inspector-General of Fortifications, 1891-96; Deputy Inspector-General 1896. (C. M. W.)

**WATTS, Philip**, F.R.S.; Director of Naval Construction; formerly Naval Architect and Director of War Shipbuilding Department of Sir W. G. Armstrong, Whitworth and Co. (P. WA.)

**WATTS-DUNTON, Theodore**; poet, novelist, and critic; author of 'Poetry,' 'Rossetti,' 'Sonnet,' 'Vanbrugh,' 'Wycherley,' etc., in Ninth Edition of 'Ency. Brit.,' 'The Coming of Love,' 'Aylwin'; edited 'Lavengro,' etc. (T. W. D.)

**WAUGH, Arthur**; London Correspondent to the 'New York Critic,' 1893-97; literary adviser to Kegan Paul and Co. Ltd.; author of 'Gordon in Africa,' 'Alfred, Lord Tennyson'; edited 'Johnson's Lives of the Poets'; edited the 'Pamphlet Library,' 'Legends of the Wheel,' 'Robert Browning.' (A. WA.)

**WEBB, Gen. Alexander Stewart**; President of the College of the City of New York; Brig.-Gen. of Volunteers in the Civil War; author of 'The Peninsula,' 'M'Clellan's Campaign of 1862,' etc. (A. S. W*.)

**WEBBER, Maj.-Gen. C. E.**, C.B., M.I.C.E., M.I.E.E.; Indian Mutiny, 1857-60; instructor in topography, R.M.A.; with Prussian Army in 1866; Paris Exhibition, 1867; Egyptian expedition, 1882; Nile expeditions, 1884-85; founder (with late Sir Francis Bolton) and past President of the Institution of Electrical Engineers; author of various articles on military subjects, Telegraphy, Telephony, and Electrical Engineering. (C. E. W.)

**WEBER, Gustavus A.**; U.S. Dept. of Labour, Washington, D.C. (G. A. W.)

**WEDMORE, Frederick**; art critic of the 'Standard,' London; author of 'Pastorals of France,' 'Renunciations,' 'English Episodes,' and 'Orgeas and Miradou,' with other short stories and imaginative pieces; 'The Life of Balzac,' 'Studies in English Art,' 'Méryon,' 'Etching in England,' 'Fine Prints: On Books and Arts,' 'The Collapse of the Penitent.' (F. WE.)

**WELCH, Lewis S.**, A.B.; editor of the 'Yale Alumni Weekly.' (L. S. W.)

**WELDON, Walter F. R.**, M.A., D.Sc., F.R.S.; Linacre Professor of Comparative Anatomy, Oxford; late Fellow of St John's Coll. Cambridge; late Jodrell Professor of Comparative Anatomy and Zoology, University Coll. London. (W. F. R. W.)

**WELLS, Joseph**, M.A.; Fellow and Tutor, Wadham College, Oxford; Delegate of Local Examinations, for Extension of University Teaching and for Training of Teachers; on Oxford and Cambridge Schools Examining Board; author of 'A Short History of Rome,' 'Oxford and its Colleges,' 'Wadham College.' (J. WE*.)

**WELLS, Captain Lionel de Lautour**, R.N.; Chief Officer, Metropolitan Fire Brigade; author of 'Jack Afloat,' 'M.F.B. Drill-book.' (L. DE L. W.)

**WESTLAKE, John**, K.C., LL.D.; Professor of International Law, Cambridge; author of 'A Treatise on Private International Law, or the Conflict of Laws,' 'Chapters on the Principles of International Law.' (JNO. WE.)

**WETHERELL, W.**; assistant editor, 'Liverpool Daily Post.' (W. WE.)

**WHATES, H.**; assistant editor of the 'Standard'; editor of the 'Politician's Handbook.' (H. WH.)

**WHEATLEY, Henry Benjamin**; Asst. Secretary, Society of Arts, Assistant Sec. Brit. Royal Commission, Section of Chicago Exhibition, 1893; Hon. Sec. Early English Text Society, 1864-72; Treasurer, 1872-1901; author of 'Index,' etc., in Ninth Edition of 'Ency. Brit.,' 'Anagrams,' 'Round about Piccadilly and Pall Mall,' 'What is an Index?' 'Samuel Pepys and the World he lived in,' 'How to form a Library,' 'How to Catalogue a Library,' 'London Past and Present,' 'New Edit. Pepys' Diary,' 'Historical Portraits,' 'Prices of Books,' 'Pepysiana,' etc. (H. B. W*.)

**WHEELER, Maj.-Gen. Joseph**; Member of U.S. Congress, 1881-99; Lieut.-Gen. and Senior Cavalry General of the Confederate Armies in the Civil War; in charge of the cavalry under Gen. Joseph E. Johnston; Maj.-Gen. of Volunteers, U.S.A., Span.-American War. (J. WH.)

**WHETHAM, William Cecil Dampier**, M.A., F.R.S.; Fellow of Trinity Coll. Cambridge; Lecturer on Physics, Cambridge; author of various papers on scientific subjects, and of text-book on 'Solution and Electrolysis,' etc. (W. C. D. W.)

**WHITAKER, Edgar**; editor of the 'Constantinople Messenger'; author of 'The Outlook in Asiatic Turkey'; translated Giacometti's 'Russia's Work in Turkey,' etc. (E. W*.)

**WHITE, Horace**; editor of the N.Y. 'Evening Post'; sometime editor of the 'Chicago Tribune'; author of 'The Silver Question,' 'The Tariff Question,' 'Money and Banking,' 'The Gold Standard,' etc. (H. WH*.)

**WHITE, James**; Department of the Interior, Ottawa. (J. WH*.)

**WHITE, James Forbes**, M.A., LL.D.; art critic; author of 'Rembrandt,' 'Velasquez,' in the Ninth Edition of the 'Ency. Brit.' (J. F. W.)

**WHITFELD, W. H.**; successor to 'Cavendish' on the 'Field.' (W. H. W*.)

**WHYTE, Frederic W.**; author and dramatic critic; author of 'Actors of the Century'; trans. of A. Filon's 'English Stage,' etc. (F. W. W.)

**WILHELM, C.**; designer of theatrical spectacle; author of 'Essays on Ballet and Spectacle,' etc. (C. WI.)

**WILKINSON, Henry Spenser**, M.A., on staff of the 'Morning Post'; author of 'Citizen Soldiers,' 'Essays on the War Game,' 'Exercises in Strategy and Tactics' (from the German), 'The Command of Artillery in the Army Corps and the Infantry Division' (from the German), 'The Brain of an Army,' 'The Volunteers and the National Defence,' 'Imperial Defence' (in collaboration with Sir Charles Dilke), 'The Great Alternative, a Plea for a National Policy,' 'The Command of the Sea,' 'The Brain of the Navy,' 'British Policy in South Africa,' 'Lessons of the War,' 'War and Policy.' (H. S. W.)

**WILLCOX, Walter F.**, LL.B., Ph.D; Chief Statistician, U.S. Census Bureau; Professor of Social Science and Statistics, Cornell University; Member of the American Social Science Association, and Secretary of the American Economical Association; author of 'The Divorce

Problem: A Study in Statistics,' 'Social Statistics of the United States,' etc. (W. F. W.)

**WILLEY, A.,** D.Sc. (A. W*.)

**WILLIAMS, Aneurin;** author of 'Relation of Co-operative Movements to National and International Commerce,' etc. (A. Wi*.)

**WILLIAMS, E. H.,** M.D.; formerly Associate Professor of Pathology, State University of Iowa; and Assistant Physician at the Hospital for the Insane, Matteawan, N.Y., and at the Manhattan State Hospital, N.Y. (E. H. W.)

**WILLIAMS, Sir E. Leader;** consulting engineer Manchester Ship Canal; engaged as engineer since 1846 on the works of the Great Northern Railway, Shoreham and Dover Harbours, River Weaver and Bridgwater Canal Navigations; chief engineer of the Manchester Ship Canal during its construction; Member of Council of Institution of Civil Engineers; author of papers printed in 'Proceedings of Institution of Civil Engineers.' (E. L. W.)

**WILLIAMS, Henry Smith,** M.D., B.Sc.; former lecturer in the Hartford School of Sociology, U.S.A.; editor of forthcoming 'History of the World' in 25 volumes; author of 'The Story of Nineteenth Century Science,' 'The History of the Art of Writing,' 'The Lesson of Heredity,' etc. (H. S. W*.)

**WILLIAMS, R. Vaughan,** B.A.; Mus. Doc., Trinity College, Cambridge. (R. V. W.)

**WILLIAMS, Talcott;** editor of the 'Philadelphia Press.' (T. W*.)

**WILLSON, Beckles;** staff of 'Boston Globe,' U.S.A., 1887; correspondent in Cuba, 1888; editor, 'Press of Atlanta,' Georgia, 1889; staff of 'New York Herald,' 1890; staff of 'London Daily Mail,' 1896-98; author of 'Harold: an Experiment,' 1891, 'Drift,' 1893, 'The Tenth Island,' 1897, 'The Great Company,' 1899. (B. W*.)

**WILSON, Maj.-Gen. Sir Charles William,** R.E., K.C.B., K.C.M.G., D.C.L., LL.D., F.R.S.; secretary to North American Boundary Commission, 1858-62; surveys of Jerusalem and Palestine, 1864-66; Ordnance Survey of Scotland, 1866-68; survey of Sinai, 1868-69; director Topographical Department W.O., and A.Q.M.G. Intelligence Department, 1869-76; Ordnance Survey of Ireland, 1876-78; Royal Commission on Registration of Deeds and Insurances in Ireland, 1878; British Commissioner Servian Boundary Commission, 1878-79; Consul-Gen. Anatolia, 1879-82; special mission to Eastern Rumelia, 1880; and to Consulates in Asiatic Turkey, 1881; special service in Egypt and attached to Lord Dufferin's mission, 1882-1883; D.A.G. (Intelligence Department) Nile Expedition, 1884-85; Ordnance Survey of Ireland, 1885-86; Director-Gen. Ordnance Survey, 1886-94; Director-Gen. of Military Education, 1895-98; president Geographical Section British Association, Belfast, 1874; Bath, 1888; Vice-President Royal Geographical Society, 1897-1901; author of 'Notes to Ordnance Survey of Jerusalem,' 'Notes to Ordnance Survey of Sinai' (part), 'Picturesque Palestine' (Jerusalem vol.), 'From Korti to Khartûm,' 'Life of Lord Clive,' Murray's Handbooks to 'Constantinople' and 'Asia Minor.' (C. W. W.)

**WILSON, W. J.;** of the Canadian Geological Survey. (W. J. W.)

**WINTER, Miss E. G.;** contributor to 'The Times' Gazetteer. (E. G. W.)

**WOLCOTT, Hon. Roger,** the late; Governor of Massachusetts, 1897-99. (R. Wo.)

**WOLF, Lucien;** sub-editor and leader-writer, 'Jewish World,' 1874-93; staff of 'Daily Graphic'; London correspondent, 'Le Journal,' Paris; Fellow of Inst. of Journalists; first President and now Vice-President of Jewish Historical Society of England; author of 'Sir Moses Montefiore'; joint-editor with Joseph Jacobs of 'Bibliotheca Anglo-Judaica'; 'Menasseh B. Israel's Mission to Oliver Cromwell'; many essays on foreign and colonial politics in 'Fortnightly Review,' 'Nineteenth Century,' and other magazines. (L. W.)

**WOLFF, Rt. Hon. Sir Henry Drummond,** G.C.B., G.C.M.G.; Ambassador-Extraordinary and Plenipotentiary at Madrid, 1892-1900; author of a 'Life of Napoleon at Elba'; 'Memnon Letters on the Suez Canal,' 'Some Notes of the Past.' (H. D. W.)

**WOOD, General Sir Evelyn,** G.C.B., G.C.M.G., V.C.; commanding 2nd Army Corps; entered Navy, 1852; served in Crimea with Naval Brigade, 1 Oct. 1854 to 18 June 1855; Knight of Legion of Honour, Medjidieh, Turkish medal; Ashantee, Kaffir, Zulu, and Transvaal Wars, 1879-81; commanded Chatham District, 1882-83; 2nd Brigade (2nd Division) Expedition to Egypt, 1882; raised the Egyptian Army, 1883; served in Nile Expedition, 1894-95; commanded Eastern District, 1886-88; Aldershot Division, 1889-93; Quartermaster-Gen. to the Forces, 1893-97; Adjutant-General to Forces, 1897-1901; author of 'The Crimea in 1854-94,' 'Cavalry at Waterloo,' 'Achievements of Cavalry.' (E. Wo.)

**WOODBERRY, George Edward,** A.B.; Professor of English Literature, Columbia University, New York; author of 'The North Shore Watch,' 'Life of E. A. Poe,' 'Heart of Man,' 'Studies in Letters and Life,' 'Makers of Literature,' etc. (G. E. W.)

**WOODHEAD, German Sims,** M.A. M.D. Edin., F.R.C.P.Ed., F.R.S.Ed.; Fellow of Trinity Hall, Cambridge; Prof. of Pathology, Cambridge Univ., since 1899; formerly Director of the Laboratories of the Conjoint Board of the Royal Colleges of Physicians (London) and Surgeons (England); President Royal Medical Society; acted as Assistant Commissioner to the Royal Commission on Tuberculosis, 1892-95; Surgeon-Capt. Volunteer Medical Staff Corps; author of 'Practical Pathology,' 'Pathological Mycology' (with Arthur W. Hare, M.B.), 'Bacteria and their Products,' 'Report to the Royal Commission on Tuberculosis,' 'Report on Diphtheria' to the Metropolitan Asylums Board; editor of the 'Journal of Pathology and Bacteriology.' (G. S. W.)

**WOODWARD, Arthur Smith,** F.R.S., Hon. LL.D. (Glasgow); Asst. Keeper of Geology, British Museum; author of 'Cat. of Fossil Fishes in the British Museum,' 'Outlines of Vertebrate Palæontology,' etc. (A. S. Wo.)

**WOOLSEY, Theo. S.,** LL.D.; Professor of International Law, Yale University; editor of 'Woolsey's International Law' (6th ed.), and of 'Pomeroy's International Law'; author of 'America's Foreign Policy.' (T. S. W.)

**WORCESTER, Dean Conant;** Assistant Professor of Zoölogy, University of Michigan; Member of the First and Second U.S. Philippines Commission; author of 'The Philippine Islands and their People.' (D. C. W.)

**WRIGHT, Hon. Carroll Davidson;** U.S. Commissioner of Labour; author of 'Factory System of the United States,' 'Strikes and Lock-outs,' 'Cost of Production of Iron, Steel, etc.,' 'Industrial Evolution of the United States,' 'Outline of Practical Sociology,' etc. (C. D. W.)

**WRIGHT, Charles Theodore Hagberg,** B.A., LL.D.; Secretary and Librarian, London Library; Assistant Librarian, National Library of Ireland, 1890-93. (C. T. H. W.)

**WRIGHT, Lewis;** author of 'The Book of Poultry,' 'The Practical Poultry Keeper,' 'The Poultry Club Standards'; editor of 'Fulton's Book of Pigeons,' etc. (L. Wr.)

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## Y

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